ST. CHARLES COUNTY
STANDARD SPECIFICATIONS
FOR
SUBDIVISION STREET CONSTRUCTION

February, 2014

St. Charles County Highway Department
St. Charles, Missouri
SECTION 200

EARTHWORK

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Division 200

EARTHWORK
SECTION 201
CLEARING AND GRUBBING

201.1 Description. This work shall consist of clearing, grubbing, removing, and disposing of vegetation within the limits of right-of-way and easement areas, except such vegetation as is designated to remain or to be selectively treated.

Should grave sites be found during clearing or grading, the contractor will stop all construction work in the immediate area and notify the County Engineer.

Parking meters and posts located within the construction limits shall be removed and stored at locations designated by the engineer. Parking meters damaged by removal will be repaired or replaced by the contractor at no additional cost to the County.

Existing fencing located within the construction limits shall be removed and stored at locations designated by the engineer.

201.2 Construction Requirements.

201.2.1 The engineer will establish right-of-way and construction lines and will designate all trees, shrubs, and plants that are to remain. The engineer will also designate the trees, shrubs, and plants, in developed or undeveloped areas, that are to be removed and are not designated on the plans. No tree shall be removed from developed areas without express approval of the engineer. The contractor shall preserve without damage the vegetation designated to remain. All trees, stumps, brush, and hedge not designated to remain shall be cleared, grubbed, or cleared and grubbed as required and shall be disposed of in an acceptable manner.

201.2.2 Stumps and roots in cut areas shall be grubbed to a depth of not less than 300 mm (12 in.) below the finished earth grade. Grubbing of Osage orange or locust hedge shall include removal of roots. In embankment areas, undisturbed stumps and roots extending not more than 150 mm (6 in.) above the ground line may remain, provided they are a minimum of 1.0 m (3 ft.) below the finished earth grade or the slope of the embankment. Except in areas to be excavated, stump holes shall be backfilled with suitable material and compacted to the approximate density of the adjacent area. In lieu of grubbing, stumps outside of the slope stake limits may be cut off not more than 75 mm (3 in.) above the ground. Grubbing of borrow areas, channel changes, and inlet and outlet easements will be required only to the extent necessitated by the proposed construction.

201.2.3 The contractor shall dispose of combustible materials in accordance with all applicable County, State, and Federal regulations. When burning is permissible under controlling air pollution regulations, all burning of products of clearing and grubbing shall be done under the care of a competent watchman at such times and in such manner that neither vegetation on adjacent property nor that designated to remain within the construction limits will be
jeopardized. The burial of stumps and debris will not be permitted in the construction limits. Products of clearing and grubbing may be removed from the construction limits and disposed of out of sight from the roadway provided an acceptable written agreement with the property owner on whose property the products are placed is submitted by the contractor.

201.2.4 All timber not designated to remain and that has not been removed from the right-of-way prior to the beginning of construction shall become the property of the contractor. Low hanging and unsound or unsightly branches on trees or shrubs designated to remain shall be removed as directed and in accordance with good tree surgery practices.

201.2.5 The contractor shall scalp all areas where excavation or embankment is to be made, except that mowed, burned over sod need not be removed where the embankment to be constructed is 1.2 m (4 ft.) or more in height. Scalping shall include the removal of material such as sod, grass, residue of agricultural crops, sawdust, and decayed vegetable matter from the surface of the ground without removing more earth than is necessary. The products of scalping shall be deposited at the toe of embankments where such areas are available within the limits of the roadway balance affected. If such areas are not available, the products shall be suitably removed in accordance with Sec 201.2.3.

201.2.6 Cemetery headstones to be removed shall be tagged, marked, and stored in a safe location to prevent breakage or vandalism. Care will be taken to adequately identify the grave-site and its headstone for resetting of the headstones after construction has been completed.

201.2.7 After construction has been completed, each mailbox shall be permanently reset at locations as hereinafter specified:

(1) Reset the mailbox laterally with front face 50 mm (2 in.) from the edge of the pavement, and 1.1 m (42 in.) above the elevation of the edge of pavements with no curb.

(2) Reset the mailbox laterally with front face 2.1 m (7 ft.) from the edge of the pavement at mailbox turnouts in the roadway shoulder, and 1.1 m (42 in.) above the elevation of the edge of the pavement.

(3) At sidewalks and curbs, reset the mailbox laterally with front face 0.3 m (1 ft.) from the outside edge of the sidewalk or curb, and 1.1 m (42 in.) above the elevation of the finished grade.

(4) Special locations for mailboxes will be designated on the plans. No direct payment will be made for this work.

201.3 Method of Measurement.

201.3.1 No separate measurement will be made for clearing and for grubbing. Payment will be on a lump sum basis.
201.4 Basis of Payment.

201.4.1 The accepted quantities of clearing and grubbing will be paid for at the unit bid price, per lump sum.

201.4.2 Exclusions. When no pay item for clearing or grubbing is included in the contract, clearing and grubbing, including scalping, will be considered incidental to the work and no direct payment will be made.

201.4.3 Payment for cemetery headstones will be made at a lump sum bid price for special item entitled “Tagging, Marking, Removing and Resetting Headstone.”

201.4.4 No special payment will be made for removal and storage of salvageable items.

201.10 Temporary Project Water Pollution Control. (Soil Erosion)

201.11 Description. This work shall consist of temporary control measures as shown on the plans or ordered by the engineer during the life of the contract to control water pollution, through use of berms, dikes, dams, sediment, basins, fiber mats, netting, gravel, mulches, grasses, slope drains, and other erosion control devices or methods.

The temporary pollution control provisions contained herein shall be coordinated with the permanent erosion control features specified elsewhere in the contract to the extent practical to assure economical, effective, and continuous erosion control throughout the construction and post-construction period.

201.12 Materials. All material shall conform to Division 1000, Materials Details, as specified:

(a) Mulches may be hay, straw, fiber mats, netting, wood cellulose, corn or tobacco stalks, bark, corn cobs, wood chips, or other suitable material acceptable to the engineer and shall be reasonably clean and free of noxious weeds and deleterious materials.

(b) Slope drains may be constructed of pipe, fiber mats, rubble, portland cement concrete, bituminous concrete, plastic sheets, or other material acceptable to the engineer that will adequately control erosion.

(c) Grass shall be a quick growing species (such as rye grass, Italian rye grass, or cereal grasses) suitable to the area providing a temporary cover which will not later compete with the grasses sown later for permanent cover.

(d) Fertilizer and soil conditioners shall be a standard commercial grade, acceptable to the engineer.

(e) Others as specified by the engineer.
201.13 Construction Requirements.

201.13.1 The engineer has the authority to limit the surface area of erodible earth material exposed by clearing and grubbing, the surface area of erodible earth material exposed by excavation, borrow, and fill operations and to direct the contractor to provide immediate permanent or temporary pollution control measures to prevent contamination of adjacent streams or other watercourses, lakes, ponds, or other areas of water impoundment. Such work may involve the construction of temporary berms, dikes, dams, sediment basins, slope drains, and use of temporary mulches, mats, seeding or other control devices or methods as necessary to control erosion. Cut slopes shall be seeded and mulched as the excavation proceeds to the extent considered desirable and practicable.

201.13.2 At the preconstruction conference or prior to the start of the applicable construction, the contractor shall submit for acceptance his schedules for accomplishment of temporary and permanent erosion control work, as are applicable for clearing and grubbing, grading, bridges, and other structures at watercourses, construction, and paving. He shall also submit for acceptance his proposed method of erosion control on haul roads and borrow pits and his plan for disposal of waste materials. No work shall be started until the erosion control schedules and methods of operations have been accepted by the engineer.

201.13.2.1 The engineer may increase or decrease the amount of surface area of erodible earth material to be exposed at one time by clearing and grubbing, excavation, borrow, and fill operations as determined by his analysis of project conditions.

201.13.3 In the event of conflict between these requirements and pollution control laws, rules, or regulations of other Federal or State or local agencies, the more restrictive laws, rules, or regulations shall apply.

201.13.4 The contractor will be required to incorporate all permanent erosion control features into the project at the earliest practicable time as outlined in his accepted schedule. Temporary pollution control measures will be used to correct conditions that develop during construction that were not foreseeable during the design stage; that are needed prior to installation of permanent pollution control features; or that are needed temporarily to control erosion that develops during normal construction practices, but are not associated with permanent control features on the project.

201.13.5 Where erosion is likely to be a problem, clearing and grubbing operations should be so scheduled and performed that grading operations and permanent erosion control features can follow immediately thereafter if the project conditions permit; otherwise, temporary erosion control measures may be required between successive construction stages. Under no conditions shall the surface area of erodible earth material exposed at one time by clearing and grubbing exceed 70,000 m² (750,000 sq. ft.) without approval by the engineer.

201.13.6 The engineer will limit the area of excavation, borrow, and embankment operations in progress to commensurate with the contractor’s capability and progress in keeping the finish grading, mulching, seeding, and other such permanent pollution control measures current in accordance with the accepted schedule. Should seasonal limitations make such
coordination unrealistic, temporary erosion control measures shall be taken immediately to the extent feasible and justified.

201.13.7 Under no conditions shall the amount of surface area of erodible earth material exposed at one time by excavation, borrow, or fill within the right-of-way exceed 70 000 m² (750,000 sq. ft.) without prior approval by the engineer.

201.14 Method of Measurement and Basis of Payment.

201.14.1 In the event that temporary erosion and pollution control measures are required due to the contractor’s negligence, carelessness, or failure to install permanent controls as a part of the work as scheduled, and are ordered by the engineer, such work shall be performed by the contractor at his own expense. Temporary erosion and pollution control work required, which is not attributed to the contractor’s negligence, carelessness or failure to install permanent controls, will be performed as ordered by the engineer.

201.14.2 Where the work to be performed is not attributed to the contractor’s negligence, carelessness, or failure to install permanent controls and falls within the specifications for a work item that has a contract price, the units of work shall be paid for at the proper contract price. Should the work not be comparable to the project work under the applicable contract items, the contractor shall be ordered to perform the work on a force account basis, or by agreed unit prices.

201.14.3 In case of repeated failures on the part of the contractor to control erosion, pollution, and/or siltation, the engineer reserves the right to employ outside assistance or to use his own forces to provide the necessary corrective measures. Such incurred direct costs plus project engineering costs will be charged to the contractor and appropriate deductions made from the contractor’s monthly progress estimate.

201.14.4 The contractor may be required to establish temporary pollution control measures at his own expense in keeping with the intent of these requirements on work outside the right-of-way where such work is necessary as a result of roadway construction such as contractor-furnished borrow pits, haul roads, and equipment storage sites.

The erosion control features installed by the contractor shall be acceptably maintained by the contractor.
SECTION 202
REMOVALS

SECTION 202.20 REMOVAL OF IMPROVEMENTS

202.21 Description.

202.21.1 Description. This work shall consist of the removal and disposal of all existing improvements, except those designated or permitted to be left in place or to be removed under other items of work, from the right-of-way and within the limits of any construction area outside the right-of-way. Improvements, to be left in place within construction limits, must be adequately protected and remain in operating condition. All coal chute and window well structures shall be removed and the openings into the buildings closed with brick with flush mortar joints ready to receive damp proofing. Damp proofing shall be in accordance with Sec 708.

202.21.2 Removal of improvements shall include removing all buildings, drainage structures, all rigid, reinforced, flexible or combination pavements, surfacing, and base courses of all types, curb, curb and gutter, sidewalk approaches (residential, commercial and street) and house walks, steps, retaining walls, foundation walls, columns, footings, floors and any other types of building appurtenances, cisterns, catch basins, manholes, drainage and sewer pipes, box culverts, water and gas main pipes, other objects or structures including scattered or piled bricks, stones, broken masonry, rubbish, debris, etc. from building demolition work, and other existing improvements. This item shall also include the salvaging of materials as designated in the contract, and the backfilling of the resulting trenches, holes and pits, and any grading work required to shape, smooth, and finish the disturbed areas. All guard rail materials within the right-of-way shall remain the property of the County and shall be stored on the right-of-way as directed by the engineer.

202.21.3 The plans may not show a complete list of all items to be removed as there may be an undetermined number of abandoned utilities, basement or foundation walls, columns, footings, other types of building appurtenances, or other improvements encountered. The contractor shall determine for himself the extent of the work to be performed under this item and shall base his bid accordingly. When portions of existing buildings are to be removed and portions are to remain, the contractor shall exercise extreme care to protect the portions of the buildings that are to remain. The contractor shall confine his activities within the construction limits and the slope license line shown on the plans.

202.22 Construction Requirements.

202.22.1 All buildings, disused structures, old pavements, base courses, abandoned sewers or pipe lines, or other obstructions to the construction of the roadway or within the limits of the right-of-way and not designated or permitted to remain, shall be removed or disposed of by the contractor as required. Existing structures or pavements used for handling temporary
traffic shall not be removed until the replacement structures are open to traffic. The contractor may make use of existing structures, roadways, or portions of them during construction, but no material designated for use elsewhere shall be removed from the project, cut, bent, broken, or otherwise damaged.

202.22.2 Material designated in the contract to be salvaged from existing structures shall be removed without damage, in sections which may be readily handled or transported, and shall be piled neatly at an accessible point. Material not designated for salvage will be considered the property of the contractor, unless owned and claimed by any political subdivision or utility company. Salvaged materials becoming the property of the contractor shall not be stored upon the right-of-way, nor shall any portion of the right-of-way be used by the contractor as a sales yard. All discarded material or debris shall be disposed of at locations furnished by the contractor, or at locations on the right-of-way approved by the engineer. Discarded material or debris not be deposited on private property unless authorized in advance by the County Engineer. Property owners interested in obtaining waste products shall be instructed to write the County Engineer, St. Charles County Highway Department, giving particulars of their request.

202.22.3 In removing pavement, curb, curb and gutter, gutters, sidewalk, and other similar improvements, and where a portion of such improvements are to be left in place, they shall be removed to an existing joint or to a joint sawed to a minimum depth of 3/4 the pavement thickness with a true line and vertical face. Sufficient removal shall be made to provide for proper grades and connections in the new work regardless of any limits that may be indicated on the plans.

202.22.4 Removal of concrete pavement or base course, concrete floors, basement floors, and concrete sidewalk may consist either of breaking up and disposing of the broken concrete in embankments or in disposal areas furnished at the contractor’s expense, or of breaking the slab into pieces not exceeding 0.4 m² (4 sq. ft.) where new embankment exceeding 600 mm (24 in.) high is to be placed over the slab. At locations designated on the plans where piling is to be driven, existing pavements, sidewalks, footings, foundations, walls, and all other types of removal items shall be completely removed for a sufficient distance to permit piling to be driven. Existing improvements not removed in their entirety shall be removed to a minimum depth of 300 mm (12 in.) below the finished grading section or natural ground.

202.22.5 All sewers and drainage pipes which have been or are to be abandoned in place shall be completely filled with a sand-cement material which shall consist of a mixture of portland cement and sand combined in the proportions of 223 kg of cement to 1 m³ (376 pounds of cement to one cubic yard) of sand mixed with sufficient water to form a plastic mortar like mixture of a consistency appropriate for pumping into place with pressure pumping equipment. The sand and cement shall be mixed in a mixer of a type approved by the engineer, after which water shall be added and the mixing continued until a consistency of mixture has been attained which can be pumped into the sewer openings under sufficient pressure, to insure the filling of all openings free of voids and air pockets or at the request of the contractor and with the approval of the engineer, the existing pipe may be crushed in place or removed. All floor drains shall be sealed by bulkhead in an acceptable manner by concrete meeting the requirements of Sec. 501.12 or brick masonry as directed by the engineer. No direct payment will be made for bulkheads.
202.22.6 All trenches, holes, and pits resulting from the removal of improvements shall be filled with earth or with broken masonry and earth. No broken masonry shall extend closer than 300 mm (12 in.) to the finished surface. The material shall be placed in the same manner and compacted to approximately the same density as that required in adjoining areas.

202.22.7 Removing and disposing of abandoned fences will be considered as included in final cleaning up of the right-of-way and no direct payment will be made for such work.

202.23 Method of Measurement. The work provided herein will not be measured for payment, but will be considered a lump sum unit. This shall include the removal of all items, whether in view or hidden underneath the surface of the ground, regardless of whether shown on the plans or encountered during construction. No deductions will be made from the volumes measured for payment of roadway excavation where existing improvements are removed from within the limits of the sections measured for determining pay volumes of excavation. Sand-cement backfill will be measured by theoretically computed volume rounded to the nearest 0.1 m$^3$ (0.1 cu. yd.).

202.24 Basis of Payment. The accepted removal of improvements will be paid for at the contract lump sum price. If no lump sum unit for the removal of improvements is included in the contract, the removal of improvements required to complete the contract, or as directed by the engineer, will be considered incidental to the work and no direct payment for the removal will be made. Sand-cement backfill will be paid to the nearest 0.1 m$^3$ (0.1 cu. yd.) in place at the unit bid price.

SECTION 202.30 REMOVAL OF RIGID PAVEMENT

202.31 Description. This work shall consist of the removal and disposal of concrete pavement or concrete base courses, and curb and gutter sections, except those designated or permitted to be left in place, from the right-of-way and within the limits of any construction area outside the right-of-way.

202.31.2 The plans may not show a complete list of all items to be removed, the contractor shall determine for himself the extent of the work to be performed under this item.

202.31.3 When portions of existing rigid pavements are to be removed and portions are to remain in place, the contractor shall exercise care to protect the portions of the rigid pavements that are to remain.

202.32 Construction Requirements.

202.32.1 All concrete pavement, concrete base courses, curb and gutter sections, and driveways within the limits of the right-of-way and not designated or permitted to remain, shall be removed and disposed of by the contractor as required. Existing rigid pavements used for handling temporary traffic shall not be removed until the replacement pavements are open to traffic. The contractor may make use of the existing rigid pavements or portions of them during construction, but no material designated for use elsewhere shall be removed from the project.
202.32.2 In removing concrete pavement, concrete base courses, and curb and gutter sections where a portion of such improvements are to be left in place, they shall be removed to an existing joint or to a joint sawed to a minimum depth of 3/4 the pavement thickness with a true line and vertical face. Sufficient removal shall be made to provide for proper grades and connections in the new work regardless of any limits that may be indicated on the plans.

202.32.3 Removal of concrete pavement or concrete base courses, and curb and gutter sections shall consist either of breaking up and disposing of the broken concrete in embankments or in disposal areas furnished at the contractor’s expense, or of breaking the slab into pieces not exceeding 0.4 m² (4 sq. ft.) in area when new embankment exceeding 600 mm (24 in.) in height is to be placed over the slabs. At locations designated on the plans where piling is to be driven, existing rigid pavements shall be completely removed for sufficient distance to permit piling to be driven.

202.33 Method of Measurement.

202.33.1 Measurement of rigid pavement will be made to the nearest square meter (square yard) for that area of material actually removed from within the limits of the project.

202.34 Basis of Payment.

202.34.1 The accepted removal of rigid pavement will be paid for at the contract unit bid price. Hauling, disposing and placing of removed portions of rigid pavement will be considered incidental to the work and no direct payment will be made.
SECTION 203
ROADWAY AND DRAINAGE EXCAVATION,
EMBANKMENT, AND COMPACTION

203.1 Description. This work shall consist of excavation, disposal, or compaction of all materials encountered within the limits of the work not being removed under some other item. This work shall be performed in accordance with the specifications and in conformance with the lines, grades, thicknesses, and typical cross sections shown on the plans, or established by the engineer. All excavation will be classified as hereafter described.

203.1.1 Class A Excavation will consist of all roadway and drainage excavation not classified as Class C, Sandstone, or Igneous Rock.

203.1.2 Class C Excavation will consist of the removal of stone in ledges 150 mm (6 in.) or more in thickness. A ledge will be considered to be a continuous deposit of rock that may or may not include thin, interbedded seams of soft material or shale. The vertical limits of each ledge will be determined by beds of soft material or shale more than 300 mm (12 in.) thick. The beds of soft material or shale will be included in the measurement of Class A Excavation only. Boulders or other detached stones each having a volume of 2.0 m³ (2 1/2 cu. yd.) or more will be considered as Class C Excavation.

203.1.2.1 Shale, fire clay, chert (joint flint rock) broken by intermittent clayey partings or clay seams, stratified chert cemented with clay seams (hardpan), and plain or bituminous-bound bases or surface courses of macadam, gravel, broken stone, or similar materials will not be considered as Class C Excavation or Sandstone Excavation.

203.1.3 Sandstone Excavation will consist of the removal of material determined to be sandstone in ledge formation. Laboratory analysis will be made, if necessary, to aid in the determination.

203.1.4 Igneous Rock Excavation will consist of the removal of rock of igneous origin (porphyry, granite, rhyolite) occurring in continuous formation, or of detached boulders having a volume of 2.0 m³ (2 1/2 cu. yd.) or more.

203.1.5 Unclassified Excavation will consist of the excavation of all materials of whatever character encountered in the work. All material excavated will be considered as Unclassified Excavation unless the contract specifies classified material.

203.1.6 Borrow and Waste.

203.1.6.1 Borrow will consist of approved material required for the construction of embankment or for other portions of the work, and shall be obtained either from borrow areas
shown on the plans, from areas designated by the engineer, or from other approved sources. The contractor shall notify the engineer sufficiently in advance of opening any borrow areas in order that the necessary soil sampling, cross sections, or measurements may be taken. Borrow will be classified in the same manner as roadway excavation. Borrow areas will be given a final dressing and seeding prior to completion of the contract, so as to provide a pleasing appearance to the overall area. Payment for seeding only, for dressing of borrow areas shown on the plans, will be included as an item of the contract. Seeding of borrow areas not shown on the plans will be considered incidental to the work, and no direct payment will be made.

203.1.6.2 The use of borrow or waste area other than those shown on the plans or designated by the engineer may be approved, provided:

(a) The material and area is equally satisfactory.

(b) The final cost to the County including the cost of easements is not greater than the cost as originally designated.

(c) The substitution is to the best interest of the County.

When borrow areas are on private property a letter of permission must be obtained from the property owner before any material may be removed. Following final grading and seeding of the borrow area a letter of release from liability must be obtained from the property owner prior to final payment.

203.2 Construction Requirements.

203.2.1 General. Prior to beginning excavation and embankment operations in any area, all necessary clearing, grubbing, and stripping in that area shall have been performed. The excavation and embankment for roadway, intersections, and entrances shall be made to the designated alignment, grade, and cross section. Side slopes, cuts, and fills shall be finished to a reasonably smooth and uniform surface that will merge with the adjacent terrain without variations readily discernible from the road. Finishing by hand methods will not be required, except that all brush, weeds, excess mud and silt, or other debris shall be removed from culverts and channels within the scope of the work even though such structures are used in place. Areas disturbed by the contractor outside the limits of construction shall be restored at the contractor’s expense to a condition similar to that prior to construction operations.

203.2.1.1 Field Stone. All loose field stone within the limits of the right-of-way, field stone necessary to be removed before commencing operations on light grading sections, and small rocks and boulders resulting from the operations of subgrade scarifying and finishing a graded earth roadway shall be disposed of as directed by the engineer.

203.2.1.2 Shoulders. Earth shoulders shall be constructed of suitable material to the grade and cross section shown on the plans and shall be compacted by use of a steel wheeled roller weighing not less than 4.5 metric tons (5 tons). The construction of shoulders shall start when sufficient surfacing has been completed and attained satisfactory strength to permit
continuous shouldering operations. Equipment that will damage the surfacing will be prohibited from operating on the surfacing during shouldering operations. Surfacing and curbs shall be protected where equipment is crossing or turning.

203.2.2 Maintenance. During construction, the roadway shall be maintained by the contractor in such condition that it will be passable and well drained at all times. Roadway ditches, channel changes, inlet and outlet ditches, and any other ditches in connection with the roadway shall be cut and maintained to the required cross section. All drainage work shall be performed in proper sequence with other operations. All ditches and channels shall be kept free of debris or obstructions. All slides shall be removed and material disposed of as directed by the engineer.

203.2.3 Drilled and Dug Wells. The contractor will notify the engineer 24 hours in advance of his intent to plug the well. Drilled well casings shall be cut off flush with the existing ground line or 300 mm (12 in.) below the finished grading section, whichever is lower. The well shall then be plugged from the bottom of the well to the top of the casing with a mixture of commercial concrete or 4:1 sand-cement grout. If the mixture is to be placed below water, it shall be placed by means of a tremie, where feasible. If the use of a tremie is not considered feasible, the mixture shall be placed in two stages. During the first stage, the mixture may be deposited directly through the water to plug the well from the bottom to an elevation 3.0 m (10 ft.) below the bottom of the casing or to an elevation 25 m (80 ft.) below the top of the casing, whichever is lower. After a minimum period of 48 hours, the well shall be dewatered and the remaining mixture placed in the dry. The mixture used to plug wells less than 25 m (80 ft.) in depth shall be placed by tremie or completely in the dry. Dug wells and cisterns shall be pumped out, the bottom broken and the well or cistern filled to the ground line or within 300 mm (12 in.) of the finished grading section, whichever is lower, with suitable earth compacted in 150 mm (6 in.) layers to the approximate density of the adjacent soil. Direct payment will not be made for the plugging or disposal of wells or cisterns.

203.2.4 Subgrade Scarifying. The engineer may order subgrade scarifying performed to remove oversized material if the upper 150 mm (6 in.) of the subgrade as tentatively completed contains material of a dimension greater than 100 mm (4 in.) sufficient in quantity to make it unacceptable as a road bed for the proposed type of surfacing.

203.2.5 Excavating in Rock. Excavating and undergrading in rock (i.e., material conforming to the description of Class C, Sandstone or Igneous Rock, whether the contract calls for classified or unclassified excavation) shall be performed in a manner to produce material of such size as to permit being placed in embankments in accordance with the requirements. Rock within the roadbed limits shall be removed to the limits of undergrading insofar as practicable and in such manner as to leave no undrained pockets in the surface. Unless specifically set forth in the contract, the contractor will be required to obtain the necessary permission from all governmental entities before considering blasting as a means of rock excavation. Care shall be taken to avoid overshooting when blasting. Any loose or shattered rock, overhanging ledges, and boulders above the roadbed that might dislodge shall be removed. When the contract provides a specific use for rock from roadway excavation, the work shall be performed in such order and manner as may be necessary to insure that the desired quantity of such material may be placed as
203.2.5.1 The contractor, at his option, may perform the excavating of rock cuts by the technique of “pre-splitting” on the neat line of the proposed excavation, with the results subject to the approval of the engineer. Holes for pre-splitting shall be drilled to the full depth of the cut or to a pre-selected bench elevation as shown on the plans or as determined by the engineer. The spacing and diameter of holes and the amount, type, and spacing of the explosive charges in the holes shall be the full responsibility of the contractor. Pre-splitting shall be done according to accepted practice to produce a clean face on the excavated cut.

203.2.5.2 Undergrading. Areas of required undergrading shall be backfilled with one of the following materials with preference in the order given, dependent on availability:

(a) Rock fragments or spalls.

(b) A granular type material having a plasticity index not to exceed 10 and a gradation such that at least 50 percent of the material will be retained on the 4.75 mm (No. 4) sieve.

(c) A material having a low plasticity index and designated by the engineer as suitable.

203.2.5.3 Overbreak. The areas of overbreak resulting from excavating rock below the required limits of undergrading shall be backfilled with spalls or rock fragments. If spalls are not available and if the contractor does not elect to use rock fragments, the use of either of the following will be satisfactory.

(a) Material meeting the requirements of Sec 1007, Aggregate Base Material.

(b) A granular type material having a plasticity index not to exceed 10 and a gradation such that at least 50 percent of the material will be retained on the 4.75 mm (No. 4) sieve.

203.2.6 Where excavation to the finished graded section results in a subgrade or slopes of unsuitable material, the engineer may require the contractor to remove the unsuitable material, and backfill to the finished graded section with approved material. The contractor shall conduct his operations in such manner that the engineer may make the necessary measurements before the backfill is placed. Required backfill shall be provided to furnish a stable foundation for the roadway. The engineer may order additional excavation beyond the pay limits established for roadway excavation in order to remove material found unsuitable for roadway construction. 50 or 75 mm (2 or 3 in.) clean stone shall be used as backfill for such excavations. The gradation of the material will be determined by the engineer. Measurement for the volume of unsuitable material excavated beyond or outside the limits shown on the plans or established by the specifications for roadway excavation will be made by the engineer.

203.2.7 Borrow material shall not be placed until after material from roadway excavation has been placed in the fill, except as approved otherwise by the engineer. The contractor shall not
excavate beyond the dimensions and elevations established, and no material shall be removed prior to staking and cross sectioning the site. If the contractor places more borrow than required and thereby causes a waste of excavation, such waste will be deducted from the borrow volume as measured in the borrow area. All borrow areas shall be bladed and left in such shape as to permit taking the necessary cross sections after excavating has been completed. The finished borrow areas shall be approximately true to line and grade when so specified in the contract, and shall be finished, where practicable, so that no water will collect or stand therein. When necessary to remove fencing in order to obtain borrow material, it shall be replaced in as good condition as it was at the time of removal. The contractor shall be responsible for confining livestock when a portion of the fence is removed. No direct payment will be made for removing and replacing such fence nor for the confining of livestock.

203.2.8 Obliteration of old roads shall be performed in areas shown on the plans and shall include all grading operations necessary to incorporate the old road into the work. The obliteration shall provide a pleasing appearance. Obliteration of existing pavements will be paid for as Removal of Improvements. The earthwork for obliteration will be paid for as roadway excavation, unless otherwise provided in the contract.

203.2.9 Artifacts. When remains of prehistoric sites or artifacts of historical or archaeological significance are encountered, the excavation operations shall be temporarily discontinued. The engineer will determine the disposition of such sites or artifacts. When directed by the engineer, the contractor shall excavate the site in such manner as to preserve the artifacts encountered.

203.2.10 During the process of excavating cuts, the engineer may order specific excavated material placed in stockpiles in order to have suitable material available to complete the upper portion of embankments and to backfill portions of undergraded cuts.

203.2.11 Embankment Construction. Embankment construction shall consist of constructing roadway embankments, including preparation of the areas upon which they are to be placed, constructing dikes and berms, placing and compacting approved materials within roadway areas where unsuitable material has been removed, and placing and compacting of embankment material in holes, pits, and other depressions within the roadway area. Only approved materials free of trees, stumps, rubbish, and any other deleterious material shall be used in the construction of embankments and backfills. Rocks, broken concrete or other solid material shall not be placed in embankment areas where piling is to be placed or driven.

203.2.11.1 Embankments requiring surcharges, restricted loading rates, embankment control stakes, or pore pressure measurement devices, shall be constructed to the design template progressively for the full height. Failure of embankments or embankment foundations, or damage to structures which occur when the contractor fails to observe restricted loading rates, or fails to construct slopes initially to the design template, shall be repaired as directed by the engineer at the contractor’s expense.

203.2.11.2 Construction of embankments shall not be started on foundation soil or partially completed embankments having more than 50 mm (2 in.) of frost. When such
conditions exist the surface must be thoroughly broken and mixed with non-frosted material to the satisfaction of the engineer. No frozen material may be incorporated into the embankment. No material shall be placed on frost layers encountered within 300 mm (12 in.) of the top of the proposed grading section. Frozen material on foundation soil or partially completed embankment not meeting the above requirements shall be removed before placing material for the embankment. The removal of frozen material from the foundation of an embankment, or from any layer of the embankment, and the replacement with satisfactory material shall be at the expense of the contractor.

203.2.12 When embankment is to be placed on hillsides or when new embankment is to be constructed against existing embankments, the existing slopes that are steeper than 6 to 1 when measured at right angle to the roadway shall be continuously benched in not less than 300 mm (12 in.) rises over those areas where it is required as the work is brought up in layers. Benching shall be of sufficient width to permit placing and compacting operations. Each horizontal cut shall begin at the intersection of the ground line and the vertical side of the previous bench. Existing slopes shall also be stepped to prevent any wedging action of the embankment against structures. No direct payment will be made for the material thus cut out nor for its compaction along with the new embankment material.

203.2.13 Where an embankment less than 1.2 m (4 ft.) in height is to be made, all sod and vegetable material shall be removed from the surface upon which the embankment is to be placed, and the cleared surface completely broken up by plowing, scarifying, or stepping to a minimum depth of 150 mm (6 in.). This area shall be compacted in the same manner as that required for the embankment placed on the area. Sod not required to be removed shall be thoroughly disced before construction of embankment. Where an embankment less than 1.0 m (3 ft.) in height is to be made over a compacted road surface containing bituminous or granular material, the old road surface shall be scarified to a depth of at least 150 mm (6 in.). This scarified material shall be recompacted.

203.2.14 If embankment is deposited on one side only of abutments, wingwalls, piers, or culvert headwalls, care shall be taken that the area immediately adjacent to the structure is not compacted to the extent that it will cause overturning of or excessive pressure against the structure. Equipment of such weight as may cause damage to culverts of other structures will not be permitted to work over or immediately adjacent to such structures. The fill adjacent to the end bent of a bridge shall not be placed higher behind than in front of end bents until the superstructure is in place. When embankment is to be placed on both sides of a concrete wall or box type structure, operations shall be so conducted that the embankment is kept at approximately the same elevation on each side.

203.2.15 Surcharged embankments shall be built in accordance with the plans and shall remain in place for such time as required by the contract. The requirements for placing and compacting will be waived on the surcharge material above the specified completed area.

203.2.16 Surplus roadway material shall be removed and stored at the stockpile area indicated. The stockpiled material will be confined within the area shown, and necessary precautions will be taken to insure that surface drainage or storm culvert drainage is not
interrupted. Prior to contract completion, the contractor shall give the stockpile area a final
dressing and seeding so as to provide a pleasing appearance to the overall area. Payment for
seeding only, for stockpile areas shown on the plans, will be included as an item of the contract.
Seeding of stockpile areas not shown on the plans will be considered incidental to the work and
no direct payment will be made.

203.2.16.1 Surplus roadway excavation and waste materials resulting from removals shall
be disposed of in areas obtained by the contractor. The contractor shall comply with the
following requirements in securing waste areas and in depositing waste products thereon.

(a) The site shall not be in a flood plain.

(b) Letters of permission and release are required from the affected property owner or
owners.

(c) Precautions shall be taken to insure that surface water or storm culvert drainage is not
interrupted.

(d) The waste disposal area or areas shall be given a final dressing and seeding to provide
a presentable appearance and to prevent soil erosion.

(e) Other siltation control measures such as straw bales shall be applied during
construction as directed by the engineer.

The permit letter provided from the property owner shall be submitted for approval a minimum
of five (5) working days prior to the start of operations that will result in waste products or
excess excavation. The letter of release will be required before the retained percentage will be
released. The contractor will be required to haul over city streets and any hauling operations of
the contractor shall be subject to the requirements of such permits and other applicable city
regulations and ordinances. No direct payment will be made for complying with the requirements
of this specification. All costs incurred as a result thereof, including seeding, will be considered
to be completely covered by the unit prices bid for other items included in the contract. When
dump sites are located in municipalities, a letter of authorization signed by the Mayor or City
Administrator will be required.

203.2.17 Roadway embankment shall be placed in layers not exceeding 200 mm (8 in.)
(loose measurement) and shall be compacted as specified before the next layer is placed. The
layers shall be placed approximately parallel to both the proposed profile grade and to the
finished roadbed. Effective spreading equipment shall be used on each lift to obtain uniform
thickness prior to compacting. Continuous leveling and manipulating will be required during
compacting operations. Construction equipment shall be routed uniformly over the entire surface
of each layer.

203.2.17.1 Occasional stones or rock fragments exceeding the thickness of the 200 mm (8
in.) layer shall be disposed of by being incorporated into the embankment outside the limits of
the proposed surfaced traffic lanes. The thickness of the layer in these areas may be increased if
necessary to accommodate the stones, but shall not exceed 300 mm (12 in.) in thickness (loose measurement). The stones or rock fragments are to be placed so there will be no nesting.

**203.2.17.2** Lifts may be increased to a maximum of 300 mm (12 in.) in thickness (loose measurement) for berms, filling of old channels, waste, or similar areas. These areas shall be compacted by uniformly distributing the hauling over the entire area and specific density control will not be required. No direct payment will be made for compaction performed in these areas.

**203.2.18** When the excavated material consists predominantly of rock fragments of such size that the material cannot be placed in layers of the thickness prescribed, such material shall be placed in the embankment in layers having a thickness of the approximately average size of the larger rocks, but not to exceed 600 mm (24 in.). Rocks or boulders too large to permit placing in a 600 mm (24 in.) layer shall be reduced in size as necessary to permit this placement. Rock shall not be dumped in place, but shall be distributed by blading or dozing in a manner to insure proper placement in final position in the embankment. The spalls and smaller stone fragments shall be left on the surface of each layer as formed. The uppermost portion of rock embankments placed in this manner shall be constructed as follows:

Where the specified or proposed surfacing consists of a rigid or flexible type pavement, the top consolidated rock layer for the full width between roadbed slopes shall be finished to the same limits as shown on the plans for undergrading in rock cuts. When rigid pavement is to be constructed without an aggregate base, the material requirements of Sec 203.2.5.2 shall govern for the construction of the area between the bottom of the pavement and the top of the top consolidated rock layer. Any embankment necessary outside the limits of the pavement shall be constructed of suitable earth or as otherwise specified in the contract.

**203.3 Compaction of Embankment and Treatment of Cut Areas with Moisture and Density Control.** Modified AASHTO T-180 Compaction Test (ASTM D-1557) will be used as the Standard Compaction Test for determining the moisture density relations of soils. The optimum moisture as determined by the Standard Compaction Test may be used as a guide in determining the proper moisture content at which each soil type should be compacted. Water shall be added or removed as necessary to permit obtaining the required density and moisture control. The field density of the embankment after compaction will be determined, using the total material, in accordance with AASHTO T 191 (Sand Cone Method), or AASHTO T 238, Method B Direct Transmission, for wet density. When nuclear density methods are used, moisture content will be determined in accordance with AASHTO T 239. The volume of the test hole may be reduced as necessary to accommodate available testing equipment. The calculated density obtained in this field density test will be compared with the maximum density as established by the Standard Compaction Test to determine the percent compaction attained. All density tests will be made by the County.

**203.3.1** Compaction to at least 90 percent of maximum density, as determined by the Standard Compaction Test, will be required in the following areas:

(a) All roadway embankments except as otherwise provided in the following sections: Sec 203.2.15, 203.2.16, 203.2.17.2, 203.3.4, 203.3.5, and 203.3.8.
(b) All backfilled undergraded cuts, except as modified by Sec 203.3.3.

(c) Certain portions of the roadbed in cuts specified in Sec 203.3.7 except as modified in Sec 203.3.3.

203.3.2 The moisture content of the soil at the time of compaction shall be as herein specified.

203.3.2.1 When necessary to eliminate rubbery condition of the embankment, it may be required that some soils have a moisture content below the optimum during compacting work. Clays, heavy clays, and other Class A materials having liquid limits of 40 or more shall not be placed as embankment when the moisture content of the soil surpasses its optimum moisture by three (3) percent. Existing embankments shall be dissected, aerated, or reworked to comply with the moisture requirements of this provision subsequent to the resumption of embankment placement operation.

203.3.2.2 Loessial soils shall have moisture controlled so as not to exceed optimum plus three percentage points when placed in embankments of less than 9.0 m (30 ft.) in height. Such soils when placed in embankments of 9.0 m (30 ft.) or more in height shall have moisture controlled so as not to exceed optimum moisture. If wet foundation conditions contribute to the embankment moisture while compacting, the engineer may waive this specified moisture content for a height not to exceed 1.0 m (3 ft.) above the embankment foundation. In the event of conflict of provisions of this section with provisions in Sec 203.3.2.1, Sec 203.3.2.1 shall govern.

203.3.3 When a flexible type surface is proposed, at least 90 percent of maximum density will be required for the upper 450 mm (18 in.) of the earth subgrade extending the full width between roadbed slopes.

203.3.4 Roadway embankment within 30 m. (100 ft.) of each end of a structure on which the top slab or deck is to be used as the riding surface, and the spill fill under such a structure, shall be compacted to not less than 95 percent of maximum density.

203.3.5 Density requirements will not apply to portions of embankments constructed of material so rocky that they cannot be satisfactorily tested in accordance with AASHTO T 191 or T 205. Material of a gradation having more than approximately 20 percent retained on a 19 mm (3/4 in.) sieve will generally be considered too rocky for satisfactory density testing. In lieu thereof, compactive effort on rock and rocky material shall consist of making four complete coverages of each layer with a tamping-type roller or two complete coverages of each layer with a vibratory roller. The tamping-type roller shall have tampers or feet protruding not less than 150 mm (6 in.) from the surface of the drum and have a minimum load on each tamper of 1700 kPa (250 psi) of tamping area. The vibratory roller shall have a manufacturer’s rating of 14 to 18 metric tons (16 to 20 tons) compacting power.

203.3.6 Compacting in Cut. Cut compaction, after removal of the roadway excavation material to the required pavement or lowest base course, shall be temporarily exposed for the full
width between roadway inslopes. The exposed material, to a depth of 150 mm (6 in.), shall be manipulated and compacted to not less than the required density. The material above this compacted plane shall be respread in layers not exceeding 200 mm (8 in.) loose thickness, each layer being wetted or dried as necessary and compacted to the specified density. The entire volume of materials so handled and compacted, including the 150 mm (6 in.) layer compacted in place, will be considered as Compacting in Cut. All Class A material having a liquid limit of 40 or more including the 150 mm (6 in.) layer compacted in-place, shall be compacted at not less than optimum moisture content.

203.3.6.1 The existing ground for the full width between roadway slopes under embankments of less than 450 mm (18 in.) in height shall be treated in accordance with Sec 203.3.6 to only such depth as to insure having 450 mm (18 in.) of material of the required density and moisture below the top of the finished subgrade.

203.3.6.2 The entire volume of materials so handled and compacted as specified in Sec 203.3.6 and Sec 203.3.6.1, including the 150 mm (6 in.) layer compacted in-place will be considered compacting in cut.

203.3.7 Each layer shall be wetted or dried, as necessary, and shall be compacted to the required density. Regardless of the type of equipment used, the roadway shall be compacted uniformly and the surface kept reasonably smooth at all times. When large pieces of heavy clay are encountered, the material shall be broken down by suitable manipulation to permit satisfactory embankment construction. When shale is encountered, it shall be broken down as much as is practicable and compacted at or above optimum moisture.

203.3.8 Compaction to at least 95 percent of maximum density will be required for that portion of any embankment below an elevation 15 m (50 ft.) below the top of the finished subgrade. If, because of embankment foundation conditions, the 95 percent of maximum density cannot be obtained after reasonable compactive effort has been expended, the engineer may waive the 95 percent requirement for a height not to exceed 1.0 m (3 ft.) above the embankment foundation.

203.4 Compaction of Embankments Not Constructed with Density or Moisture and Density Control. The compactive effort on each layer shall consist of distributing all equipment movements over the entire fill area and of at least three complete coverages with a tamping-type roller over the entire area to be compacted. The tamping-type roller shall have tampers or feet projecting not less than 150 mm (6 in.) from the surface of the drum and shall have a minimum load on each tamper of 1700 kPa (250 psi). Compactive effort shall be continued, if necessary, until the tamping feet penetrate not more than 50 mm (2 in.) into the layer of material being compacted. Continuous leveling and manipulating will be required during compacting operations and the moisture content shall be adjusted as is necessary, in the judgment of the engineer, to permit proper consolidation.

203.4.1 Dumping and rolling areas shall be kept separate, and no lift shall be covered by another until compaction complying with these requirements has been secured. Unstable areas in the embankment shall be removed and replaced with suitable material at the expense of the
203.4.2 Each layer of embankment constructed of rock or rocky material shall also be compacted by three complete coverages of the tamping-type roller. A vibratory roller may be used on approval of the engineer.

203.5 Compaction of Embankments without Specified Compaction Results or Specified Compaction Equipment. Only when specifically designated on the plans, compaction will not be required other than that obtained by distributing equipment movements over the entire fill area.

203.6 Method of Measurement.

203.6.1 Contract Quantity Payment. The quantities of excavation for which payment will be made will be those shown in the contract for the various items, provided the project is constructed essentially to the lines and grades shown on the plans. A partial check of existing ground elevations will be made at the time slope stakes are set, and of the finished work for deviations in the grade, width, or slope from the authorized grade or typical section. Contract quantities will be used for final payment of Class A Excavation, Unclassified Excavation, and Compacting Embankment except when:

(a) Errors are found in the original computations.

(b) An original cross section is found to have an average deviation from the true elevation in excess of 0.3 m (1 ft.).

(c) An authorized change in grade, slope, or typical section is made.

(d) Unauthorized deviations decrease the quantities on the plans.

(e) Class C, Sandstone, or Igneous Rock Excavation is encountered, unless the contract calls for unclassified excavation.

When the above conditions are encountered the corrections or revisions will be computed and added to or deducted from the contract quantity.

203.6.1.1 When the plans have been altered or when disagreement exists between the contractor and the engineer as to the accuracy of the plan quantities of any balance, or the entire project, either party shall have the right to request a recomputation of contract quantities of excavation within any area by written notice to the other party. The written notice shall contain evidence that an error exists in the original groundline elevation or in the original computations which will materially affect the final payment quantity. When such final measurement is required, it will be made from the latest available ground surface and the design section.

203.6.2 Measured Quantities. When payment of excavation is to be made on a measured quantity basis, volumes of authorized excavation will be computed from cross section
measurements by the average end area method. When not attributable to carelessness of the contractor, slides in Class A Excavation and in Unclassified Excavation will be included in such measurements. Authorized excavation of rock, shale, muck, or other unsuitable material will also be included.

203.6.2.1 Authorized excavation of rock, shale, muck, or other unsuitable material below grade shall consist of that excavation necessary to provide the designated depth of undergrading. If the plane of the designated bottom of excavation falls within a layer or stratum of rock, the below grade excavation to the bottom of the layer, not exceeding 300 mm (12 in.) below the designated limits of undergrading will be considered as authorized and will be measured for payment, provided the overbreak has been removed sufficiently to permit accurate cross sectioning. Rock excavation more than 300 mm (12 in.) below the designated limits of undergrading will not be paid for. No measurement will be made of any material removed from below the design limits of undergrading if the nature of the material, the thickness of the layer or stratum, and the method of operations are such that it is practicable to excavate only to the depth shown on the plans. No measurement will be made for overbreakage or for the disposal of the same when such material is obtained from outside the neat lines of the proposed backslopes in rock excavation except that such overbreakage will be measured as Class A Excavation or Unclassified Excavation, as applicable, when all suitable authorized excavation has been used and the overbreak material is required for completion of the embankment. A maximum tolerance of 0.3 m (1 ft.) will be permitted for rock protruding or extending within the neat lines of the proposed backslopes.

203.6.2.2 While work involving classified excavation is in progress, the engineer will fix points of elevation and stationing as required to establish the lines of demarcation between the materials of different classification. These top points will be determined before any Class C, Sandstone, or Igneous Rock Excavation is removed and it shall be the contractor’s responsibility to notify the engineer before removing any such material. Any excavation removed before the engineer has been notified and given 24 hours to establish lines of demarcation will be included in the measurement of Class A Excavation only.

203.6.2.3 Excavation may be encountered in which lines of demarcation between materials of different classifications are impracticable to establish. The quantity of material classified as other than Class A Excavation may be determined by the engineer on a percentage basis as the work progresses after the limits of determinate classification material have been established.

203.6.2.4 Measured quantities of excavation will be used where the ground elevations shown on the plans are found to be erroneous. No revision of contract quantities will be made when the actual ground elevations are considered to agree generally with the ground line shown on the plans. Where the engineer authorizes a change in grade, slope, or typical section affecting the volume of excavation allowed for payment in that particular balance or area, the revised volume will be determined by the average end area method on the basis of the revised grade, slope, or typical section. Where unauthorized deviations result in a decrease in the contract quantities, the deviations will be measured and deducted from the contract quantity.
203.6.2.5 The quantity of Class C, Sandstone, or Igneous Rock Excavation will be computed on a measured quantity basis. The volume of Class A Excavation allowed for payment in roadway balances involving rock excavation will be determined by one of the following methods, whichever in the judgment of the engineer is more applicable.

(a) Measuring and computing both the Class A Excavation and the Class C, Sandstone, or Igneous Rock Excavation within the limits affected.

(b) Deducting the volume of Class C, Sandstone, or Igneous Rock Excavation from the total adjusted volume of roadway excavation, regardless of classification, within the limits affected.

203.6.2.6 Measurements will be made for unsuitable material actually excavated and removed to permit proper compaction in cut sections and in foundations for fill sections. No measurement will be made of the suitable material temporarily removed, and replaced, to facilitate compaction in cuts or under shallow fills.

203.6.2.7 Borrow quantities will be determined by measuring the borrow area before and after excavating.

203.6.2.8 Excavation material stockpiled in accordance with Sec 203.2.10 will be measured in the stockpile by the average end area method.

203.6.2.9 Only that material placed in accordance with the requirements of Sec 203.3 will be included in the measurement of Compacting Embankment. If an error has been found in the original computations or ground elevations, or if there has been an authorized change in grade, slope, or typical section, the plan quantity for Compacting Embankment for those areas or balances affected will be adjusted for final payment. All required compaction above the original ground line and all compacting of material placed in undergraded cut sections will be considered as Compacting Embankment.

203.6.2.10 Compacting in Cuts will be the measured quantity of material compacted. The volume allowed for payment will be computed for actual areas compacted during construction, to the dimensions shown on the plans, and will include any required compaction of the original ground under shallow fills.

203.6.2.11 Measurement of roadway and drainage excavation, compacting embankments, and compacting in cuts will be made to the nearest cubic meter (cubic yard).

203.7 Basis of Payment. Payment for roadway excavation will be made at the contract unit bid price per cubic meter (cubic yard) which price shall be full compensation for the excavating and hauling; placing and forming of embankments; preparation of subgrade; shouldering, rounding slopes, obliterating old roadway, finishing of graded earth roadway, picking up and disposing of pickup rock; and any work noted on the plans to be included in the price bid for excavation. No payment will be made for any material used for purposes other than those designated, except as approved by the engineer.
203.7.1 Payment will be made at the contract unit bid price per cubic meter (cubic yard) for the applicable item of Class A Excavation or Unclassified Excavation for each handling of stockpiled excavation approved by the engineer.

203.7.2 Payment for authorized excavation of unsuitable material, placement of the backfill material and disposal of the unsuitable material will be made at a unit price of $23.50/m³ ($18.00/cu. yd.) of additional excavation.

203.7.3 If the contract contains a unit price for either Sandstone Excavation or Class C Excavation, but not both, it shall apply to the other if both are encountered. Payment will be made at four times the unit price bid per cubic meter (cubic yard) for Class A Excavation if the contract does not contain a unit price for either Sandstone or Class C Excavation and such material is encountered, unless the project is let on an unclassified excavation basis. The unit price per cubic meter (cubic yard) established in this manner shall apply regardless of quantities involved.

203.7.4 If the contract does not contain a unit price for Igneous Rock Excavation and such material is encountered during construction, payment will be made at a unit price of $5.25/m³ ($4.00/cu. yd.) regardless of quantity, unless the project is let on an unclassified excavation basis.

203.7.5 No direct payment will be made for water required in compaction work. Any costs involved in reducing the moisture content in soils will be at the expense of the contractor.

203.7.6 Payment for finishing a graded earth roadway will be completely covered by the contract unit bid price for the various classes of excavation.

203.7.7 Payment will be made at the unit bid price for each of the pay items included in the contract.
SECTION 204
EMBANKMENT AND COMPACTION

204.1 Description. This work shall consist of placing and compacting embankment on the project utilizing any necessary excavation or borrow required to construct the roadway to the plan configuration. This work will conform to the lines, grades and thickness and typical cross sections shown on the plans and will be performed in accordance with the specifications or as established by the engineer.

204.2 Construction Requirements. Embankment in place will be constructed utilizing the material excavated on the project or supplied from an approved borrow area. Excavation from the project will include Class A, Class C, Sandstone and Igneous Rock excavations as defined in Sec 203.1.1 to Sec 203.1.4 and any material derived from excavation for structures, excavations for sewers, cleanout of existing sewers, on site utility adjustments or from other of the contractor’s on site operations may be used in construction of the roadway embankments if such materials are approved by the engineer prior to use.

204.2.1 Borrow will consist of approved material required for the construction of embankment or for other portions of the work, and shall be obtained from approved sources. Borrow areas shall be given a final dressing and seeding prior to completion of the contract, so as to provide a pleasing appearance to the overall area. Seeding the borrow area or areas will be considered incidental to other items and no direct payment will be made.

204.2.1.1 The use of borrow or waste area other than those shown on the plans or designated by the engineer may be approved provided:

(a) The material and area is equally satisfactory.

(b) The final cost to the County including the cost of easements is not greater than the cost as originally designated.

(c) The substitution is to the best interest of the County.

When borrow areas are on private property, a letter of permission must be obtained from the property owner before any material may be removed. Following final grading and seeding of the borrow area, a letter of release from liability must be obtained from the property owner prior to final payment.

204.2.2 Material designated by the engineer as unsuitable for embankment construction shall be disposed of off site by the contractor at his expense in accordance with the provisions of Sec 204.2.16.1. No direct payment will be made for such excavation unless otherwise noted on the plans, or for the disposal of excess or unsuitable material.
204.2.2.1 Prior to beginning embankment operations in any area, all necessary clearing, grubbing, and stripping in that area shall have been performed. The excavation and embankment for roadway, intersections, and entrances shall be made to the designated alignment, grade, and cross section. Side slopes, cuts, and fills shall be finished to a reasonably smooth and uniform surface that will merge with the adjacent terrain without variations readily discernible from the road. Finishing by hand methods will not be required, except that all brush, weeds, excess mud and silt, or other debris shall be removed from culverts and channels within the scope of the work even though such structures are used in place. Areas disturbed by the contractor outside the limits of construction shall be restored at the contractor’s expense to a condition similar to that prior to construction operations.

204.2.2.2 Field Stone. All loose field stone within the limits of the right-of-way, field stone necessary to be removed before commencing operations on light grading sections, and small rocks and boulders resulting from the operations of subgrade scarifying and finishing a graded earth roadway shall be disposed of as directed by the engineer.

204.2.2.3 Shoulders. Earth shoulders shall be constructed of suitable material to the grade and cross section shown on the plans and shall be compacted by use of a steel wheeled roller weighing not less than 4.5 metric tons (5 tons). The construction of shoulders shall start when sufficient surfacing has been completed and attained satisfactory strength to permit continuous shouldering operations. Equipment that will damage the surfacing will be prohibited from operating on the surfacing during shouldering operations. Surfacing and curbs shall be protected where equipment is crossing or turning.

204.2.2.4 Maintenance. During construction, the roadway shall be maintained by the contractor in such condition that it will be passable and well drained at all times. Roadway ditches, channel changes, inlet and outlet ditches, and any other ditches in connection with the roadway shall be cut and maintained to the required cross section. All drainage work shall be performed in proper sequence with other operations. All ditches and channels shall be kept free of debris or obstructions. All slides shall be removed and material disposed of as directed by the engineer.

204.2.3 Drilled and Dug Wells. The contractor will notify the engineer 24 hours in advance of his intent to plug the well. Drilled well casings shall be cut off flush with the existing ground line or 300 mm (12 in.) below the finished grading section, whichever is lower. The well shall then be plugged from the bottom of the well to the top of the casing with a mixture of commercial concrete or 4:1 sand-cement grout. If the mixture is to be placed below water, it shall be placed by means of a tremie, where feasible. If the use of a tremie is not considered feasible, the mixture shall be placed in two stages. During the first stage, the mixture may be deposited directly through the water to plug the well from the bottom to an elevation 3.0 m (10 ft.) below the bottom of the casing or to an elevation 25 m (80 ft.) below the top of the casing, whichever is lower. After a minimum period of 48 hours, the well shall be dewatered and the remaining mixture placed in the dry. The mixture used to plug wells less than 25 m (80 ft.) in depth shall be placed by tremie or completely in the dry. Dug wells and cisterns shall be pumped out, the bottom broken and the well or cistern filled to the ground line or within 300 mm (12 in.) of the finished grading section, whichever is lower, with suitable earth compacted in 150 mm (6 in.)
layers to the approximate density of the adjacent soil. Direct payment will not be made for the plugging or disposal of wells or cisterns.

204.2.4 Subgrade Scarifying. The engineer may order subgrade scarifying performed to remove oversized material if the upper 150 mm (6 in.) of the subgrade as tentatively completed contains material of a dimension greater than 100 mm (4 in.) sufficient in quantity to make it unacceptable as a road bed for the proposed type of surfacing.

204.2.5 Undergrading. Areas of required undergrading shall be backfilled with one of the following materials with preference in the order given, dependent on availability:

(a) Rock fragments or spalls.

(b) A granular type material having a plasticity index not to exceed 10 and a gradation such that at least 50 percent of the material will be retained on the 4.75 mm (No. 4) sieve.

(c) A material having a low plasticity index and designated by the engineer as suitable.

204.2.5.1 Overbreak. The areas of overbreak resulting from excavating rock below the required limits of undergrading shall be backfilled with spalls or rock fragments. If spalls are not available and if the contractor does not elect to use rock fragments, the use of either of the following will be satisfactory:

(a) Material meeting the requirements of Sec 1007, Aggregate Base Material.

(b) A granular type material having a plasticity index not to exceed 10 and a gradation such that at least 50 percent of the material will be retained on the 4.75 mm (No. 4) sieve.

204.2.6 Where excavation to the finished graded section results in a subgrade or slopes of unsuitable material, the engineer may require the contractor to remove the unsuitable material, and backfill to the finished graded section with approved material. The contractor shall conduct his operations in such manner that the engineer may make the necessary measurements before the backfill is placed.

204.2.7 Borrow material shall not be placed until after acceptable material from roadway excavation has been placed in the embankment, except as otherwise approved by the engineer. The finished borrow areas shall be approximately true to line and grade when so specified in the contract, and shall be finished, where practicable, so that no water will collect or stand therein. When necessary to remove fencing in order to obtain borrow material, it shall be replaced in as good condition as it was at the time of removal. The contractor shall be responsible for confining livestock when a portion of the fence is removed. No direct payment will be made for removing and replacing such fence nor for the confining of livestock.

204.2.8 Obliteration of old roads shall be performed in areas shown on the plans and shall
include all grading operations necessary to incorporate the old road into the work. The obliteration shall provide a pleasing appearance. Obliteration of existing pavements will be paid for as Removal of Improvements.

204.2.9 Artifacts. When remains of prehistoric sites or artifacts of historical or archaeological significance are encountered, the excavation operations shall be temporarily discontinued. The engineer will determine the disposition of such sites or artifacts. When directed by the engineer, the contractor shall excavate the site in such manner as to preserve the artifacts encountered.

204.2.10 During the process of excavating cuts, the engineer may order specific excavated material placed in stockpiles in order to have suitable material available to complete the upper portion of embankments and to backfill portions of undergraded cuts.

204.2.11 Embankment Construction. Embankment construction shall consist of constructing roadway embankments, including preparation of the areas upon which they are to be placed, constructing dikes and berms, placing and compacting approved materials within roadway areas where unsuitable material has been removed, and placing and compacting of embankment material in holes, pits, and other depressions within the roadway area. Only approved materials free of trees, stumps, rubbish, and any other deleterious material shall be used in the construction of embankments and backfills. Rocks, broken concrete or other solid material shall not be placed in embankment areas where piling is to be placed or driven.

204.2.11.1 Embankments requiring surcharges, restricted loading rates, embankment control stakes, or pore pressure measurement devices, shall be constructed to the design template progressively for the full height. Failure of embankments or embankment foundations, or damage to structures which occur when the contractor fails to observe restricted loading rates, or fails to construct slopes initially to the design template, shall be repaired as directed by the engineer at the contractor’s expense.

204.2.11.2 Construction of embankments shall not be started on foundation soil or partially completed embankments having more than 50 mm (2 in.) of frost. When such conditions exist, the surface must be thoroughly broken and mixed with non-frosted material to the satisfaction of the engineer. No frozen material may be incorporated into the embankment. No material shall be placed on frost layers encountered within 300 mm (12 in.) of the top of the proposed grading section. Frozen material on foundation soil or partially completed embankment not meeting the above requirements shall be removed before placing material for the embankment. The removal of frozen material from the foundation of an embankment, or from any layer of the embankment, and the replacement with satisfactory material shall be at the expense of the contractor.

204.2.12 When embankment is to be placed on hillsides or when new embankment is to be constructed against existing embankments, the existing slopes that are steeper than 6 to 1 when measured at right angle to the roadway shall be continuously benched in not less than 300 mm (12 in.) rises over those areas where it is required as the work is brought up in layers. Benching shall be of sufficient width to permit placing and compacting operations. Each
horizontal cut shall begin at the intersection of the ground line and the vertical side of the previous bench. Existing slopes shall also be stepped to prevent any wedging action of the embankment against structures. No direct payment will be made for the material thus cut out nor for its compaction along with the new embankment material.

204.2.13 Where an embankment less than 1.2 m (4 ft.) in height is to be made, all sod and vegetable material shall be removed from the surface upon which the embankment is to be placed, and the cleared surface completely broken up by plowing, scarifying, or stepping to a minimum depth of 150 mm (6 in.). This area shall be compacted in the same manner as that required for the embankment placed on the area. Sod not required to be removed shall be thoroughly disced before construction of embankment. Where an embankment less than 1.0 m (3 ft.) in height is to be made over a compacted road surface containing bituminous or granular materials, the old road surface shall be scarified to a depth of at least 150 mm (6 in.). This scarified material shall be recompacted.

204.2.14 If embankment is deposited on one side only of abutments, wingwalls, piers, or culvert headwalls, care shall be taken that the area immediately adjacent to the structure is not compacted to the extent that it will cause overturning of or excessive pressure against the structure. Equipment of such weight as may cause damage to culverts of other structures will not be permitted to work over or immediately adjacent to such structures. The fill adjacent to the end bent of a bridge shall not be placed higher behind than in front of end bents until the superstructure is in place. When embankment is to be placed on both sides of a concrete wall or box type structure, operations shall be so conducted that the embankment is kept at approximately the same elevation on each side.

204.2.15 Surcharged embankments shall be built in accordance with the plans and shall remain in place for such time as required by the contract. The requirements for placing and compacting will be waived on the surcharge material above the specified completed area.

204.2.16 Surplus roadway material shall be removed and stored at the stockpile area indicated. The stockpiled material will be confined within the area shown, and necessary precautions will be taken to insure that surface drainage or storm culvert drainage is not interrupted. Prior to contract completion, the contractor shall give the stockpile area a final dressing and seeding so as to provide a pleasing appearance to the overall area. Payment for seeding only, for stockpile areas shown on the plans, will be included as an item of the contract. Seeding of stockpile areas not shown on the plans will be considered incidental to the work, and no direct payment will be made.

204.2.16.1 Surplus roadway excavation and waste materials resulting from removals shall be disposed of in areas obtained by the contractor. The contractor shall comply with the following requirements in securing waste areas and in depositing waste products thereon.

(a) The site shall not be in a flood plain.

(b) Letters of permission and release are required from the affected property owner or owners.
(c) Precautions shall be taken to insure that surface water or storm culvert drainage is not interrupted.

(d) The waste disposal area or areas shall be given a final dressing and seeding to provide a presentable appearance and to prevent soil erosion.

(e) Other siltation control measures such as straw bales shall be applied during construction as directed.

The permit letter provided from the property owner shall be submitted for approval a minimum of five (5) working days prior to the start of operations that will result in waste products or excess excavation. The letter of release will be required before the retained percentage will be released. When dump sites are located in municipalities, a letter of authorization signed by the Mayor or City Administrator will be required.

The contractor may be required to haul over city streets and any hauling operations of the contractor shall be subject to the requirements of such permits and other applicable city regulations and ordinances.

No direct payment will be made for complying with the requirements of this specification. All costs incurred as a result thereof, including seeding, will be considered to be completely covered by the unit prices bid for other items included in the contract.

204.2.17 Roadway embankment shall be placed in layers not exceeding 200 mm (8 in.) (loose measurement) and shall be compacted as specified before the next layer is placed. The layers shall be placed approximately parallel to both the proposed profile grade and to the finished roadbed. Effective spreading equipment shall be used on each lift to obtain uniform thickness prior to compacting. Continuous leveling and manipulating will be required during compacting operations. Construction equipment shall be routed uniformly over the entire surface of each layer.

204.2.17.1 Occasional stones or rock fragments exceeding the thickness of the 200 mm (8 in.) layer shall be disposed of by being incorporated into the embankment outside the limits of the proposed surfaced traffic lanes. The thickness of the layer in these areas may be increased if necessary to accommodate the stones, but shall not exceed 300 mm (12 in.) in thickness (loose measurement). The stones or rock fragments are to be placed so there will be no nesting.

204.2.17.2 Lifts may be increased to a maximum of 300 mm (12 in.) in thickness (loose measurement) for berms, filling of old channels, waste, or similar areas. These areas shall be compacted by uniformly distributing the hauling over the entire area, and specific density control will not be required. No direct payment will be made for compaction performed in these areas.

204.2.18 When the excavated material consists predominantly of rock fragments of such size that the material cannot be placed in layers of the thickness prescribed, such material shall be placed in the embankment in layers having a thickness of the approximately average size of
the larger rocks, but not to exceed 600 mm (24 in.). Rocks or boulders too large to permit placing in a 600 mm (24 in.) layer shall be reduced in size as necessary to permit this placement. Rock shall not be dumped in place, but shall be distributed by blading or dozing in a manner to insure proper placement in final position in the embankment. The spalls and smaller stone fragments shall be left on the surface of each layer as formed. The uppermost portion of rock embankments placed in this manner shall be constructed as follows:

Where the specified or proposed surfacing consists of a rigid or flexible type pavement, the top consolidated rock layer for the full width between roadbed slopes shall be finished to the same limits as shown on the plans for undergrading in rock cuts. When rigid pavement is to be constructed without an aggregate base, the material requirements of Sec 203.2.5.2 shall govern for the construction of the area between the bottom of the pavement and the top of the top consolidated rock layer. Any embankment necessary outside the limits of the pavement shall be constructed of suitable earth or as otherwise specified in the contract.

204.3 Compaction of Embankment and Treatment of Cut Areas with Moisture and Density Control. Modified AASHTO T-180 Compaction Test (ASTM D-1557) will be used as the Standard Compaction Test for determining the moisture density relations of soils. The optimum moisture as determined by the Standard Compaction Test may be used as a guide in determining the proper moisture content at which each soil type should be compacted. Water shall be added or removed as necessary to permit obtaining the required density and moisture control. The field density of the embankment after compaction will be determined, using the total material, in accordance with AASHTO T 191 (Sand Cone Method) or AASHTO T 238, Method B Direct Transmission, for wet density. When nuclear density methods are used, moisture content will be determined in accordance with AASHTO T 239. The volume of the test hole may be reduced as necessary to accommodate available testing equipment. The calculated density obtained in this field density test will be compared with the maximum density as established by the Standard Compaction Test to determine the percent compaction attained. All density tests will be made by the County.

204.3.1 Compaction to at least 90 percent of maximum density, as determined by the Standard Compaction Test, will be required in the following areas:

(a) All roadway embankments except as otherwise provided in the following sections: Sec 204.2.15, 204.2.16, 204.2.17.2, 204.3.4, 204.3.5 and 204.3.8.

(b) All backfilled undergraded cuts.

(c) Certain portions of the roadbed in cuts specified in 204.3.7 except as modified in Sec 204.3.3.

204.3.2 The moisture content of the soil at the time of compaction shall be as herein specified.

204.3.2.1 When necessary to eliminate rubbery condition of the embankment, it may be required that some soils have a moisture content below the optimum during compacting work.
Clays, heavy clays and other Class A materials shall not be placed as embankment when the moisture content of the soil surpasses its optimum moisture content by 3 percent. Existing embankments shall be disced, aerated or reworked to comply with the moisture requirements of this provision subsequent to the resumption of embankment placement operation.

**204.3.2.2** Loessial soils shall have moisture controlled so as not to exceed optimum plus three percentage points when placed in embankments of less than 10 m (30 ft.) in height. Such soils when placed in embankments of 10 m (30 ft.) or more in height shall have moisture controlled so as not to exceed optimum moisture. If wet foundation conditions contribute to the embankment moisture while compacting, the engineer may waive this specified moisture content for a height not to exceed 1.0 m (3 ft.) above the embankment foundation. In the event of conflict of provisions of this section with provisions in Sec 204.3.2.1, Sec 204.3.2.1 shall govern.

**204.3.3** When a flexible type surface is proposed, at least 90 percent of maximum density will be required for the upper 450 mm (18 in.) of the earth subgrade extending the full width between roadbed slopes.

**204.3.4** Roadway embankment within 30 m (100 ft.) of each end of a structure on which the top slab or deck is to be used as the riding surface, and the spill fill under such a structure, shall be compacted to not less than 95 percent of maximum density.

**204.3.5** Density requirements will not apply to portions of embankments constructed of material so rocky that they cannot be satisfactorily tested in accordance with AASHTO T 191. Material of a gradation having more than approximately 20 percent retained or a 19 mm (3/4 in.) sieve will generally be considered too rocky for satisfactory density testing. In lieu thereof, compactive effort on rock and rocky material shall consist of making four complete coverages of each layer with a tamping-type roller or two complete coverages of each layer with a vibratory roller. The tamping-type roller shall have tampers or feet protruding not less than 150 mm (6 in.) from the surface of the drum and have a minimum load on each tamper of 1700 kPa (250 psi) of tamping area. The vibratory roller shall have a manufacturer’s rating of 14 to 18 metric tons (16 to 20 tons) compacting power.

**204.3.6 Compacting in Cut.** Cut compaction, after removal of the roadway excavation material to the required pavement or lowest base course, shall be temporarily exposed for the full width between roadway inslopes. The exposed material, to a depth of 150 mm (6 in.) shall be manipulated and compacted to not less than the required density. The material above this compacted plane shall be respread in layers not exceeding 200 mm (8 in.) loose thickness, each layer being wetted or dried as necessary and compacted to the specified density. The entire volume of materials so handled and compacted, including the 150 mm (6 in.) layer compacted in place, will be considered as Compacting in Cut. All Class A material having a liquid limit of 40 or more, including the 150 mm (6 in.) layer compacted in place, shall be compacted at not less than optimum moisture content.

**204.3.6.1** The existing ground for the full width between roadway slopes under embankments of less than 0.5 m (18 in.) in height shall be treated in accordance with Sec 204.3.6 to only such depth as to insure having 450 mm (18 in.) of material of the required density and
moisture below the top of the finished subgrade.

204.3.6.2 The entire volume of materials so handled and compacted as specified in Sec 204.3.6 and Sec 204.3.6.1 including the 150 mm (6 in.) layer compacted in place will be considered Compacting in Cut.

204.3.7 Each layer shall be wetted or dried, as necessary, and shall be compacted to the required density. Regardless of the type of equipment used, the roadway shall be compacted uniformly and the surface kept reasonably smooth at all times. When large pieces of heavy clay are encountered, the material shall be broken down by suitable manipulation to permit satisfactory embankment construction. When shale is encountered, it shall be broken down as much as is practicable and compacted at or above optimum moisture.

204.3.8 Compaction to at least 95 percent of maximum density will be required for that portion of any embankment below an elevation 15 m (50 ft.) below the top of the finished subgrade. If, because of embankment foundation conditions, the 95 percent of maximum density cannot be obtained after reasonable compactive effort has been expended, the engineer may waive the 95 percent requirement for a height not to exceed 1.0 m (3 ft.) above the embankment foundation.

204.4 Compaction of Embankments Not Constructed with Density or Moisture and Density Control. The compactive effort on each layer shall consist of distributing all equipment movements over the entire fill area and of at least three complete coverages with a tamping-type roller over the entire area to be compacted. The tamping-type roller shall have tampers or feet projecting not less than 150 mm (6 in.) from the surface of the drum and shall have a minimum load on each tamper of 1700 kPa (250 psi) on tamping area. Compactive effort shall be continued, if necessary, until the tamping feet penetrate not more than 50 mm (2 in.) into the layer of material being compacted. Continuous leveling and manipulating will be required during compacting operations and the moisture content shall be adjusted as is necessary, in the judgment of the engineer, to permit proper consolidation.

204.4.1 Dumping and rolling areas shall be kept separate, and no lift shall be covered by another until compaction complying with these requirements has been secured. Unstable areas in the embankment shall be removed and replaced with suitable material at the expense of the contractor.

204.4.2 Each layer of embankment constructed of rock or rocky material shall also be compacted by three complete coverages of the tamping-type roller. A vibratory roller may be used on approval of the engineer.

204.5 Compaction of Embankments without Specified Compaction Results or Specified Compaction Equipment. Only when specifically designated on the plans, compaction will not be required other than that obtained by distributing equipment movements over the entire fill area.
204.6 Method of Measurement.

204.6.1 Contract Quantity Payment. The quantity of embankment in place will be paid as follows:

The quantities for which payment will be allowed have been determined from the fill yardages shown on the roadway cross-sections only and include only those embankment quantities necessary to construct the roadway to the finished design template. Direct payment will not be made for roadway or borrow excavation. Measurement and payment for fills beyond that required to produce the finished roadway template will not be made. Quantities shown on the Earthwork Summary are for information only and are not intended to represent roadway excavation or borrow as pay items. Adjustments in the quantity of Embankment in Place will be made only when:

(a) Errors are found in the original computations.

(b) An original cross-section is found to have an average deviation from the true elevation in excess of 0.3 m (1 ft.).

(c) Rock excavation is encountered.

(d) An authorized change in grade, slope or typical section is made.

When the above conditions are encountered, the corrections or revisions will be computed by the engineer and added or deducted from the contract quantity.

204.6.1.1 When the plans have been altered or when a disagreement exists between the contractor and the engineer as to the accuracy of the plan quantities, either party shall have the right to request a recomputation of the contract quantity by written notice to the other party. The written notice shall contain evidence that an error exists in the original groundline elevation or in the original computations which will materially affect the final payment quantity. When such final measurement is required, it will be made from the last available ground surface and the design section.

204.6.2 Measured Quantities. Payment will be made on a plan quantity basis. Volumes of embankment have been computed from the cross-section measurements of embankment by the average end area method. Should rock excavation be encountered, regardless of classification, final volumes will be computed from cross-section measurements by the average end area method. The volume thus determined will be deducted from the total plan quantity of embankment in place, unless quantities have been established as contract items in the original proposal.

204.6.2.1 When rock excavation is required, the engineer will fix points of elevation and stationing as required to establish the top of rock. These top points will be determined before any Class C, Sandstone, or Igneous Rock Excavation is removed and it shall be the contractor’s responsibility to notify the engineer before removing any such material. Any excavation removed before the engineer has been notified and given 24 hours to establish top elevation will
not be included for payment.

204.6.2.2 Measurement will be made for unsuitable material excavated and removed to permit proper compaction in cut sections and in foundations for fill sections. No measurement will be made of the suitable material temporarily removed and replaced to facilitate compaction in cuts or under shallow fills 0.5 m (18 in.) or less.

204.6.2.3 Only that material placed in accordance with Sec 204.3 will be included in the measurement of Embankment in Place to the nearest cubic meter (cubic yard). Measurement of Embankment in Place will only occur if an error has been found in the original computations or ground elevations, or if there has been an authorized change in grade, slope or typical section which alters the plan quantities. All required embankment, where approved by the engineer, and all placing and compacting of earth material in undergraded cut sections will be considered as Embankment in Place for construction purposes.

204.7 Basis of Payment. Payment for Embankment in Place will be made at the contract unit price bid per cubic meter (cubic yard) and will be considered full compensation for all excavation, both roadway and borrow, all hauling costs, placement and compacting of embankments, preparation of earth subgrade, shouldering, rounding slopes, obliterating old roadways (except rigid pavements), all types of grading, picking up and disposing of pick-up rock and all other earthwork related items. No payment will be made for any material used for purposes other than those designated, except as approved by the engineer.

204.7.1 Payment for authorized excavation of unsuitable material, placement of the backfill material and disposal of the unsuitable material will be made at a unit price of $23.50/m$^3$ ($18.00/cu. yd.) of additional excavation. No direct payment will be made for backfilling overbreak areas or for backfilling around structures.

204.7.2 If the contract contains a unit price for either Sandstone Excavation or Class C Excavation, but not both, it shall apply to the other if both are encountered. If the contract does not contain a unit price for either Sandstone Excavation or Class C Excavation and such material is encountered, payment will be made at four (4) times the unit price bid for Embankment in Place unless the project is let on an unclassified basis. The unit price established in this manner will apply regardless of quantities involved.

204.7.3 If the contract does not contain a unit price for Igneous Rock Excavation and such material is encountered during construction, payment will be made at a unit price of $5.25/m$^3$ ($4.00/cu. yd.) regardless of quantity.

204.7.4 No direct payment will be made for water required in compaction work. Any costs involved in reducing the moisture content in soils will be at the expense of the contractor.

204.7.5 Payment will be made at the unit bid price for each of the pay items included in the contract.
SECTION 206
EXCAVATION FOR STRUCTURES

206.1 Description.

206.1.1 This work shall consist of the necessary excavating for the foundations of all structures, the removing and disposing of all excavated materials, the backfilling around the completed structures, and all related work.

206.1.2 Separate payment will not be made for removing existing structures within the limits of excavation for structures. All removal work which might endanger the new structure shall be completed before any work on the new structure is started. Partial removals of any structure or adjustments of any utility shall be made with care to preserve the value of the retained portions. Work around any live utility shall be done in such manner that uninterrupted service can be maintained.

206.1.3 Excavated material which is unsuitable for backfill and embankments, and excess material not required for either, shall be disposed of. It shall not be dumped into the channel of a stream without the written authorization of the engineer.

206.2 Depth of Excavation. The elevation of the bottoms of footings as shown on the plans shall be considered an approximate elevation, and the engineer by written order may make such changes in plan elevations and dimensions of footings as may be necessary to secure a satisfactory foundation.

206.2.1 When blasting is approved in accordance with Sec 203.2.5, the lower limit of blasting allowed will be 450 mm (18 in.) above the bottom of footing elevation. In the event that over fracturing of the underlying rock below bottom of footing occurs, the removal of loose rock and the backfilling of the resultant void with fill concrete will be at the contractor’s expense.

206.3 Foundation Stabilization and Tests. The contractor shall furnish and place sand, rock, gravel, or other suitable backfill material to replace unsuitable material encountered below the foundation elevation of the structures. He shall stabilize suitable foundation material or form the bottom of pile footings if necessary to obtain a stable foundation. He shall furnish assistance in driving sounding rods or drilling test holes to permit an adequate inspection of the foundation. The depth of the excavation, the character of the material, and the condition of the foundation shall be approved by the engineer before any concrete is placed in the footing.

206.4 Construction Requirements.

206.4.1 Methods shall be used in excavating for foundations of structures that will insure maintaining the stability of the material adjacent to the excavation. Sheeting, cribbing, timbering, or bracing shall be placed by the contractor where indicated on the plans and wherever
considered necessary. The contractor will be held responsible for the adequacy of all sheeting, cribbing, timbering, or bracing used. Shop drawings prepared, sealed and signed by a Professional Engineer registered in the State of Missouri showing bracing or cribbing to be employed by the contractor must be submitted for approval prior to any installation on the project.

206.4.2 Foundations for structures and retaining walls shall be free of loose, shelly, or disintegrated rock, and the footing shall be placed on undisturbed material. Footings shall be keyed not less than 150 mm (6 in.) into hard, solid rock and not less than 450 mm (18 in.) into soft rock or shale or other suitable material specified for spread footings. Excavation in rock or shale for the key shall be made as near as practicable to the size of the footing, or of the key as shown on the plans. When placing the footing, the key portion shall be cast against the vertical, undisturbed face of the rock or shale. When side forms are necessary for footings, they will be adequately braced and they shall be removed approximately 24 hours after placing the concrete, and the excavation shall immediately be backfilled to the top of the footing. All cavities or crevices or low areas below the bottom of footing elevation shall be cleaned out and filled with concrete in accordance with Sec 703.3.12.8, or spanned with a reinforced concrete beam, as directed by the engineer.

206.4.3 Care shall be taken to avoid disturbing the material below the bottom of the footings when the structure is founded on material other than rock, and final removal of grade shall not be made until just prior to placing concrete. Where foundation piles are required, the excavation of each pit shall be completed before the piles are driven, and after the driving is completed all loose and displaced material shall be removed.

206.4.4 If rock is encountered under a portion of the bottom slab of a concrete box-type structure, the rock shall be removed to at least 150 mm (6 in.) below the bottom of the slab and curtain walls, and backfilled with material similar to that under the remainder of the structure.

206.4.5 Concrete footings for structures shall be placed on reasonably dry foundation material. The contractor shall perform all draining, bailing, or pumping operations, drive any sheeting, and construct any cofferdams or cribs necessary to obtain this condition. Pumping from the interior of any foundation enclosure shall be done in a manner to preclude the possibility of the movement of water, or other fluids or semi-fluids, through any fresh concrete. If necessary, the footing form shall be made watertight and shall be sealed around the bottom, and all pumping done between the footing form and the wall of the enclosure.

206.4.6 All holes, pits, or sumps resulting from excavating operations shall be kept drained or pumped out until the completion of the work. No ponding of water around footings on other than rock will be permitted.

206.4.7 Cofferdams. Cofferdams shall, in general, be carried well below the bottom of the footings, and shall be well braced and as watertight as practicable. The interior dimensions of cofferdams shall provide sufficient clearance for the construction of forms and ample room for a sump and for pumping outside the footing forms. Cofferdams which have been tilted or moved laterally during the process of sinking shall be corrected to provide the necessary clearance. They
shall be constructed to protect the work against damage from sudden rising of the stream and to prevent damage to the foundation by erosion. Cofferdams, with all sheeting and bracing, shall be removed after the completion of the substructure unit, unless specific authority is given for them to be left in place. The contractor shall submit drawings showing his proposed method of cofferdam construction and other details open to his choice or not fully shown on the plans.

206.4.8 Seal Courses. Seal courses will be required when indicated on the plans or when conditions are encountered which, in the judgment of the engineer, render it impracticable to unwater the foundation area. The dimensions of the seal course shall be adequate to seal the foundation area. Pumping will not be permitted while excavating, driving piling, or placing the seal course, and not until, by determination of the engineer, the seal course has attained sufficient strength to withstand the hydrostatic pressure. In case seal courses are shown on the plans, and it develops that the footings may be satisfactorily placed without sealing, the contractor will be required to unwater any completed excavation for investigation purposes. Seal courses, other than those on the plans, will not be authorized or permitted except for extreme cases where it is impracticable to unwater the footing area by other means, and then only with the written permission of the engineer.

206.4.9 Backfill. Backfill material shall be of an acceptable quality and shall be free from large or frozen lumps, wood, or other extraneous material. All spaces excavated and not occupied by the new structure or by porous backfill shall be refilled with earth to the original ground surface or to the finished ground lines shown on the plans. All backfill shall be thoroughly compacted and its top surface neatly graded. The backfill at end bents, walls, or other units which falls within the limits of the roadbed shall be placed in successive 150 mm (6 in.) layers and compacted to the same density required for the adjacent roadbed. Large rock, broken concrete, asphalt or other solid material shall not be used as backfill within 450 mm (18 in.) of the fill face of culverts, retaining walls or end bents. Special precaution shall be taken to prevent any wedging action against the masonry. The slope bounding the excavation, if steeper than six horizontal to one vertical, shall be stepped or serrated. Backfill placed around culverts and piers shall be kept at approximately the same elevation on opposing sides. Drains consisting of 0.15 m$^3$ (5 cu. ft.) of coarse aggregate shall be placed at weepholes except where porous backfill is required. Backfill material shall not be placed against end bents or bridges, sides of box culverts, or back of retaining walls until the concrete has attained the strength specified in Sec 703.3.10. Backfill material shall not be placed higher behind than in front of end bents until the superstructure is in place. Until the grade is in place, drainage shall be maintained away from the end bent backwall by constructing a 6 to 1 or steeper slope away from the backwall for a minimum distance of 1.0 m (3 ft.) and providing a lateral path for all water to flow off of the roadway section.

206.4.10 Porous Backfill. Porous backfill meeting the requirements of Sec 1009.1 shall be placed back of abutments, wings, and retaining walls where specified and shown on the plans. It shall be 0.5 m (18 in.) thick and shall extend from the bottom of weep holes or other drainage devices to within 0.6 m (2 ft.) of the finished ground line. The remaining 0.6 m (2 ft.) shall be backfilled with earth. Porous backfill shall be so placed and consolidated in successive 300 mm (12 in.) layers that it will not become mixed with other backfill material.
206.4.11 Excavation Classification. Unless otherwise shown on the plans, excavation for structures will be classified as Class 1 or Class 2. In general, Class I and Class 2 Excavation will apply to excavation for bridges and large retaining walls. Class 1 Excavation will include all excavation above a specified elevation indicated on the plans while Class 2 Excavation will include all excavation below this specified elevation. The classification of excavation for all structures will be shown on the plans.

206.5 Method of Measurement.

206.5.1 Measurement of Class 1 and Class 2 Excavation will be made to the nearest 0.5 m$^3$ (1/2 cu. yd.) for each structure of that volume of material actually removed from within the limits herein established. The volume measured will be limited by vertical planes 450 mm (18 in.) outside of and parallel with the neat lines of footings, tie beams, or overhangs of structures classed as bridges or retaining walls. The upper limits of the volume measured will be the existing ground line or the lower limits of the roadway, drainage, or channel excavation, including any allowable overbreak, whichever is lower. Where roadway spill fills are required to be placed and compacted before driving piles for end bents, no measurement of excavation will be made for the end bents. If such roadway spill fills are placed and compacted before constructing an intermediate bent, any required additional excavation for the intermediate bent will be measured from the spill slope. For stream crossings the measured volume will not include water, but will include mud, muck, and other semi-solids. The lower limits of the volume measured will be the bottom of the footings, bottom of seal courses, or 450 mm (18 in.) below the bottom of tie beams and overhangs. For timber bents, the excavation will be measured within the horizontal limits shown on the plans to the bottom of the backing supports for end bents, and to the bottom of the sway bracing for intermediate bents.

206.5.1.1 Excavation for columns above pedestal piles will be Class 1 Excavation with measurement being made of the volume of material actually removed above top of pedestal. The volume measured will not exceed that of a cylinder having a diameter 1.0 m (36 in.) greater than that of the column above the pedestal. No measurement will be made of the material excavated for the pedestal below the bottom of the column.

206.5.2 Where concrete in footings or walls is cast against the vertical faces of the excavation, the neat lines of the concrete footings will be considered the limits of excavation for the depth in which the concrete is in contact with the excavation, and no measurement will be made of any excavation or overbreak beyond the neat footing lines.

206.5.3 The volume of porous backfill will be computed to the nearest cubic meter (cubic yard) at each structure from dimensions on the plans. Any porous backfill material placed outside the neat lines shown on the plans will be placed at the contractor’s expense. Final measurement of the porous backfill will not be made except for authorized changes during construction, or where appreciable errors are found in the contract quantity. The revision or correction will be computed and added to or deducted from the contract quantity.
206.6 Basis of Payment.

206.6.1 Payment for additional Class 1 and Class 2 Excavation required to carry footings a maximum of 2.5 m (8 ft.) below elevations shown on the plans will be made at 125 percent of the contract unit bid price for that additional excavation within the limits of Class 1, and at 150 percent of the contract unit bid price for that additional excavation within the limits of Class 2 Excavation. Additional excavation required to carry footings a depth of more than 2.5 m (8 ft.) below plan elevations will be considered extra work, and will be paid for based on unit prices previously agreed to in writing by the parties to the contractor or, where such prices cannot be agreed to, the work shall be done on a force account basis if so ordered by the County Engineer.

206.6.2 Payment for drilling test holes for foundations test will be made at the rate of $23.00/m ($7.00/ft.) of hole drilled.

206.6.3 Payment will not be made for removal or replacement of foundation material which became unsuitable because of improper methods of construction by the contractor. No payment will be made for any cost involved in replacing the volume below grade.

206.6.3.1 Payment for backfill material, 50 mm to 75 mm (2 to 3 in.) clean stone, required in areas where unsuitable material has been removed, will be made at the invoice price plus $1.50/metric ton ($1.35/ton) for providing required material. Measurement of this backfill material will be determined from certified weight tickets delivered with the material and verified by the engineer. No direct payment will be made for spreading, shaping and compacting of this backfill material. The cost for spreading, shaping and compacting is considered to be covered by the additional payment described in Sec 206.6.1.

206.6.4 No direct payment will be made for placing coarse aggregate at weepholes as required by Sec 206.4.9. No direct payment will be made for backfilling the structure unless so specified in the contract.

206.6.5 The accepted quantities of excavation for structures will be paid for at the unit bid price for each of the pay items included in the contract.
SECTION 207
LINEAR GRADING

207.1 Description. This work shall consist of that grading work necessary to bring the roadway to the required grade and cross section within reasonable tolerances. It shall also include:

(a) The construction of all inlet and outlet ditches and ditch blocks within the linear grading limits unless otherwise provided for in the contract.

(b) The construction of entrances and approaches.

(c) The breaking up and satisfactorily removing or incorporating into the roadway of all gravel, macadam, or bituminous surfaces.

All linear grading will be classified as hereafter described.

207.1.1 Linear Grading, Class 1, shall consist of grading where the topography is such that the excavation necessary to bring the roadway to the designated cross section will approximately make the nearby fills with a minimum of drifting or hauling, and where it will not be necessary to control the finished grade line for purposes other than to obtain minimum cover over culverts.

207.1.2 Linear Grading, Class 2, shall consist of grading where it is necessary to excavate and haul material to bring the roadway to the desired grade and may involve work on high banks and side hills.

207.1.3 The class of linear grading designated on the plans will apply only to those sections which have been specifically indicated as such on the plans and will not be subject to change during construction.

207.2 Construction Requirements.

207.2.1 The roadway shall be brought to the required grade and cross section within reasonable tolerances by backsloping, ditching, removing stone and boulders from the roadbed surface, or any other work necessary, including drifting and hauling of any excavated material. A reasonable tolerance in alignment means a maximum gradual deviation of 0.6 m (2 ft.), free of sharp breaks, to take advantage of favorable topography. Gradual deviation in alignment will also be permitted, if necessary to center an existing drainage structure that is to be used in place. A reasonable tolerance in grade means a final grade that is uniform in appearance, free of sharp breaks or humps, and within 0.15 m (0.5 ft.) of plan grade.

207.2.2 Stumps, roots, rubbish, or any other deleterious material shall not be placed in
embankments. Where an embankment of less than 0.6 m (2 ft.) in height is to be constructed, all vegetable matter shall be cut and removed from the surface upon which the embankment is to be placed. The cut-over surface shall be thoroughly broken. All ditches including inlet and outlet ditches shall be cut to grades that will properly drain. The required cross section for inlet and outlet ditches leading to or from structures shall be of a width not less than the width of the floor or the diameter of the structure being served. Finishing operations shall continue until the roadbed is free from sharp breaks in alignment and grade, and until it has been shaped to the required cross section. Material considered unsuitable for the subgrade shall be disposed of on nearby slopes or as otherwise directed by the engineer.

207.2.3 If obliteration of old roads is designated in the contract to be performed on a linear grading basis, such obliteration shall include all grading operations necessary to fill the ditches and blend the old road with the natural ground to provide a pleasing appearance.

207.3 Method of Measurement. Measurement of Linear Grading, Class 1 and Class 2 will be made to the nearest 0.1 station.

207.3.1 Unless otherwise provided in the contract, measurement and payment for entrances and approaches will be made as Linear Grading, Class 1. Entrances and approaches will be measured along the centerline of each facility, regardless of the width to be constructed, beginning at the shoulder line of the road that is being entered and extending to the point of zero cut or fill of the entrance or approach.

207.3.2 If material is encountered that may be classified as other than Class A Excavation as described in Sec 203.1, the limits of Linear Grading will not be underrun but the material classified as other than Class A Excavation will be measured and paid for on a volume basis in accordance with Sec 203.7. If the contract does not contain a unit price for Class A Excavation and if Class C Excavation is encountered, payment for Class C Excavation will be made at a unit price of $3.50/m³ ($3.00/cu. yd.) regardless of quantity, unless the project is let on an unclassified basis. Where undergrading is necessary backfilling of the undergraded area will be considered as a part of the linear grading operation.

207.4 Basis of Payment. The accepted quantities of linear grading will be paid for at the unit bid price for each of the pay items included in the contract.
SECTION 209
SUBGRADE PREPARATION

209.1 Description. This work shall consist of preparing the earth subgrade upon which a base course is to be constructed or a surfacing placed.

209.2 Equipment. A self-propelled steel wheel roller weighing not less than 9 metric tons (10 tons) shall be used in preparing any subgrade for flexible type surfacing and weighing not less than 4.5 metric tons (5 tons) when preparing any subgrade for portland cement concrete base course or pavement.

209.3 Construction Requirements. The earth subgrade shall be substantially uniform in density throughout its entire width. It shall conform to the lines, grades, and typical cross sections shown on the plans, or as established by the engineer. The earth subgrade shall be constructed to drain surface water to the side ditches and all ditches shall be kept open by the contractor. Where hauling results in ruts or other objectionable irregularities, the contractor shall reshape and reroll the earth subgrade before the base or surfacing is placed. If an old traveled roadway comprises any part of the roadbed, the contractor shall loosen the compacted portions to a depth of at least 150 mm (6 in.) and shall reshape the roadbed.

209.3.1 All earth subgrades, except those for aggregate type surfacing, shall be rolled. The earth subgrades shall be checked after rolling, and if not at the proper elevation at all points, sufficient material shall be removed or added and compacted to bring all portions of the subgrade to the required elevation and density. The moisture content of the top 150 mm (6 in.) of the finished earth subgrade at the time the base is placed, or at the time the pavement is placed if no base is provided under the pavement, shall be not less than the minimum specified for compacting in Sec 203. If the moisture content has not been maintained, the earth subgrade shall be scarified, wet to the required moisture content, and compacted. An occasional maximum deviation of 13 mm (1/2 in.) from the required elevation will be permitted on the surface of the finished earth subgrade. The extent of acceptable areas of deviation will be determined by the engineer.

209.3.2 Prior to laying base or setting paving forms on projects where grading and paving are included in the same contract, the subgrade shall conform to the density requirements for compaction. Soft spots and unsuitable material shall be removed to a depth determined by the engineer and backfilled with approved stable material. It is the intent of this specification that the required backfill be provided to furnish a stable foundation for the roadway. The engineer may order additional excavation beyond the pay limits established for roadway construction. 50 mm (2 in.) or greater clean stone shall be used as backfill for such excavations. The gradation of the material will be determined by the engineer.

209.3.3 The earth subgrade for portland cement concrete pavement shall be compacted, and brought to true shape by an approved subgrade machine. Any material added shall be
satisfactorily incorporated and compacted. Before the concrete is placed, a true subgrade shall be shaped by an approved subgrade planer rolling on the forms and any resulting loose material on the earth subgrade behind the planer shall be recompacted with the 4.5 metric ton (5 ton) steel wheel roller. The planer shall be adjustable to produce earth subgrade of the exact elevation and cross section. After all grading or planing operations have been completed and immediately before the concrete is placed, the earth subgrade shall be checked with an approved heavy metal template which shall be rolled on the forms. Scratch templates with spikes or teeth will not be permitted. A taut line across the top of side forms and a ruler may be used in lieu of a template for checking the subgrade on irregular areas or variable widths. Extreme care shall be taken in forming the crown and shaping the subgrade to assure that the specified thickness of concrete will be attained in the finished pavement.

209.3.3.1 The finished earth subgrade at the time of paving shall be moist, but sufficiently firm to resist rutting or deforming under construction traffic.

209.3.4 In the event the contractor elects to use slip forming method for pavement construction, additional earth subgrade preparation will be in conformance to specifications heretofore; however, no direct payment will be made for such additional earth subgrade preparation requirements.

209.4 Method of Measurement. Measurement for the volume of unsuitable material excavated beyond or outside the limits shown on the plans or established by the specifications for roadway excavation will be made by the engineer to the nearest cubic meter (cubic yard).

209.5 Basis of Payment.

209.5.1 No direct payment will be made for earth subgrade preparation. No direct payment will be made for water necessary for earth subgrade preparation.

209.5.2 Payment for authorized excavation of unsuitable material, placement of the backfill material and disposal of the unsuitable material will be made at a unit price of $23.50/m³ ($18.00/cu .yd.) of additional excavation.
SECTION 210
SUBGRADE COMPACTION

210.1 Description. This work shall consist of compacting earth subgrade that is yielding or not substantially uniform in density or which does not contain the proper moisture content in the top 150 mm (6 in.). This item of work shall be performed when (1) the subgrade density, following the use of the roller required by Sec 209.2 is less than that required under Sec 203 or (2) the moisture content is less than the minimum specified in Sec 203. Subgrade Compaction, Type 1, is defined as compaction of the subgrade for the full width of the roadbed. Subgrade Compaction, Type 2, is defined as compaction of the subgrade for a width extending not less than 450 mm (18 in.) beyond the edge of the pavement.

210.1.1 The contractor shall perform this work on the subgrade at all locations specified by the engineer. Tentative locations of subgrade compaction will be shown on the plans, but the engineer will specify all locations and depths of this work by written order. Any overrun, or partial or complete underrun, shall not be a basis for claim.

210.2 Construction Requirements.

210.2.1 The subgrade shall be scarified to a depth of at least 150 mm (6 in.), and the scarified material brought to a uniform moisture content either by drying or by adding water, and manipulating with suitable equipment. At the contractor’s option, the upper 150 mm (6 in.) of soil may be removed and replaced with satisfactory material, or removed and manipulated with suitable equipment before replacing. The material shall be compacted to produce a subgrade having a density not less than the density required and within the moisture contents specified under Sec 203 by the use of approved equipment producing satisfactory results.

210.2.2 When it is determined that the required subgrade density cannot be obtained by moisture control and compaction of the upper 150 mm (6 in.), the unsuitable material shall be excavated to a depth not to exceed 450 mm (18 in.), and replaced with satisfactory material in layers not to exceed 150 mm (6 in.), except as otherwise permitted by the engineer. Each 150 mm (6 in.) layer shall be processed, wetted or dried as necessary and compacted to the required density.

210.2.3 If an unsatisfactory subgrade has developed through negligence on the part of the contractor, he will be required to restore it to a satisfactory condition at his expense.

210.3 Method of Measurement. Measurement will be made to the nearest 0.1 station along the center line of each roadbed, regardless of width, for each depth of compaction authorized. For the purpose of measurement, a divided highway will be considered as having two roadbeds. Measurement of ramps will be made from or to a point opposite the intersection of the outer edge of the pavement on the thruway, or its widening, and the inner edge of the pavement on the ramp.
210.4 Basis of Payment. Subgrade compaction for material placed in two 150 mm (6 in.) lifts to a depth of 300 mm (12 in.) will be paid for at the rate of two times the contract unit price for subgrade compaction 150 mm (6 in.) depth. Subgrade compaction for material placed in three 150 mm (6 in.) lifts to a depth of 450 mm (18 in.) will be paid for at the rate of three times the contract unit price for subgrade compaction 150 mm (6 in.) depth.
SECTION 211
SUBGRADE SCARIFYING

211.1 Description. This work shall consist of loosening the surfacing of the roadbed and removing all rocks larger than 100 mm (4 in.). Although locations of subgrade scarifying may be shown on the plans, the contractor shall perform this work at such locations only as are specified in writing by the engineer.

211.2 Construction Requirements. When subgrade scarifying is ordered by the engineer, the contractor shall perform all work necessary to loosen the surface of the roadbed over its full width to a depth of 150 mm (6 in.) below the finished grading section, and remove all rocks larger than 100 mm (4 in.). Oversize material shall be disposed of as directed by the engineer. After all of the oversized material has been removed, the roadbed shall be brought back to a satisfactory grade and cross section by the addition of extra material, if needed, without rocks that exceed 100 mm (4 in.) in size.

211.3 Method of Measurement. Measurement will be made to the nearest 0.1 station for each increment, and totaled to the nearest 0.5 station for the sum of all the increments composing the measurement along the center line of the roadbed, regardless of the width of subgrade scarifying performed.

211.4 Basis of Payment. The accepted quantity of subgrade scarifying will be paid for at the contract unit price.
SECTION 212
SUBGRADING AND SHOULDERING

212.1 Description.

212.1.1 Subgrading and shouldering, Class 1, shall consist of preparing the earth subgrade for the surfacing and shoulders by fine-grading and shaping the existing roadbed of a previously graded roadway, and shaping fill slopes, inslopes and ditches as required to complete a finished roadway conforming to the typical section.

212.1.2 Subgrading and Shouldering, Class 2, in addition to the above, shall include the construction and final shaping of earth shoulders.

212.2 Construction Requirements.

212.2.1 Subgrading and Shouldering will normally be restricted to the roadway from ditch to ditch or to the roadbed and upper portions of fill slopes. All ditches shall be graded to drain. The median, if any, shall be shaped to conform to the typical section. No work will be required on backslopes except that necessary to blend the lower portion of the existing backslope with the regraded ditch. The work on fill slopes shall be confined to the upper 3.0 m (10 ft.) of the slope, measured along the slope line. Minor drifting of excavated material to bring the subgrade, shoulders, and ditches to proper grade and section is to be expected. Minor drifting shall be considered the moving of material that one 7.5 m³ (10 cu. yd.) scraper can shift without delay to normal subgrading operations.

212.2.2 When the subgrade as prepared in accordance with Sec 209, Subgrade Preparation, has less density than that required under Sec 203.3, the engineer may order the item of Subgrade Compaction to be performed. When lack of satisfactory density results from improper maintenance by the contractor, the subgrade density shall be restored at the contractor’s expense. Earth shoulders shall be constructed in accordance with the requirements of Sec 203.2.

212.2.3 Finishing of ditches, side slopes, cuts, and fills shall be to a reasonably smooth and uniform surface that will merge with the adjacent slopes. Finishing by hand methods will not be required, except that all brush, weeds, excess mud and silt, or other debris shall be removed from all channels and culverts within the scope of the work even though such structures are used in place.

212.2.4 Any additional material required to complete the subgrade or shoulders to proper grade and section shall be obtained from within the right-of-way limits as directed by the engineer. Direct payment will not be made for minor drifting of excavated material, or for any additional material required; nor will overhaul be allowed for such operations. Excess excavation shall be used for widening shoulders on fill sections or wasted within the limits of the right-of-way as directed.
212.3 Method of Measurement. Measurement of Subgrading and Shouldering, Class 1 and Class 2 will be made to the nearest 0.1 station along the center line of each roadbed, regardless of width. For the purpose of measurement a divided highway will be considered as having two roadbeds. Measurement of ramps will be made from or to a point opposite the intersection of the outer edge of the pavement on the thruway, or its widening, and the inner edge of the pavement on the ramp.

212.3.1 Subgrading and Shouldering, Class 1 and Class 2 will apply only to those sections that have been specifically designated as such on the plans and the class will not be subject to change during construction.

212.4 Basis of Payment. The accepted quantity of subgrading and shouldering will be paid for at the unit bid price for each of the pay items included in the contract.
213.1 Description. This work shall consist of grading and shaping existing shoulders to conform to the typical sections shown in the contract.

213.1.1 Shaping shoulders, Class 1, is defined as shaping shoulders where, in general, the material required to bring the roadway to the designated cross section can be obtained, or disposed of within the right-of-way limits as directed by the engineer.

213.1.2 Shaping shoulders, Class 2, is defined as shaping shoulders where it may be necessary to go outside the limits of the right-of-way for additional material to construct the shoulders to the designated cross section or where it may be necessary to dispose of waste material outside the limits of the right-of-way.

213.2 Construction Requirements.

213.2.1 Shoulders shall be constructed of suitable material to the cross section shown on the typical section. Ditches are to be provided in cut sections as indicated on the plans. Such additional ditch work as is necessary to insure proper drainage shall also be performed. Vegetation on existing shoulders and slopes shall be mowed or cut in areas of grading work, and such cuttings shall be disposed of prior to the placing of any shoulder material. Shoulder material shall be compacted by a roller weighing not less than 4.5 metric tons (5 tons). Finishing of shoulders of slopes, and ditches where necessary shall be to a reasonably smooth and uniform surface. Only that work will be required on backslopes as is necessary to blend the lower portion of the existing backslopes with any regraded ditch. Finishing by hand methods will not be required.

213.2.2 If additional material is required for shaping shoulders to the minimum width, it shall be obtained from the backslopes as directed by the engineer, or from borrow areas outside the limits of the right-of-way in areas provided by the contractor at his expense. If excess excavation results, it shall be disposed of by uniformly widening shoulders on embankment sections, or wasted outside the limits of the right-of-way in areas provided by the contractor at his expense. The contractor shall provide the engineer with an acceptable written agreement with any property owner from whose property additional material is to be obtained or on which excess excavation is to be disposed.

213.2.3 A temporary shoulder having a minimum width of 0.6 m (2 ft.) shall be constructed on the high side of superelevated curves immediately upon completion of the wedge course and base widening of the curve. The contractor shall also roughly shape the shoulders and provide for surface drainage when work is to be discontinued for an extended period.

213.2.4 Shaping shoulders shall also include adjusting grades on existing entrances and
approaches as necessary to meet shoulder grades. Such adjustments shall extend to the right-of-way line, if necessary to provide a satisfactory approach grade.

213.2.5 Shaping shoulders shall start when enough of the final surfacing course has been placed and cured that the operation of shaping shoulders can be practicably continuous. In no case shall the work of shaping shoulders be delayed after one kilometer (one mile) of surfacing has been completed and has cured sufficiently to support equipment for shaping shoulders without damage to the surface.

213.3 Method of Measurement. Measurement will be made to the nearest 0.01 km (0.01 mile) along the center line of the pavement, which measurement shall include shaping shoulders on both sides of the center line regardless of width of roadbed.

213.3.1 Class 1 or Class 2 shoudering will apply only to those sections that have been specifically designated as such on the plans and the class will not be subject to change during construction.

213.3.2 Final measurement will not be made except where appreciable errors are found in the contract quantity. The correction will be added to or deducted from the contract quantity.

213.4 Basis of Payment. No direct payment will be made for any additional material required for completion of the shoulders.

213.4.1 The contractor will not be required to excavate any classified rock excavation under this item.

213.4.2 The accepted quantity of shaping shoulders will be paid for at the unit bid price for each of the pay items included in the contract.
SECTION 214
WATER

214.1 Water shall be applied as specified. The source and quality of water shall meet the approval of the engineer.

214.2 Water quantities required shall be included as part of dust control and subgrade preparation. No direct payment will be made for water used in performing these operations.
SECTION 215
SHAPING SLOPES

215.1 Description. This work shall consist of grading and shaping existing slopes in conformity with the lines, grades, and typical sections shown on the plans or established by the engineer.

215.1.1 Shaping slopes, Class 1, is defined as shaping slopes where, in general, the material required to bring the roadway to the designated cross section can be obtained or disposed of within the right-of-way limits as directed by the engineer.

215.1.2 Shaping slopes, Class 2, is defined as shaping slopes where it may be necessary to go outside the limits of the right-of-way for additional material to construct the slopes to the designated cross section or where it may be necessary to dispose of waste material outside the limits of the right-of-way. The contractor shall provide the engineer with an acceptable written agreement with any property owner from whose property additional material is to be obtained or on which excess excavation is to be disposed.

215.2 Construction Requirements. Slope areas to be shaped by the addition of material shall be scarified to allow bonding with the added material. The density shall be that obtained from a reasonable compaction effort consisting of not less than three passes with a roller approved by the engineer.

215.3 Method of Measurement. Measurement will be made to the nearest 0.01 km (0.01 mile) separately for each length of slope measured along the centerline of the travel way.

215.3.1 Shaping slopes, Class 1 or Class 2 will apply only to those sections that have been specifically designated as such on the plans and the class will not be subject to change during construction.

215.3.2 Final measurement will not be made except where appreciable errors are found in the contract quantity. The correction will be added to or deducted from the contract quantity.

215.4 Basis of Payment. No direct payment will be made for any additional material required for shaping slopes.

215.4.1 The contractor will not be required to excavate any classified rock excavation under this item.

215.4.2 The accepted quantity of shaping slopes will be paid for at the unit bid price for each of the pay items in the contract.
SECTION 216
GRADING, SHAPING, AND COMPACTING

216.1 Description. This work shall consist of grading the scarified road surface and existing subgrade material to a maximum depth of 450 mm (18 in.). Grading shall be confined within the limits of the ditch inslope and must incorporate into the roadbed all gravel, macadam or bituminous remains of the original surfacing or base. Shaping of the subgrade material shall be required to bring the roadbed to the required typical section, upon which a base course is to be constructed.

216.1.1 Locations of grading, shaping and compacting will be shown on the plans.

216.2 Construction Requirements. The graded material shall be brought to a uniform moisture content either by drying or by adding water and manipulating with suitable equipment. The material shall be compacted to produce a subgrade having a density of not less than the density required under Sec 203.3. In other respects, the compaction requirements shall be in accordance with Sec 203.3.7. Equipment requirements shall conform in all respects to those set out in Sec 203.4.

216.3 Method of Measurements. Measurement will be made to the nearest 0.1 station along the centerline of the pavement, which measurement shall include grading, shaping, and compacting on both sides of the centerline regardless of the width of the roadbed.

216.4 Basis of Payment. No additional payment will be made for additional material required for bringing the roadbed to the required typical section. The accepted quantity of grading, shaping, and compacting will be paid for at the contract unit price.
Division 300

BASES AND AGGREGATE SURFACES
SECTION 304
AGGREGATE BASE COURSE

304.1 Description. This work shall consist of furnishing and placing one or more courses of aggregate on a prepared subgrade in accordance with these specifications and in conformity with the lines, grades, thicknesses, and typical cross sections shown on the plans or established by the engineer. The type of aggregate to be used will be specified in the contract.

304.2 Materials. All materials shall conform to Division 1000, Materials Details, and specifically as follows:

<table>
<thead>
<tr>
<th>Item</th>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type 1 Aggregate</td>
<td>1007.1</td>
</tr>
<tr>
<td>Type 2 Aggregate</td>
<td>1007.2</td>
</tr>
<tr>
<td>Type 3 Aggregate</td>
<td>1007.3</td>
</tr>
<tr>
<td>Type 4 Aggregate</td>
<td>1007.4</td>
</tr>
<tr>
<td>Type 5 Aggregate</td>
<td>1007.5</td>
</tr>
</tbody>
</table>

304.3 Construction Requirements.

304.3.1 Field Laboratory. The contractor shall provide a field laboratory only when specifically required by the contract.

304.3.2 Subgrade. All work on that portion of the subgrade on which the base is to be constructed shall be completed in accordance with the requirements of Sec. 209.3.1 prior to the placing of any base material on that portion. Aggregate base shall not be placed on a frozen subgrade.

304.3.3 Mixing. Unless otherwise specified, base material, any additional material required, and sufficient water to obtain the desired compaction shall be thoroughly mixed and delivered to the road as a combined product.

304.3.4 Placing. The maximum compacted thickness of any one layer shall not exceed 150 mm (6 in.). When the specified compacted depth of the base course exceeds 150 mm (6 in.), the base shall be constructed in two or more layers of approximately equal thickness. The compacted depth of a single layer of the base course may be increased to 200 mm (8 in.) for shoulders and lightly traveled areas.

304.3.4.1 The contractor shall be responsible for placing the correct quantity of base material on the roadbed to construct a base conforming to the contract. Excess material shall be hauled ahead and reused, or weighed over scales at point of origin with a bonded weighmaster’s certification stamp. Only material incorporated in the completed base will be included in the quantity allowed for payment.
304.3.4.2 If the contractor elects to construct concrete pavement by slip-form methods, the width of aggregate base shown on the plans shall be increased to provide a 1.0 m (3 ft.) width outside the edge of the pavement being placed. The width of aggregate base shown on the plans shall be increased to provide a 0.5 m (18 in.) width outside the edge of the pavement being placed for residential subdivision street pavement.

304.3.4.3 Types 1, 2, 4, and 5 aggregate used for shoulders adjacent to rigid or flexible type pavement, including pavement resurfacing, shall be simultaneously deposited and spread on the subgrade with an approved spreading machine. Aggregates shall not be deposited on the pavement and bladed or dozed into place.

304.3.5 Shaping and Compacting. Immediately before spreading the mixture, the subgrade shall be sprinkled as directed by the engineer. The mixture shall be uniformly spread in successive layers of such depth that when compacted, the base will have the approximate thickness specified. Aggregate base course shall be compacted to not less than standard maximum density. Each layer shall be compacted to the specified density before another layer is placed, with the following exception. If difficulty is encountered in obtaining the specified density after reasonable compactive effort has been expended on the first lift placed over Type 4 aggregate, the engineer may permit placing another layer. The testing for density will then be made on the combined lifts or layers.

304.3.5.1 Segregated surface areas of base constructed of Types 1, 2, and 3 aggregate may be corrected by adding and compacting limestone screenings of such gradation and quantity as required to fill the surface voids and firmly bind the loose materials in place. Screenings used in correcting segregated surface areas will be measured and paid for as base material. Base material contaminated to such an extent that it no longer complies with the specifications shall be removed and replaced with satisfactory material at the expense of the contractor.

304.3.5.2 The top 13 mm (1/2 in.) of base constructed of Type 3 aggregate may be of material meeting the requirements of Sec. 1007.3 and having a maximum size of 13 mm (1/2 in). It shall be compacted as may be required to obtain the specified density.

304.3.5.2.1 Shaping and compacting shall be performed until a true, even and uniform surface of proper grade, cross section and density is obtained. Types 1, 2, and 5 aggregate used for shoulders and Type 3 aggregate shall be compacted to not less than 90 percent of standard maximum density. Types 1, 2, and 5 aggregate, for use on other than shoulders shall be compacted to not less than standard maximum density. The Standard Compaction Test will be made in accordance with Modified AASHTO T-180 Compaction Test (ASTM-1557). Field density will be determined in accordance with AASHTO T 191, using the total material or AASHTO T 238, Method B Direct Transmission, for wet density. The volume of the test hole may be reduced as necessary to accommodate available testing equipment. If nuclear density test methods are used, moisture content will be determined in accordance with AASHTO T 239, except that a moisture correction factor will be determined for each aggregate. In lieu of the density requirements for Types 1, 2, and 5 aggregate used for shoulders with thicknesses less than 100 mm (4 in.), the aggregate shall be compacted by not less than three complete coverages.
with a 4.5 metric ton (5 ton) roller. Rolling shall be continued until there is no visible evidence of further consolidation. In lieu of the density requirement the compacting of Type 4 aggregate shall continue until the material is sufficiently compacted and stabilized to permit adequate densification of the upper portion of the shoulder or base. During shaping and compacting operations the moisture content of the base shall be maintained at the level necessary for compaction by wetting or drying as required. Final rolling shall be accomplished by a self-propelled smooth-wheeled roller weighing not less than 4.5 metric tons (5 tons).

304.3.5.3 Shaping of the completed surface of the aggregate base for flexible type surfacing shall be continued until the deviation from the required elevation does not exceed an occasional maximum deviation of 6 mm (1/4 in.). The surface of aggregate base for rigid type surfacing shall be brought to proper crown and elevation in accordance with the requirements of Sec. 502.6. Allowable deviation in final subgrade template will not rescind the contractor’s responsibility of placing concrete in accordance with Sec. 502.17.

304.3.5.4 The surface of the aggregate base shall be well drained at all times. If at any time the compacted aggregate base or subgrade becomes unstable, it shall be the contractor’s responsibility to restore, at his expense, the earth subgrade and the aggregate base to the required grade, cross section, and density.

304.3.5.5 When measurement of aggregate base course by area, complete in place, is specified, thickness of the aggregate base will be determined from measurements through the finished base at approximately 30 m (100 ft.) intervals. When the measurement indicates the thickness is deficient in excess of 13 mm (1/2 in.) from the plan thickness, additional measurements will be taken at 8 m (25 ft.) intervals parallel to centerline ahead and back of the affected location until the extent of the deficiency has been determined. It will be assumed that each measurement is representative of the base thickness for a distance extending one-half the distance to the next measurement, measured along centerline, or in the case of a beginning or ending measurement, the distance will extend to the end of the base section. Any deficient areas shall be corrected by reworking and adding material within the limits of the deficiency.

304.3.6 Maintenance. When the base is to be constructed in more than one layer, the contractor shall maintain each layer by wetting or drying, blading, and rolling in a manner satisfactory to the engineer, until it is covered by the next layer. This maintenance, including necessary water, shall be entirely at the contractor’s expense. If a prime coat is specified in the contract, the contractor will be required to apply the prime coat on any completed portion of the base as soon as practicable, or as otherwise specified. However, he will not be permitted to apply prime if the moisture in the top 50 mm (2 in.) of the aggregate base exceeds two-thirds of the optimum moisture as determined by the Standard Compaction Test. The contractor shall maintain the required density and surface condition of any portion of the completed base until either the prime or a succeeding aggregate course or pavement is placed.

304.4 Method of Measurement.

304.4.1 Measurement of Aggregate by Weight Measurement will be made by using an accurate and reliable platform scale to produce platform scale weigh tickets. The scale will be the
material suppliers’ equipment that is inspected and certified.

304.4.2 Measurement of Aggregate Base Course by Area. Measurement of aggregate base course complete in place will be made to the nearest square meter (square yard), except that the area of additional material required by Sec. 304.3.4.2 will not be included. Separate measurement will be made for each type and each thickness of base course. Final measurement of the completed aggregate base course will not be made except for authorized changes during construction, or where appreciable errors are found in the contract quantity. The revision or correction will be computed and added to or deducted from the contract quantity. When the aggregate base course extends to the inslope of the shoulder, the pay limit of the aggregate base course will be measured from the mid-point of the sloped portion.

304.5 Basis of Payment. The accepted quantities of aggregate base course of the thickness and type specified will be paid for at the unit price for each of the pay items included in the contract. No direct payment will be made for water used in performing this work.
SECTION 306
MODIFIED SUBGRADE

306.1 Description. This work shall consist of modifying a wet subgrade to improve stability prior to paving operations. This work may be performed at the contractor’s option and with concurrence of the engineer, within the limits of this specification.

306.2 Material. All material shall conform to Division 1000, Materials Details, and specifically as follows.

306.2.1 The modifying material is specifically limited to hydrated lime, with no substitutes. Hydrated lime shall meet the chemical and physical characteristics of AASHTO M 216. The supplier shall furnish certification to the same for each load. Hydrated lime shall be kept free from moisture prior to use. Lime stored on the project shall be placed in weatherproof bins or buildings with adequate protection from ground dampness.

306.3 Construction Requirements.

306.3.1 Application.

306.3.1.1 The contractor may determine the locations, amount of modifying material and depth of application, within the limits of this specification and subject to the concurrence of the engineer. No lift shall exceed 150 compacted millimeters (6 compacted inches), however there is no limit to the number of lifts that may be modified.

306.3.1.2 Mixing equipment may include disk harrows or rotary mixers, or other equipment which provides uniform mixing and is approved by the engineer.

306.3.1.3 Where subgrade modification is performed, it shall be done to all areas uniformly and laterally between outside shoulder points plus 450 mm (18 in.) on each side. Furthermore, when the modified areas are stopped and started, there shall be a longitudinal transition zone, at the rate of 9 m per 150 mm (30 ft. per 6 in.) of modified depth. The transition may be made by reducing modifying material or mixing depth.

306.3.1.4 The modifying material shall be spread in uniform and regular patterns. No material shall be applied if it is being blown from the work area.

306.3.1.5 Hydrated lime shall be applied at a dry rate of not less than 8 kg/m² (15 lbs./yd.²) for the depth modified, nor more than 13 kg/m² per 150 mm (26 lbs./yd.² per 6 in.) of depth modified.

306.3.2 Compaction. The subgrade shall be uniformly mixed with the modifying material. Mixing and compaction shall continue until the subgrade is shown to have suitable compaction as demonstrated by the roller equipment. Density and moisture testing will ordinarily
be waived for subgrade modified under this specification, except that should compaction not be demonstrated to the engineer’s satisfaction, the engineer reserves the right to run such tests as necessary to ensure density.

306.4 Method of Measurement.
306.4.1 Measurement will be made to the nearest square meter (square yard) as measured along the centerline of the roadway including transition areas and for the affected width. Subgrade meeting all other requirements, suitable for the placing of base material and having modifying material incorporated as specified herein, will be paid for at the designated price per square meter (square yard) except as noted herein.

306.4.2 Reimbursement for transition areas will be made at the rate of 1/2 the payment for modified subgrade.

306.4.3 Reimbursement will be limited to modified areas, the width of the pavement and shoulders, plus a maximum of 450 mm (18 in.) on each side.

306.4.4 Only one payment for modified subgrade will be made for any area, regardless of the depth of stabilized material, number of applications or other circumstances.

306.5 Basis of Payment. Payment for modified subgrade will be made at the rate of $1.20 per square meter ($1.00/sq. yd.) of modified subgrade, regardless of depth.
Division 400

FLEXIBLE PAVEMENTS
SECTION 404
ASPHALTIC CONCRETE PAVEMENT

404.1 Description. This work shall consist of a mixture of aggregate, filler if required, hydrated lime and asphalt cement prepared in a stationary plant, to be used for base, wedging, leveling, and surface courses of pavement. The several aggregate fractions shall be sized, uniformly graded, and combined in such proportions that the resulting mixture meets the grading requirements, within specified tolerances, of the job-mix formula. This mixture shall be placed in one or more courses on a prepared base or underlying course in conformity with the lines, grades, thicknesses, and typical cross sections shown on the plans, or established by the engineer.

404.1.1 When Special Asphaltic Concrete Mixture for Surfacing (Slag + Limestone) is called for in the contract, the work shall consist of a mixture of crushed limestone, slag aggregates, natural or manufactured fine aggregate, mineral filler, and asphalt cement prepared in a plant meeting the requirements of Sec. 404.5, to be used for a surface course of pavement. The aggregate fractions shall be sized, uniformly graded, and combined in such proportions that the resulting mixture meets the grading requirements, within specified tolerances, of the job-mix formula. This mixture shall be placed in one (1) course on an underlying course in conformance with lines, grades, and typical cross sections shown on the plans, or established by the County Engineer.

404.1.2 When Special Asphaltic Concrete Surface Mixture (Porphyry + Limestone) is called for in the contract, the asphaltic concrete surface shall consist of a mixture of crushed limestone, crushed porphyry rock, natural or manufactured fine aggregate, mineral filler, and asphalt cement prepared in a plant meeting the requirements of Sec. 404.5, to be used for a surface course of pavement. The aggregate fractions shall be sized, uniformly graded, and combined in such proportions that the resulting mixture meets the grading requirements, within specified tolerances, of the job-mix formula. This mixture shall be placed in one (1) course on an underlying course in conformance with lines, grades and typical cross sections shown on the plans, or established by the County Engineer.

404.2 Materials. All materials shall conform to Division 1000, Materials Details, and specifically as follows:

<table>
<thead>
<tr>
<th>Item</th>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asphalt Cement (40-50, 60-70, 85-100), ..................................................</td>
<td>1015.5</td>
</tr>
<tr>
<td>(AC-10, AC-20 or AC-30)</td>
<td></td>
</tr>
<tr>
<td>Coarse Aggregate .................................................................</td>
<td>1002.1</td>
</tr>
<tr>
<td>Fine Aggregate .................................................................</td>
<td>1002.2</td>
</tr>
<tr>
<td>Mineral Filler .................................................................</td>
<td>1002.3</td>
</tr>
<tr>
<td>Hydrated Lime .................................................................</td>
<td>1002.6</td>
</tr>
</tbody>
</table>

The grade of asphalt cement will be specified in the contract.
404.2.1 When Special Asphaltic Concrete Mixture for Surfacing (Slag + Limestone) is called for in the contract, all materials shall conform to Division 1000, Materials Details, and specifically as follows:

<table>
<thead>
<tr>
<th>Item</th>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asphalt Cement</td>
<td>1015.5</td>
</tr>
<tr>
<td>Coarse Aggregate (Limestone)</td>
<td>1002.1</td>
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<tr>
<td>Fine Aggregate</td>
<td>1002.2</td>
</tr>
<tr>
<td>Mineral Filler</td>
<td>1002.3</td>
</tr>
</tbody>
</table>

Slag aggregate meeting the approval of the engineer shall be a uniform product, furnished in one or more fractions, and shall comply with Sec. 1002.1 except that the percent of wear of the coarse aggregate when tested in accordance with AASHTO T 96 (Los Angeles Abrasion) shall not exceed 20.

404.2.2 When Special Asphaltic Concrete Surface Mixture (Porphyry + Limestone) is called for in the contract, all materials shall conform to Division 1000, Materials Details, and specifically as follows:

<table>
<thead>
<tr>
<th>Item</th>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asphalt Cement (60-70) or (AC-20)</td>
<td>1015.5</td>
</tr>
<tr>
<td>Coarse Aggregate (Limestone)</td>
<td>1002.1</td>
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<tr>
<td>Fine Aggregate</td>
<td>1002.2</td>
</tr>
<tr>
<td>Mineral Filler</td>
<td>1002.3</td>
</tr>
</tbody>
</table>

Crushed Porphyry Aggregate meeting the approval of the engineer shall be a uniform product, furnished in one or more fractions, and shall comply with Sec. 1002.1, except that the percent of wear of the coarse aggregate when tested in accordance with AASHTO T 96 (Los Angeles Abrasion) shall not exceed 20.

404.3 Composition of Mixtures.

404.3.1 Prior to mixing with asphalt cement, the total aggregate, including the filler if needed, shall meet the following gradation for the type of mixture specified in the contract.
## TYPE C (BP-1) ASPHALTIC CONCRETE

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Percent Passing</th>
</tr>
</thead>
<tbody>
<tr>
<td>19 mm (3/4 in.)</td>
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<tr>
<td>12.5 mm (1/2 in.)</td>
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<td>9.5 mm (3/8 in.)</td>
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<td>4.75 mm (No. 4)</td>
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<td>2.36 mm (No. 8)</td>
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<td>1.18 mm (No. 16)</td>
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## TYPE B ASPHALTIC CONCRETE

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<th>Sieve Size</th>
<th>Percent Passing</th>
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<tbody>
<tr>
<td>25 mm (1 in.)</td>
<td>100</td>
</tr>
<tr>
<td>19 mm (3/4 in.)</td>
<td>80, 100</td>
</tr>
<tr>
<td>12.5 mm (1/2 in.)</td>
<td>60, 85</td>
</tr>
<tr>
<td>9.5 mm (3/8 in.)</td>
<td>50, 75</td>
</tr>
<tr>
<td>4.75 mm (No. 4)</td>
<td>35, 55</td>
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<tr>
<td>2.36 mm (No. 8)</td>
<td>25, 40</td>
</tr>
<tr>
<td>1.18 mm (No. 16)</td>
<td>15, 30</td>
</tr>
<tr>
<td>600 µm (No. 30)</td>
<td>10, 20</td>
</tr>
<tr>
<td>300 µm (No. 50)</td>
<td>6, 15</td>
</tr>
<tr>
<td>150 µm (No. 100)</td>
<td>4, 12</td>
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<tr>
<td>75 µm (No. 200)</td>
<td>2, 7</td>
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<table>
<thead>
<tr>
<th>Item</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asphalt Cement</td>
<td>4, 7</td>
</tr>
</tbody>
</table>
404.3.2 Mix Design Parameters. At least 45 days prior to preparing any of the mixture on the project, the contractor shall obtain, in the presence of the engineer, representative samples of asphalt cement and mineral aggregates for tests. The samples of materials shall be of the size designated by the engineer and shall be submitted to the Central Laboratory for testing. The contractor shall also submit for the engineer’s approval, a job-mix formula for each mixture to be supplied for the project. No mixture will be accepted for use until the job-mix formula for the project is approved by the engineer. The job-mix formula shall be within the master range specified for the particular type of asphaltic aggregates, the relative quantity of each ingredient, and shall state a definite percentage for each sieve fraction of aggregate and for asphalt cement. The combined aggregate mix shall, in the judgment of the engineer, plot favorably on the .45 power gradation chart. The plotted graph shall be based on percent passing the nominal maximum particle sieve size. This shall be defined as the largest sieve size listed in the applicable specification upon which any material is retained. No job-mix formula will be approved which does not permit, within the limits of the master range, the full tolerances specified in Sec. 404.3.5 for asphalt cement and for material passing the 75 μm (No. 200) sieve. The job-mix formula approved for each mixture shall be in effect until modified in writing by the engineer. When unsatisfactory results or other conditions make it necessary, or should a source of material be changed, a new job-mix formula may be required.

404.3.2.1 The engineer may make adjustments in the job-mix formula submitted by the contractor in order that 60 to 80 percent of the Voids in Mineral Aggregate (VMA) are filled with asphalt and the ratio by weight of the minus 75 μm (No. 200) material to asphalt cement is between 0.6 and 1.2. The percentage of VMA, and VMA filled with asphalt will be specified by the engineer. Approved mixtures, when compacted and tested in the laboratory in accordance with AASHTO T 245 (Modified to 75 Blow Marshall), shall yield stability values of 6675 N
The flow values for all asphaltic mixes shall be not less than 8 nor more than 16 when measured in 0.25 mm (0.01 in.) gradations. The mixture of aggregates, filler if needed, and asphalt cement shall demonstrate satisfactory cohesion.

404.3.2.2 The Special Asphaltic Concrete Surface Mixture (Slag + Limestone) shall contain approximately 60 percent by weight of plus 2.36 mm (No. 8) material. At least 50 percent by volume of the plus 2.36 mm (No. 8) material shall be from crushed steel slag as specified in Sec. 1002.1. Depending on the actual gradation of slag aggregate furnished, the amount of crushed slag required will vary. The actual percentages of required materials will be designated by the engineer at the time the job mix is approved, but at least 50 percent by weight of crushed slag will be required in the special mixture. Either natural or manufactured fine aggregate may be used in this mixture. The cold aggregate feeders shall be controlled to insure proper proportioning of the various aggregate fractions in the mix.

404.3.2.3 The total aggregate for Special Asphaltic Concrete Surface Mixture (Porphyry + Limestone) mixtures shall contain approximately 60 percent by weight of plus 2.36 mm (No. 8) material. At least 50 percent by volume of the plus 2.36 mm (No. 8) material shall be from crushed porphyry as specified in Sec. 1002.1. Depending on the actual gradation of porphyry aggregate furnished, the amount of crushed porphyry required will vary. The actual percentage of required materials will be designated by the engineer at the time the job-mix is approved, but at least 40 percent by weight of crushed porphyry will be required. Either natural or manufactured fine aggregate may be used in this mixture. The cold aggregate feeders shall be controlled to ensure proper proportioning of the various aggregate fractions in the mix.

404.3.3 If difficulty is experienced in obtaining a satisfactory mixture with the aggregate combinations submitted, the contractor will be advised and new types or sources of materials may be required by the engineer.

404.3.3.1 Approved mixtures, when compacted and tested in the laboratory in accordance with AASHTO T 245, shall have a density of not less than 95 nor more than 97 of a voidless mixture composed of the same materials in like proportions. The number of blows with the compaction hammer shall be 75 and the mixing and compacting temperatures shall be as specified in AASHTO T 245.

404.3.4 The total aggregate for Type B and C (BP-1) Asphaltic Concrete mixtures shall contain not less than 85 percent crushed material. Natural fine aggregate shall be limited to a maximum of 15 percent of the total aggregate in Type B and C (BP-1) Asphaltic Concrete mixtures. The engineer will adjust quantities of the various components of the mixture as necessary to obtain the required characteristics of the mixture.

404.3.5 Gradation Control. In producing mixtures for the project, the plant shall be operated so that no intentional deviations from the job-mix formula are made. Mixtures as produced shall be subject to the following tolerances and controls:

(a) They shall be within the master range in Sec. 404.3.1 for the particular type of mixture specified.
(b) The maximum variation from the approved job-mix formula shall be within the following tolerances:

<table>
<thead>
<tr>
<th>Passing Sieve Size</th>
<th>Maximum Percent Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>19 mm (3/4 in.)</td>
<td>±5.0</td>
</tr>
<tr>
<td>12.5 mm (1/2 in.)</td>
<td>±5.0</td>
</tr>
<tr>
<td>9.5 mm (3/8 in.)</td>
<td>±4.0</td>
</tr>
<tr>
<td>4.75 mm (No. 4)</td>
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</tr>
<tr>
<td>150 μm (No. 100)</td>
<td>±2.0</td>
</tr>
<tr>
<td>75 μm (No. 200)</td>
<td>±1.0</td>
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</tbody>
</table>

(c) The quantity of asphalt cement introduced into the mixer shall be that quantity specified in the job-mix formula. No change may be made in the quantity of asphalt cement specified in the job-mix formula without written approval of the engineer. The quantity of asphalt cement determined by calculation or tests on the final mixture shall not vary more than ±0.5 percentage point from the approved job-mix formula.

(d) Approved Slag and Porphyry mixtures shall contain a minimum of one percent of material that meets the requirements for mineral filler. The percentage to be used will be specified by the engineer at the time the job-mix formula is approved. Such material shall be added to the mixture as a separate ingredient. Hydrated lime may be used as a mineral filler.

(e) Approved Type B and C (BP-1) mixtures shall contain one percent hydrated lime by weight of the total aggregate. The hydrated lime shall be added during, or ahead of, the addition of the asphalt cement. If minus 75 μm (No. 200) material is needed in addition to the one percent hydrated lime in Type B or C (BP-1) mixtures to comply with gradation requirements, mineral filler shall be added. Additional hydrated lime may be used as a mineral filler.

(f) One of the aggregate bin sizes produced by the screening unit shall contain not more than 15 percent by weight retained on the 2.36 mm (No. 8) sieve.

404.3.5.1 The gradation of the aggregates will be determined from samples taken from the hot bins on batch-type plants or from the composite cold feed belt on drum mix plants.

404.3.5.2 Preparation of Mixture. The asphalt cement shall be carefully heated, without damage by overheating, to a workable temperature as designated by the engineer within the range established by Sec. 1015.1.5, Application Temperatures for Bituminous Materials. If asphalt is measured by volume, the temperature of the asphalt at the time of measuring shall not
vary more than $10^0$ C ($15^0$ F) from that designated by the engineer when the metering device was calibrated. The final mixture shall not exceed $175^0$ C ($350^0$ F) when discharged from the pugmill, and shall not vary more than $15^0$ C ($25^0$ F) from the temperature designated by the engineer. The final mixture shall not be crusted over, contain lumps, or be contaminated with deleterious agents such as unburned fuel, objectionable fuel residue, or any other material not inherent to the job-mix formula. In cases of rejected material, the entire load shall be rejected.

404.3.5.3 The asphaltic concrete mixture, when sampled immediately behind the paver and tested in accordance with AASHTO Test Method T 110, shall not contain more than 0.5 percent moisture by weight of the mixture.

404.3.5.4 The asphaltic concrete mixture shall not be contaminated with deleterious agents such as unburned fuel, objectionable fuel residue, or any other material not inherent to the job-mix formula.

404.4 Plant Laboratory. Laboratory space shall be provided at plant sites for use by the County for the duration of the contract. The space provided shall contain at least 11 m$^2$ (120 sq. ft.) of work area, be equipped with a sink with faucet, and three grounded electrical outlets. The work area shall have a minimum of one door and two windows. At least one window shall provide an unobstructed view of the plant operations. Lighting is subject to the approval of the engineer. A working sieve shaker and sample splitter shall be provided. The laboratory area shall be air conditioned to maintain an interior ambient air temperature of $22^0$ C ($72^0$ F). Two work tables shall be provided and are subject to the approval of the engineer.

404.4.1 A 1.0 m x 1.0 m x 1.0 m (3.0 ft. x 3.0 ft. x 3.0 ft) enclosed and weatherproofed area shall be secured and reserved for the storage of a nuclear testing device. St. Charles County representatives shall have sole access to this area which is to be located a minimum of 4.6 m (15 feet) from any permanent work station.

404.5 Equipment.

404.5.1 Plant Site. Sufficient storage space shall be provided for each size of aggregate. Unless otherwise permitted by the County Engineer, stockpiles of coarse aggregate, screenings and sand shall be built and maintained in accordance with Sec. 1001.11. Each stockpile shall contain a minimum of 500 metric tons (500 tons) of material before asphaltic concrete production commences and shall be maintained so that the quantity of material does not fall below the minimum required. Should stockpiles be depleted below this amount they shall be rebuilt to the minimum prior to next working day. Stockpiles shall be built in an area readily accessible for inspection and sampling.

404.5.2 Plant Calibration. Personnel, scales, and equipment necessary for calibrating the plant and for verifying the accuracy of proportions shall be furnished by the contractor and shall be available at all times. If batch-type plants are used, the equipment shall include standard 20. kg (50 lb.) test weights equal to 20 percent of the net load capacity of the scales, to the nearest 20 kg (50 lb.) increment. However, not more than twenty 20 kg (50 lb.) weights will be required. Calibration by an approved commercial scale service will be required for batch-type
plants that have large capacity scales greater than 4500 kg. (10,000 lb.) or if scales do not meet calibration tolerances. If continuous mixing or drum-mix plants are used, scales conforming to the requirements of Sec. 310.4.3 shall be provided. Weights shall be calibrated by the governing state body of weights and measures in accordance to the requirements established by the U.S. Department of Agriculture. All equipment shall be calibrated by the contractor in the presence of and subject to the approval of the engineer. Plants shall be calibrated at least once each year, or as directed. Plant certification for calibration and verification will not be required, provided that this certification has been furnished to the State within a twelve (12) month period prior to the time certification is required by the County. A letter of certification to verify this will be required. This does not preclude interim checks by County forces.

404.5.3 Equipment for Preparation of Asphalt Cement. An asphalt cement storage tank shall be provided at the proportioning and mixing plant. If more than one storage tank is used to deliver asphalt cement to the proportioning unit, piping and valve arrangements shall permit material to be used from any one of the tanks without using from another at the same time.

404.5.3.1 Tanks for storage of asphalt shall be equipped for heating the material, under effective and positive control at all times, to the temperature requirements set forth in Sec. 1015.1.5. Heating shall be by steam or oil coils, electricity, or other means such that no flame shall come in contact with the heating tank.

404.5.3.2 A circulating system of adequate capacity shall provide proper and continuous circulation of the asphalt between storage tank and proportioning units during the entire operating period. The discharge end of the circulating pipe shall be maintained below the surface of the asphalt in the storage tank to prevent discharging into the open air. All pipe lines and fittings shall be steam or oil-jacketed or otherwise properly insulated to prevent heat loss.

404.5.3.3 The contractor shall provide in the asphalt feed lines connecting the plant storage tanks to the weighing system or spray bar a sampling outlet, consisting of a valve installed in such a manner that samples may be withdrawn slowly at any time during plant operation. The sampling outlet shall be installed between the pump and the return line discharge in such location that it is readily accessible. A drainage receptacle shall be provided for flushing the outlet prior to sampling.

404.5.4 Feeder for Drier. The plant shall be provided with an accurate mechanical means for uniformly feeding the aggregates into the drier to provide uniform production and temperature. A synchronized method of proportioning the aggregates at the cold feeder shall be provided.

404.5.5 Drier. A drier of any satisfactory design for drying and heating the aggregate shall be provided, and shall include an efficient dust collecting system. The drier shall be capable of drying and heating the aggregate to not less than $125^\circ$ C ($260^\circ$ F) nor more than $175^\circ$ C ($350^\circ$ F) when delivered to the batching hopper, without leaving any visible unburned oil or objectionable carbon residue on the aggregate when discharged from the drier. Feeding and drying equipment shall be operated in such a manner that the temperature of the aggregate is
maintained within 15\(^0\)C (25\(^0\)F) above or below that directed by the engineer. Absorbed moisture
in the aggregate shall be reduced to such a quantity that there is no objectionable segregation of
asphalt resulting from escaping water vapor in the prepared mixture.

**404.5.6 Screens.** Plant screens shall have adequate capacity and size range to separate
properly all of the aggregate into the sizes required for proportioning, so that they may be
recombined consistently within the limits specified in Sec. 404.3.5. The screening unit shall
separate the usable heated aggregate into at least three sizes.

**404.5.7 Bins.** The plant shall have hot bin storage of sufficient capacity to insure uniform
and continuous operation. Bins shall be divided into compartments arranged to insure separate
and adequate storage of appropriate fractions of the aggregate. Each compartment shall be
provided with an overflow pipe of such size and at such locations as to prevent any backing up of
material into other bins or into contact with the screen. The bins shall have a tailing pipe for
rejections. The discharge points of overflow and tailing pipes shall be located so they will not
create a hazard. Overflow pipes shall not return the material directly to the hot elevator.

**404.5.7.1** If mineral filler or hydrated lime is required, adequate dry storage shall be
provided, and provisions shall be made for accurate proportioning.

**404.5.7.2** Surge bins may be used in the production of bituminous mixtures, if approved
by the engineer. They shall be equipped with batchers, so located that the mixture is discharged
vertically into the center of the bin. Surge bins, except those rated at 75 metric tons (75 tons) or
less, shall be covered and insulated. They shall be equipped with heating devices, if necessary, to
maintain the temperature of the mixture in accordance with the requirements in Sec. 404.9. Bins
shall be equipped with automatic lights to indicate when the surface of the mixture has been
drawn down to the top of the sloped portion of the bin. Mixture shall be transferred from the
mixing plant to the surge bins by covered drag slat conveyors, skip hoists, or other methods
approved by the engineer. Mixture shall not be withdrawn below the level of the top of the
sloped portion of the bin except at the end of each day’s operation. Mixture, which the engineer
determines visually to be segregated, will be rejected. Material that is produced without
inspection from a representative of St. Charles County will be rejected. Mixture shall not be
stored more than eight (8) hours.

**404.5.8 Asphalt Control Unit.** Satisfactory means, either by weighing or metering, shall
be provided to obtain the proper quantity of asphalt. Metering pumps for asphalt shall deliver
accurately to within plus or minus 2.0 percent of the required quantity when tested for accuracy.
Asphalt scales shall conform to the requirement of Sec. 404.5.12.4. Where the quantity of asphalt
is controlled by metering, provision shall be made whereby the delivery of the meter may be
readily checked by actual weight.

**404.5.8.1** If a continuous mixing plant is used, a continuously registering measurement
meter and a pressure gauge shall be installed in the asphalt line at locations meeting the approval
of the engineer. The meter shall be cumulative with a nonsetback register, and have an accuracy
within 2 percent by weight of the material actually being measured in any given period of time.
The meter register shall indicate the quantity measured to the nearest 1.0 L (0.25 gal.) or less.
The pressure gauge shall have a range capable of registering all spraying pressures during plant operation and the dial shall have increments of not more than 10.0 kPa (1.0 psi). The meter and the pressure gauge shall be so located in the asphalt line that the meter will continuously register the asphalt discharge and the gauge will continuously register the discharge or spraying pressure, and also so that the discharge through both the meter and the gauge can be readily diverted to a container for measurement. During calibration and verification of the asphalt metering pump and the measurement meter, the discharge pressure shall be controlled by a valve or reduction unit to duplicate the plant’s spraying pressure. The accuracy of the measurement meter shall be verified at periodic intervals as designated by the engineer. In case of meter malfunction, plant operation will not be permitted beyond 24 hours after detection except by written approval of the engineer.

404.5.9 Thermometric Equipment A thermometer of suitable range shall be fixed in the asphalt feed line at a suitable location near the discharge at the mixer unit. An accurate registering pyrometer or other approved thermometric instrument shall be installed in the discharge chute of the drier in such manner that the temperature of the heated aggregate is automatically registered. This instrument shall be located where it is in clear view of the drier fireman and readily accessible to the inspector.

404.5.9.1 The plant shall be further equipped with approved recording thermometers, pyrometers, or other recording thermometric instruments placed in two of the hot aggregate bins to register and record automatically the temperature of the heated aggregate. One terminal shall be placed in the hot bin containing the smallest aggregate used in the mix and the other terminal shall be placed in the bin containing the largest aggregate. The terminals shall be located where the hot material will flow around them during the proportioning operation and shall not be located near the corners of the bins or at points where the material will collect or pack around them. The charts shall continuously record both time and temperature. The smallest interval of time shown shall be not more than 15 minutes and the temperature graduations shall be not more than 5°C (10°F). The charts shall be furnished to the engineer at the end of each day’s operations.

404.5.10 Control of Mixing Time. The plant shall be equipped with positive means to govern the time of mixing and to maintain it constant.

404.5.10.1 Batch Type Plants. The dry hot aggregates, hydrated lime, mineral filler if needed, and asphalt cement shall be accurately proportioned in the quantities required by the job-mix formula. Aggregate shall be charged into the weigh hopper in a sequence that will avoid segregation. The mineral aggregate shall be mixed dry for not less than 15 seconds. For Type B mixtures the dry mixing time may be reduced to 10 seconds. The dry mixing period shall start when all of the mineral aggregates have been charged into the mixer and end when introduction of the asphalt cement begins. After dry mixing, the asphalt cement shall be charged into the mixer in a manner that will uniformly distribute the asphalt over at least 3/4 the full length of the mixer. The time required to add the asphalt shall not exceed 15 seconds. Wet mixing shall begin at the introduction of the asphalt cement and continue for at least 30 seconds, or longer if necessary to produce a complete and uniform coating of the particles and a thorough distribution of the asphalt cement throughout the aggregate. The wet mixing period shall end when the discharge gate is opened. The dry and wet mixing times shall be as directed by the engineer.
404.5.10.2 Continuous Mixing Plants. Each size of hot aggregate, mineral filler or hydrated lime, if needed, and the asphaltic cement shall be accurately proportioned in the quantities required by the job-mix formula. The mixing period shall be determined in accordance with Sec. 404.5.13.4(b) and shall be not less than 35 seconds. The mixing time shall be directed by the engineer, and may be increased above the minimum specified, if necessary, to produce a complete and uniform coating of the particles and a thorough distribution of the asphalt cement throughout the aggregate.

404.5.11 Safety Requirements. A conveniently located, easily opened gate or door shall be provided in the mixer cover for observation of the mixing operations. Adequate and safe stairways to the mixer platform and sampling points shall be provided, and guarded ladders to other plant units shall be placed at all points where accessibility to plant operations is required. Accessibility to the top of truck bodies shall be provided by a platform or other suitable device to enable the engineer to obtain samples and mixture temperature data. All gears, pulleys, chains, sprockets, and other dangerous moving parts shall be thoroughly guarded and protected. Ample and unobstructed space shall be provided in and around the truck. This area shall be kept free from drippings from the mixing platform.

404.5.12 Batching Plants. For all contracts having not more than 10 000 metric tons (10,000 tons) of asphaltic concrete mixture, standard manual batching methods, approved by the engineer, will be permitted. For contracts having more than 10 000 metric tons (10,000 tons) of asphaltic concrete mixture, batching plants shall be equipped to operate automatically to the extent that the only manual operation required for the proportioning of all ingredients for one batch shall be a single actuation of a switch or starter. The equipment shall include devices capable of automatically proportioning each ingredient of the mixture in the selected sequence and quantity. Interlocks shall be provided which will hold or delay the automatic batch cycling whenever the batched quantity of any ingredient is not within the specified tolerance. The weight setting and timing controls shall be suitably equipped so they may be locked when directed by the engineer. Manual operation will not be permitted beyond 24 hours after breakdown in the automatic equipment, except by written approval of the engineer.

404.5.12.1 Weigh Box or Hopper. The equipment shall include a means for accurately weighing aggregate of each bin into a weigh box or hopper, suspended on scales, and ample in size to hold a full batch without hand raking or running over. Weigh boxes shall be charged through only one gate opening for aggregate of each bin size. The weigh box or hopper shall be supported on fulcrums and knife edges so constructed that they will not easily be thrown out of alignment or adjustment. Gates on the bins and the hopper shall be so constructed as to prevent leakage when they are closed.

404.5.12.2 Aggregate Scales. Scales for weighing aggregate and mineral filler or hydrated lime may be of the springless dial, or the electronic digital type and shall be of standard make and design having tolerances on over-registration and under-registration not exceeding 0.4 percent of the indicated weight when tested for accuracy. Each aggregate fraction shall be measured within one (1) percent of the total batch weight of the mixture. Mineral filler or hydrated lime shall be measured within 0.5 percent of the total batch weight of the mixture. The
total weight of the batch shall be within 2.0 percent of the desired batch weight. The change in load required to change the position of rest of the indicating element or elements of a non-automatic indicating scale an observable amount shall not be greater than 0.1 percent of the nominal scale capacity. Dial scales shall be equipped with adjustable pointers for marking the weight of each material to be weighed into the batch. Graduation intervals for all scales shall not be greater than 0.1 percent of the nominal scale capacity. Quantity indicators necessary for batching shall be in full view of the operator.

404.5.12.2.1 Automatic volumetric batch proportioning approved by the engineer will be permitted and shall meet the tolerances specified in Sec. 404.5.12.2.

404.5.12.3 Asphalt Bucket. If a bucket is used for weighing the asphalt, it shall be of sufficient capacity to hold and weigh the quantity required for a batch in a single weighing. The filling system and bucket shall be of such design, size, and shape that asphalt will not overflow, splash, or spill outside the confines of the bucket during filling and weighing. The bucket shall be steam or oil-jacketed or equipped with properly insulated electric heating units.

404.5.12.4 Asphalt Scales. Scales for weighing asphalt shall conform to the requirements for aggregate scales, as specified in Sec. 404.5.12.2. Bituminous material shall be measured within 0.1 percent of the total batch weight of the mixture. Springless dial scales used for weighing asphalt shall have a tare beam, and a dial graduated in increments not to exceed 0.1 percent of the nominal scale capacity, and the maximum dial capacity shall be not more than 15 percent of the nominal capacity of the mixer.

404.5.12.5 Mixer Unit. The plant shall include an approved twin shaft pugmill mixer capable of producing a uniform mixture. The mixer shall be electrically heated or hot oil or steam jacketed and have a capacity of not less than one metric ton (one ton) per batch. The mixer shall be so constructed as to prevent leakage of the contents, and the mixer box shall be equipped with a hood to prevent loss of dust.

(a) The mixer shall be designed to provide means of adjusting the clearance between the mixer blades and liner plates to insure proper and efficient mixing. Not more than one pair of paddle tips on each mixer shaft shall be reversed with respect to the other paddle tips on the shaft, except that for mixers having forty paddles or more, two pair may be reversed on each shaft. The reversed paddle tips shall be located in diagonally opposite corners of the pugmill. The clearance of blades from all fixed and moving parts shall not exceed 19 mm (3/4 in.).

(b) The mixer shall have an accurate time lock to control the operation of a complete mixing cycle by locking the weigh box gate after the charging of the mixer until the closing for the mixer gates at the completion of the cycle; it shall lock the asphalt bucket throughout the dry mixing period and shall lock the mixer gate throughout the dry and wet mixing periods.

(c) A rating plate designating the manufacturer’s rated capacity shall be attached to the mixer. The quantity of mixture produced per batch shall not exceed the
manufacturer’s rated capacity. The manufacturer’s rated capacity will not be accepted unconditionally. If the mixer does not produce a satisfactory mixture, or if its production does not coordinate with other plant units, the right is reserved to reduce the size of the batch. The decision of the engineer as to the permissible capacity of the mixer shall be final.

404.5.13 Continuous Mixing Plants.

404.5.13.1 Gradation Control Unit. The plant shall include a means of accurately checking the proportioning of each bin size of aggregate by weight. Means shall be provided to establish the rate of flow in kilograms (pounds) per revolution by scale weight. On each of the storage bins for the heated aggregates, a device shall be installed to indicate when the level of the material in the bin is below the point where accurate proportioning through the feeder gates can be accomplished. The indicators shall be positive in action and shall actuate devices to stop the flow of materials to the mixer when the material in the bin is below the safe operating level. Continuous weighing devices shall be of sturdy construction and design and shall be accurate to 0.4 percent of the net load applied.

(a) The interlocked feeders shall be equipped with a dust-proof revolution counter registering to the nearest 0.01 revolution. The mix proportions shall be set up on the basis of kilograms (pounds) of each aggregate bin size per revolution. The gradation control unit shall include interlocked feeders mounted under the bin compartments. Each bin shall have an accurately controlled individual gate to form an orifice to control the rate of flow of aggregate drawn from each respective bin compartment. The orifice shall be rectangular with one dimension adjustable by positive mechanical means. Locks shall be provided on each gate. Calibrated gauges with minimum graduations of not more than 5 mm (0.1 in.) shall be provided for each gate to establish gate openings. The rate of flow of the aggregate through the gate openings shall verify within 5 percent of the quantity as calibrated for that opening, or within one kilogram (2 pounds) per revolution of the aggregate feeder, whichever is the greater. The rate of flow shall also verify within a total variation of not more than 2 percent of the total quantity required of the combined bins, exclusive of mineral filler or hydrated lime, or 0.5 kg (1 lb.) per revolution for each gate through which aggregate is being proportioned, whichever is the greater.

(b) When added mineral filler or hydrated lime is specified, a separate bin and feeder shall be furnished with its drive interlocked with the aggregate feeders. Readily accessible ports or openings for observation of the flow of mineral filler or hydrated lime through the conveyor or delivery system shall be provided. The rate of flow at the mineral filler or hydrated lime feeder shall be accurate to 10 percent of the filler required, or to 0.25 kg (1/2 lb.) per revolution of the aggregate feeder, whichever is the greater.

404.5.13.2 Weight Calibration of Asphalt and Aggregate Feed. The plant shall include a means of calibrating gate openings and asphalt flow by means of weighed test samples in kilograms (pounds) per revolution. The aggregate fed out of the bins through individual orifices
shall be bypassed into suitable test boxes and each compartment material shall be confined in individual test receptacles or compartments. Accessories shall be supplied so that the aggregate in each compartment may be weighed separately. Test containers shall be of convenient size so as to obtain a minimum weight of 100 kg (200 lb.), or the quantity from not less than one complete revolution, whichever is the greater, for each test-run made from each bin.

404.5.13.3 Synchronization of Aggregate and Asphalt Feed. Satisfactory means shall be provided to afford positive interlocking between the flow of aggregate through the gates, the flow of mineral filler or hydrated lime through the feeder, and the flow of asphalt through the meter or other proportioning source. Means shall be provided to check the rate of flow of the asphalt by scale weight per revolution. The pump shall deliver the asphalt to the pugmill at a uniform rate, which shall not vary more than 2.0 percent by weight from the required quantity.

404.5.13.4 Mixer Unit. The plant shall be equipped with a twin shaft electrically heated, or hot oil or steam jacketed pugmill, capable of producing a uniform mixture within the permissible job-mix tolerances. It shall have a capacity of not less than 40 metric tons (40 tons) per hour. The paddles shall be of a type adjustable for angular position on the shafts and reversible to retard the flow of the mix. The clearance of blades from all fixed and moving parts shall not exceed 19 mm (3/4 in.). Mixers shall be equipped with discharge hoppers or other facilities to prevent segregation during discharge.

(a) The mixer shall carry a manufacturer’s plate giving the net volumetric content of the mixer at the several heights inscribed on a permanent gauge. The manufacturer’s rating of the mixing unit will not be accepted unconditionally. The right is reserved to reduce the rate of feed of aggregate per minute at plant-operating speed to produce a satisfactory mixture. The decision of the engineer as to the permissible capacity of the mixing unit shall be final.

(b) The mixing time shall be determined as follows:

Mixing time = \( \frac{\text{Pugmill dead capacity in kilograms (pounds)}}{\text{Pugmill output in kilograms (pounds) per second}} \)

404.5.14 Drum Mix Plants.

404.5.14.1 The plant shall be specifically designed for drum mixing and be capable of satisfactorily heating, drying, and mixing the bituminous mixtures. The aggregate shall enter the drum from the same end the burner is located and travel parallel to the flame and exhaust air stream. The system shall be equipped with automatic burner controls, and heating shall be controlled to prevent damage to the aggregate or the asphalt cement. The temperature of the mixture when discharged from the mixer shall be within the range specified in Sec. 1015.1.5 for the grade of asphalt cement being used. The rate of flow through the drum shall be controlled in order that the bituminous material and aggregate shall be mixed until a homogeneous mixture with all particles uniformly coated is obtained and in no case shall the quantity of mixture produced exceed the manufacturer’s rated capacity.
404.5.14.2 Each feeding orifice shall have an adjustable gate with an indicator provided to reference the opening setting. On each of the aggregate feeders, a device shall be installed to indicate when the flow of material from the bin is below the point where accurate proportioning through the feeder gates can be accomplished. These indicators shall be positive in action and shall actuate a clearly visible or audible signal to the plant operator or stop the flow of materials to the drum when the level of material in the bin is too low for accurate proportioning. In addition, for those particular cold bins whose aggregate material tends to either bridge or lump together causing temporary interruptions in feeds, a vibrator or other suitable means shall be provided to insure uniform flow. The order of aggregate feed onto the composite cold feed belt shall be from coarse to fine. When only one aggregate is furnished, two cold bins shall be used. A scalping screen mounted independent of other proportioning or weighing equipment shall be required if directed by the engineer.

404.5.14.3 Asphalt cement shall be introduced through a continuously registering cumulative indicating meter by a pump specifically designed for dryer-drum plants. The meter shall be located in the asphalt line so that it will continuously register the asphalt discharge to the mixer and so that the discharge through the meter can be readily diverted into a container for measurement. The meter shall be equipped with a nonsetback register and shall have an accuracy within 2 percent by weight of the material actually being measured in any given period of time. The accuracy of the pump and meter shall be verified at periodic intervals as designated by the engineer.

404.5.14.4 If mineral filler or hydrated lime is specified, a separate bin and feeder shall be furnished. Mineral filler or hydrated lime shall be introduced and uniformly dispersed into the mixture without loss to the dust collection system. The delivery system shall be variable speed and interlocked with the aggregate weigh belt so that total dry aggregate weight, including mineral filler or hydrated lime, is indicated to the asphalt proportioning system. A device shall be provided to indicate when the flow of filler into the delivery system stops, or drops below, or rises above the specified tolerance. The rate of flow of mineral filler or hydrated lime into the delivery system shall be accurate to 0.5 percent, by weight, of the total mix. Means shall be provided to readily divert the flow of mineral filler or hydrated lime into a container for measurement.

404.5.14.5 The aggregate feed system, including hydrated lime and mineral filler if specified, and the asphalt flow shall be interlocked by a blending system, which will automatically regulate the asphalt flow and cause immediate correction for variations in aggregate flow. The system shall provide positive weight measurement of the combined cold aggregate feed by use of belt scales. The combined cold aggregate feed shall be continuously recorded on a nonsetback register. The scale and the conveyor at the scale shall be protected from wind and weather effects. Feed of material to the belt scale shall be controlled to insure at normal operation the combined aggregate flow is between 50 percent and 100 percent of the rated capacity of the scales. The plant shall be equipped so that the proportion of each aggregate can be individually varied. The plant shall also be equipped so that the total aggregate rate can be varied without affecting the proportions. The plant shall be equipped with a moisture compensating device in the control panel to automatically correct for the moisture in the aggregate passing over the belt scale. Moisture determinations on the combined aggregate will be
made periodically during each day’s operations. The plant shall be equipped with a device in the control panel to automatically correct for the specific gravity of the asphalt. The plant shall also be equipped with a device to positively maintain the proportions of aggregates, mineral filler or hydrated lime, and asphalt cement throughout the full production range.

404.5.14.6 Safe, adequate and convenient facilities shall be provided for obtaining representative asphalt and aggregate samples. The plant shall be equipped with a sampling device capable of providing a sample of sufficient size from the full width of the combined aggregate cold feed flow. It shall be designed so that samples may be taken while the plant is operating at normal production rates. Safe, adequate and convenient facilities shall be provided for calibrating the asphalt flow, mineral filler or hydrated lime flow, and the aggregate flow. The manufacturer’s recommendations shall be followed for calibration. To calibrate the aggregate flow system, means shall be provided to permit a positive and uniform diversion of the aggregate in sufficient quantity for accurate timed weight checks. To calibrate the asphalt metering system for proper proportioning, an asphalt distributor or other equipment approved by the engineer shall be made available so that an accurate tare, gross and net weight may be obtained of the diverted asphalt discharge. If necessary, manual overrides of the electronic timing equipment shall be provided for testing and calibration. Electronic timing equipment shall be provided for testing and calibration purposes. The rate of flow of the total aggregate and asphalt flow shall not vary by more than 2.0 percent by weight from the required quantity of each.

404.5.14.7 Automatic Ticket Printer. For Federal contracts or for contracts having more than 10,000 metric tons (10,000 tons) of bituminous mixture, the asphalt plant shall be equipped with an automatic ticket printer connected to the weighing system in such manner that it automatically detects and prints the weight determined by the system. It shall store and recall the tare weight when the operator enters the vehicle identification. The weight shall be shown to at least the nearest 10 kg (20 lbs.) or 0.01 metric ton (1/100 ton). The automatic printer shall be capable of keeping and printing cumulative totals for each project for each type of bituminous mixture. The automatic printer shall produce a weight ticket for each load in triplicate that shows the following:

(1) Gross, tare and net weights.
(2) Identification of the vehicle.
(3) Current date and time.
(4) St. Charles County job mix designation.
(5) Job mix percent asphalt.
(6) Unique ticket number. (May be preprinted on the ticket).
(7) St. Charles County Project No. and Federal Job No. if applicable.

The ticket shall accompany each load delivered to the project and shall be furnished to the engineer.

When the net weight of bituminous mixture is determined by batch weights, the scales shall meet all requirements of this Section, including automatic ticket printing, except the gross and tare weights will not be required.
When the net weight of bituminous mixture is determined by weighing in a vehicle, the vehicle shall be weighed empty for each load, weighed daily or from time to time during the day as the engineer may direct, in order to establish the tare weight of each load.

At the end of each day’s operation the contractor shall furnish to the engineer the total tonnage of mixture produced by the asphalt plant in sufficient detail to determine the amount of asphalt cement used in that day’s operation.

In the event of automatic ticket printer failure, the contractor may be allowed, with the engineer’s approval, to furnish manually written tickets to complete that day’s operation.

**404.5.15 Hauling Equipment.** Trucks used for hauling bituminous mixtures shall have tight, clean, smooth, metal beds which have been thinly coated with a minimum quantity of lime solution or an approved bituminous mixture release agent to prevent the mixture from adhering to the beds. Use of diesel fuel, fuel oil or other detrimental products as a bed coating will not be allowed. Each truck shall have a cover of canvas or other suitable material of such size as to protect the mixture from the weather. The cover shall be securely fastened over all sides of the truck bed. When necessary, so that the mixture will be delivered on the road at the specified temperature, truck beds shall be insulated. No loads shall be sent out so late in the day that spreading and compacting of the mixture cannot be completed during daylight, unless there is adequate lighting in the area of work.

**404.5.16 Pavers.** Bituminous payers shall be self-contained units, rubber tired or trackmounted, provided with an activated screed or strike-off assembly, equipped with a vibratory system capable of consolidating the asphaltic material and a system capable of heating and maintaining the screed at a temperature which will provide for the spreading and finishing of asphaltic concrete in lane widths applicable to the specific typical section and thicknesses shown on the plans. The paver shall be equipped with a receiving hopper having sufficient capacity to produce a uniform spreading operation. The hopper shall be equipped with a distribution system of sufficient capacity and speed to place the mixture uniformly in front of the screed or strike-off. The use of auger extensions will be required when, in the opinion of the engineer, they are necessary to properly distribute the mixture before the screed or strike-off. The screed or strike-off assembly shall be equipped with an automatic control device as required in Sec. 404.9.6, and shall effectively produce a consolidated finished surface of required evenness and texture without tearing, shoving, or gouging the mixture. When laying mixtures, the paver shall be capable of operation at forward speeds that will produce a uniform consolidated mat of asphaltic material. The use of all paving equipment will be subject to the approval of the engineer.

**404.5.16.1** When conditions dictate, the engineer may disapprove the use of rubber tired pavers. Uniform tire pressure must be maintained in all pneumatic tires at all times.

**404.5.16.2** The use of petroleum distillates to clean the paver or other equipment will not be allowed on any paved surface. The cleaning of hand tools will be allowed inside of containers firmly attached to the paver which have a sufficient volume to prevent spilling of petroleum distillates on to the surface to be paved. Any spillage on to the surface to be paved will be promptly cleaned up utilizing absorbent material and if necessary the surface will be retacked. If
in the opinion of the engineer, the container attached to the paver is insufficient in any way, it will be removed and hand tools will be cleaned beyond the paving limits until a suitable container is provided. Petroleum distillates in sprayers or buckets will not be allowed within the boundaries of the area to be paved.

**404.5.17 Rollers.** All rollers, vibrators, or other equipment used to compact the asphaltic mixture shall be in satisfactory working condition. All rollers shall be capable of reversing without backlash, and steel wheel rollers shall be equipped with scrapers, scouring pads, and a controlled flow watering system. Pneumatic tired rollers shall be self-propelled, of the oscillating type, and equipped with smooth tires of equal size, diameter, and ply rating, all maintained at the same inflation pressure. Rollers shall have a scouring pad and a system for moistening each wheel or roller. The following types of rollers shall be provided:

1. **Initial Rolling.** Seven (7) metric ton to eleven (11) metric ton (eight (8) ton to twelve (12) ton) three wheel roller or two wheel tandem-type roller, or pneumatic tire roller (adjusting ballast and tire inflation pressure as required).

2. **Intermediate Rolling.** Pneumatic tire oscillating-type roller developing at least 550 kPa (80 psi) contact pressure uniformly for all wheels. The contractor shall furnish a manufacturer’s chart indicating that regarding tire size, pressure, and loading a contact pressure of 550 kPa (80 psi) is being developed.

3. **Final Rolling.** Not less than 9 metric ton (10 ton) two or three wheel tandem-type roller.

Trench rollers, vibrators, and other special equipment used for compacting mixtures placed in areas inaccessible to the rollers specified shall be of a weight and design approved by the engineer, and shall only be used where approved by the County Engineer. The contractor shall submit a certification of weight or other suitable documentation certifying compliance with specifications for each piece of compactive equipment proposed for use. Non-certified equipment will not be permitted to operate.

No direct payment will be made for the cost of complying with this requirement.

**404.6 Weather Limitations.** Asphaltic concrete shall not be placed: (1) when either the air temperature or the temperature of the surface on which the mixture is to be placed is below 10°C (50°F) for the surface course or below 5°C (40°F) for subsurface courses, (2) on any wet or frozen surface, (3) when weather conditions prevent the proper handling or finishing of the mixture, or (4) between October 1 and April 1 except when authorized by the engineer. Placement within these dates will be permitted only when it is to the Department’s advantage to do so. The contractor shall conduct operations in such a manner that all base course asphaltic concrete is covered with surface course asphaltic concrete prior to October 1.

**404.6.1** During critical temperature periods in the fall of the year, the County Engineer may authorize the placement of surface course asphaltic concrete when the on-site ambient temperature is 7°C (45°F) and rising with an anticipated high temperature of at least 10°C (50°F)
F). No further deviation in weather restrictions or temperature limitations will be granted.

404.7 Subgrade Preparation. The subgrade upon which the Type B mixture is to be placed shall be prepared in accordance with Sec. 209.

404.7.1 For widening work, the bottom of the trench shall be compacted until it is firm by use of a trench roller having a weight of not less than 5 kg/mm (300 lbs./in.) of width of rear roller, or by mechanical tampers or other methods approved by the engineer. Suitable excavated material may be used in shouldering operations. All surplus excavated material shall be disposed of by the contractor in areas to be secured by him beyond the right-of-way limits, and as specified in Sec. 203.2.16.

404.7.1.1 On the outside of curves, the design depth of trench at the beginning of the superelevation transition shall be varied gradually to the minimum depth at the end of the superelevation transition. Slight transitioning of the width of the base widening will be necessary to permit the indicated angle of repose or shear angle outside of the ultimate edge of surface. The bottom of the trench shall in no case be less than 75 mm (3 in.) below the surface of the existing pavement.

404.8 Application of Prime or Tack. The prime or tack coat, when specified, shall be applied as set forth in Sec. 407 or 408, whichever is applicable.

404.9 Spreading and Finishing. The base course, primed or tacked surface, or preceding course or layer shall be cleaned of all dirt, packed soil, or any other foreign material prior to spreading the asphalt mixture. The mixture, when delivered to the spreading and finishing machine, shall have a temperature of not less than 125° C (260° F) and be within 15° C (25° F) of that designated by the engineer. The paver shall be operated at a speed that will give the best results. The rate of delivery of the mixture to the paver shall be coordinated so as to provide, where practical, a uniform rate of placement without intermittent operation of the paver.

404.9.1 The thickness and width of each course shall conform to the typical section in the contract. The contractor may construct each course in any number of layers he chooses; but no individual layer shall have a compacted thickness greater than 50 mm (2 in.) for Type C (BP-1), Slag, or Porphyry mixtures, or 75 mm (3 in.) for Type B mixtures.

404.9.2 For pavements having a width of 4.9 to 7.3 m (16 to 24 ft.), inclusive, the asphaltic concrete pavement shall be laid in lanes approximately one half the full width of the completed pavement and the full width completed as soon as practical. Unless otherwise permitted, a single lane of any course shall not be constructed to a length that cannot be completed to full width of the pavement on the succeeding operating day unless otherwise permitted. For pavements greater than 7.3 m (24 ft.) in width, single lane width construction shall be limited to one day’s production and completion to full width shall be accomplished as soon as practical.

404.9.3 No segregation will be permitted in handling the mixture at the plant, from the truck, or during spreading operations on the roadway. Where only the top layer of the surfacing
continues across a bridge, the bottom layers shall be ended at a vertical edge. Unless otherwise
directed by the engineer or shown on the plans, all lift edges shall be sloped or tapered and shall
extend as a minimum to the radius points of existing street and driveway approaches. Under all
conditions, the final lift shall be tapered to a 3:1 slope unless adjacent to a rock shoulder.

404.9.4 The contractor shall keep the traffic off the asphaltic concrete until it has cooled
sufficiently to prevent flushing of the asphalt to the surface, marking or distorting the surface, or
breaking down the edges, and in any case until the temperature of the asphaltic concrete is 60\(^0\) C
(140\(^0\) F) or below. When the asphaltic concrete construction consists of more than a single layer,
each layer shall be compacted as specified and allowed to cool to the ambient temperature before
the next layer is placed. The final surface layer shall be laid in a continuous sequence over the
entire project unless otherwise approved by the engineer.

404.9.5 Spot Wedging and Leveling Course. The engineer will determine the locations
and thickness of spot wedging and the thickness of leveling course to obtain the smoothest
possible riding surface. This procedure may result in spot wedging operations over small areas
with feather-edging at high points and ends of wedge areas. Rigid control of the placement
thickness of the leveling course will be required. Leveling course, consisting of a layer of
asphaltic concrete of variable thickness used to superelevate curves and eliminate irregularities in
the existing base, shall be spread uniformly to the desired profile grade and cross section. The
use of an approved finishing machine with automatic screed control will be required on the spot
wedge and the leveling course. Type C (BP-1) mixture shall be used for spot wedging. The type
of mixture to be used for the leveling course will be designated in the contract. Surface grades
will be established in advance of the contractor’s wedge and level operations to prevent
unnecessary interruptions in the work.

404.9.5.1 At intersections between arterial and/or collector streets, the lane width of the
pavement shall be completed for a minimum length of 30 m (100 ft.) on either side of the
intersection centerline and feathered at the edges in a single operating day so that a uniform,
smooth riding surface is maintained across the intersection. When the asphaltic concrete
construction consists of more than one layer and a vertical face remains at a cross street at the
end of a work day, asphaltic material shall be added along the edges to provide a smooth riding
surface.

404.9.6 Automatic Screed Control. The use of automatic screed control devices will be
required except for paving small irregular areas, shoulders, entrances, and side road connections.
The screed of the mechanical spreading and finishing machine shall be regulated by an
automatically controlled grade leveling and slope control device approved by the engineer. The
device shall be of a standard commercial quality adapted to the type of paver used and shall
provide control for producing a uniform surface to the established grade and a cross slope
conforming to the requirements of the typical section. The device shall also be equipped with the
necessary controls to permit the operator to adjust or vary the slope throughout superelevated
curves.

(a) Except as modified above or by the contract, an established grade reference shall be
used. The engineer will establish the grade and will furnish variable thickness values
at intervals along the centerline of the roadway for the use of the contractor in setting a grade reference. The initial pass of the paver, when placing the first continuous layer, shall be made with the sensor following the established grade reference maintained true to grade. If the established grade reference is not required, the initial pass of the paver, when placing the first continuous layer, shall be made with the sensor following a traveling reference plane not less than 9 m (30 ft.) in length, segmented, supported on pads parallel to the paver and mounted as an integral part of the paver. Regardless of the method used for placing the first continuous layer, other layers shall be placed by use of a shoe-type sensor or indicator, the traveling reference plane, or by additional use of the established grade reference as follows:

(1) If the current construction consists of only one bituminous or asphalitic layer, a shoe-type sensor or indicator resting on the adjacent surface shall be used for control of subsequent passes of the paver for that layer. When more than two adjacent passes of the paver are required to place the material the full width of the riding surface, additional use of the established grade reference or use of the traveling reference may be required, if in the judgment of the engineer, satisfactory grade control is not being obtained by the use of the shoe-type sensor.

(2) If the current construction consists of two bituminous or asphalitic layers, subsequent passes of the paver for the first layer and the first pass of the paver for the second layer shall be made with the sensor following the traveling reference. The adjacent passes of the paver for the second layer shall be made with a shoe-type sensor or indicator resting on the previously placed second layer. When more than two adjacent passes of the paver are required to place the second layer the full width of the riding surface, additional use of the established grade reference or the traveling reference may be required, if in the judgment of the engineer, satisfactory grade control is not obtained by the use of the shoe-type sensor resting on the adjacent surface.

(3) If the current construction consists of three or more bituminous or asphalitic layers, subsequent passes of the paver for the same layer and each pass of the paver for all additional layers except the top layer, shall be made with the sensor following the traveling reference. When more than two adjacent passes of the paver are required to place the surfacing material, except for the top layer, the full width of the riding surface, additional use of the established grade reference may be required, if in the judgment of the engineer, satisfactory grade control is not obtained by the use of the traveling reference. The automatic screed control device shall not be used when placing the top layer if the current construction consists of three or more full layers of a bituminous or asphalitic mixture.

(b) The spreading operation shall be discontinued in the event of failure of the automatic control device, except that placement will be permitted of mixtures already produced at the time of the failure. The use of the automatic control equipment does not preclude the need for manual control of the screed adjustment for wedging operations over small areas requiring more correction than the maximum thickness permitted for
an individual layer of the type of material being placed.

404.9.7 Placement of Temporary Pavement. Where conditions are such that the use of a finishing machine is not deemed practical by the County Engineer for constructing the wedge and leveling course, the base course on the subgrade, narrow pavement, widths or small irregularly shaped areas, the County Engineer may allow the use of bladed motor equipment or box spreaders for this construction. The finish courses for temporary pavements shall be placed with a finishing machine.

404.10 Compaction. After the asphaltic mixture has been spread, struck off, and surface irregularities adjusted, it shall be thoroughly and uniformly compacted by rolling. Rolling shall begin as soon after spreading the mixture as it will bear the weight of the roller without undue displacement. The number of rollers furnished shall be sufficient to obtain the required compaction while the mixture is in a workable condition. Except for projects involving small quantities of mixture, the compacting equipment requirements shall meet specifications set forth in Sec. 404.5.17. If equipment breaks down or rolling does not keep up with the spreader, all work will be stopped. The County Engineer will have the option of rejecting any pavement not meeting the rolling or density requirements of Sec. 404.10.4. If pavement is designated to remain in place, penalties will be assessed for the affected material in accordance to Sec. 404.21.

404.10.1 Rollers shall move at a slow but uniform speed with the drive roller or wheels nearest the paver. Rolling shall begin at the sides and proceed longitudinally parallel to the road centerline, each trip overlapping one half the roller width, gradually progressing to the crown of the road. When paving in echelon or abutting a previously placed lane, the longitudinal joint shall be rolled first followed by the regular rolling procedure. Where practical the longitudinal lane joints will be “pinched” by rolling from the existing portion of roadway and lapping over into the newly placed asphaltic material so as to tightly bond and compact the new asphalt to the existing asphalt. On superelevated curves the rolling shall begin at the low side and progress to the high side by overlapping of longitudinal trips parallel to the centerline. Alternate trips of the roller shall be terminated in steps to prevent the formation of surface irregularities. The alternate stops shall be spaced in such manner that any excess water will drain quickly. Lateral or diagonal rolling may be permitted to remove high spots, provided the rolling is done in such manner and at such time that shoving or cracking will not result. Rolling shall be continued until all roller marks are eliminated. Lateral or cross-rolling will be required at all butt or construction joints.

404.10.2 Any displacement occurring as a result of starting, stopping, or changing direction of a roller, or from other causes, shall be avoided. Areas of displacement shall be corrected at once by the use of rakes and addition of fresh mixture when required. Care shall be exercised in rolling not to displace the line and grade of the edges of the asphaltic concrete. If necessary to prevent adhesion of the mixture to the rollers, the wheels and rollers shall be kept properly moistened with water or water mixed with very small quantities of detergent or other approved material. Excess liquid will not be permitted. Along forms, curbs, inlet sumps, headers, walls and other places not accessible to the rollers, the mixture shall be thoroughly compacted with hot hand tampers, smoothing irons, or with mechanical tampers. A trench roller shall be used on depressed areas inaccessible to regular width equipment. A one ton roller or hand roller will be required to adequately compact tapered pavement edges.
404.10.3 Any mixture that becomes loose and broken, mixed with dirt, or is in any way defective shall be removed and replaced with fresh, hot mixture, which shall be compacted to conform to the surrounding area. Any area showing an excess or deficiency of asphalt cement shall be removed and replaced.

404.10.4 Rolling shall be continued until all roller marks are eliminated and, except as otherwise specified, a minimum density of 96 percent of a laboratory specimen made in the proportions of the job-mix formula has been obtained.

404.10.4.1 The applicable density will be determined by the engineer to correspond with the mix design test method. Density will be determined by nuclear methods or by a specific gravity method. The backscatter nuclear method of test will be used for Type C (BP-1) Asphaltic Concrete or Special Asphaltic Concrete Mixtures (Slag and Porphyry/Limestone), and for Type B Asphaltic Concrete mixtures when used in lieu of plant mix bituminous base.

404.10.5 In lieu of roller and density requirements, mixtures used for surfacing medians and similar areas, shoulders adjacent to rigid pavement, shoulders adjacent to resurfaced rigid pavement, and temporary by-passes to be maintained at the expense of the contractor shall be thoroughly compacted by at least three complete coverages over the entire area, with a tandem-type steel wheel roller weighing not less than 9 metric tons (10 tons). The rolling shall be performed at the proper time intervals and shall be continued until there is no visible evidence of further consolidation.

404.11 Joints. Hand manipulation (luting) of all joints will be required to properly seal the joint. Transverse joints shall be formed in accordance with standard drawings that will produce a dense, vertical section for use when laying is resumed.

The joint formed when the fresh mixture is placed shall be dense, well sealed, and the grade, line, and surface texture of the succeeding surface shall conform to that of the joined surface. When deemed necessary by the engineer, the transverse joint shall be painted with a light coating of asphaltic material. Placing of asphaltic mixture shall be nearly continuous as possible and the roller shall not pass over the unprotected end unless laying of additional mixture is to be delayed for sufficient time to permit the mixture to become chilled. Longitudinal and transverse joints shall be carefully made and well bonded. Transverse joints shall be formed by cutting back on the previous run so as to expose the full depth of the layer.

404.11.1 Longitudinal joints shall be formed by the use of an edging plate fixed on both sides of the finishing machine. These plates shall be adjustable and the outside plate shall be set at an angle of approximately 45 degrees with the surface of the roadbed and in a position that will lightly compact the mixture. The inside plate, or that placing material for the longitudinal joint, shall be normal to the roadbed. When placing the first lane, if the mixture at the longitudinal joint tends to slump, it shall be set up to a vertical edge by light compaction with the back of the rake. Hand manipulation of the asphalt to produce a tight seam with maximum compaction at all the joints will be required. Care shall be taken to obtain a well bonded and sealed longitudinal joint by placing the hot mixture in a manner insuring maximum compaction.
at this joint. A light coating of asphaltic material shall be applied to the exposed edge before the joint is made. Irregularities in the outside edge alignment shall be corrected by removing or adding mixture before the surface is compacted. Hot joints are required at the juncture of mainline pavement overlay and the overlay for driveways and side streets. The contractor shall arrange his operations so that the overlay of adjacent side streets and driveways are completed as the mainline overlay proceeds in order to obtain the conditions necessary to meet this requirement. Irregularities in the outside edge alignment shall be corrected by removing or adding mixture before the surface is compacted. No additional payment beyond the unit prices bid for asphaltic materials will be made for compliance with this requirement.

404.11.2 The longitudinal joint in any layer shall offset that in the layer immediately below by approximately 150 mm (6 in.); however, the joints in the completed surfacing shall be at the lane lines of the travel way, when field conditions permit.

404.11.3 Required Butt Joint. The contractor is required to construct butt joints at all overlay termini occurring on existing portland cement concrete and bituminous streets and at other locations as directed by the engineer. The dimensions of the joint and other construction details shall be in accordance with the standard butt joint detail included with the plans. It is required that the contractor use a cold-planer machine in removing that portion of the existing pavement shown hatched on the detail. As noted on the detail, the overall length of the joint will be determined by the engineer during construction.

404.11.4 No direct payment will be made for cold-planer work required or for other work incidental to the construction of the joint. Butt joints will not be paid for separately, but will be considered to be completely covered by the unit prices of the other items included in the contract.

404.12 Surface Tolerance. The surface of each layer shall be substantially free from waves or irregularities. On arterial roadways and collector streets, the final surface (except on medians and similar areas, shoulders adjacent to rigid pavement, and temporary bypasses) shall not vary from a 3 m (10 ft.) straightedge, applied parallel to the center line, by more than 10 mm (3/8 in.). At transverse construction joints, surface tolerances shall not vary from the 3 m (10 ft.) straightedge by more than 6 mm (1/4 in.).

404.12.1 Surface irregularities in the final lift shall be addressed immediately and corrected in the final rolling process. Should the contractor fail to pave within the required tolerances, the operation will be halted. If surface irregularities still exist when the temperature of the asphalt drops below that which is required to roll the pavement in a workable state, the affected pavement shall be removed and replaced to a depth of 30 mm (1 1/4 in.) or treated by other methods as directed by the engineer.

404.12.2 On subdivision streets (up to 7.9 m (26 ft.) in width), testing in accordance to Sec. 404.12 will be performed, except that surface variations exceeding 13 mm (1/2 in.) in 3 m (10 ft.) will be marked for removal.

404.13 Testing Pavement. The finished courses shall have the nominal thickness shown
on the plans. Tests will be made to insure that each course is being constructed of proper thickness, composition, and density.

404.13.1 Density Sample. Each cored sample for density determination shall consist of four cores. Samples shall be taken every 600 m (2,000 ft.). At least one set of samples will be taken for each day’s production. All samples, whether sawed or cored, shall consist of an undisturbed portion of the compacted mixture removed for the full depth of the layer of course to be tested.

404.14 General Requirements.

404.14.1 Sequence of Operations. To reduce inconvenience to the traveling public during widening or surfacing, the contractor will not be permitted to place any final surface course until the base widening, the leveling course, and the binder course have been completed throughout the entire combination of sections, unless otherwise authorized by the engineer. The proper condition of the base widening, the leveling course, and the binder course, at the time of placing the surface course, shall be the contractor’s responsibility.

404.14.2 Traffic Striping. If the contractor’s work has obliterated the existing traffic striping on resurfacing projects open to through traffic, and the surface course has not been completed at the time work is suspended for any extended period, temporary striping will be placed by the County when necessary in the judgment of the County Engineer. A deduction of an amount based on $50.00 for each lane kilometer ($75.00 for each lane mile) actually striped, measured to the nearest 0.1 km (nearest 1/10 mile), of uncompleted pavement surface requiring striping will be made from money due the contractor.

404.15 Surfaced Approaches. At locations designated in the contract or as directed by the engineer, approaches are to be tacked in accordance with Sec. 407 and surfaced with Type D asphaltic concrete. The asphaltic concrete surface shall be placed in accordance with details shown on the typical section or as directed by the engineer. Approaches shall be surfaced when the surface course adjacent to the entrance is being placed. No direct payment will be made for any work required to condition and prepare the subgrade on the approaches.

404.16 Filling Drain Basins. If shown on the plans, existing drain basins shall be filled to the top of the lip with plant mix bituminous base course from the pavement edge to the edge of the shoulder. No direct payment will be made for any difficulty or delay occasioned by this requirement.

404.17 Pavement Repairs (Blow-ups). A blow-up will be considered that area where excessive expansion has resulted in distress to the existing pavement. Blow-ups occurring prior to the application of the tack coat on the existing surface will generally be repaired by the County. Blow-ups occurring after the application of the tack coat shall be repaired by the contractor by removing the distressed concrete and making replacement with asphaltic concrete mixture, thoroughly compacted.

404.17.1 Paving Fabric. Paving fabric having the properties detailed in Sec. 1015 shall
be used as a reinforced asphalt overlay for patching, and for waterproofing if specified in the contract. The fabric overlay shall be installed in continuous strips, using the manufacturer’s construction procedures. A “full width” fabric overlay shall be installed in continuous strips of 3.6 m (12 ft.) or greater in width using the manufacturer’s construction procedures.

404.18 Method of Measurement. The weight of the mixture will be determined from the batch weights when a batch-type plant is used; and will be determined by weighing each truck load in accordance with the requirements of Sec. 310.4.2 when other types of plants are used.

404.19 Basis of Payment.

404.19.1 Due to possible variations in the specific gravity of the aggregates, the tonnage used may vary from the proposal quantities and no adjustment in contract unit price will be made because of such variation.

404.19.2 Payment for Pavement Repairs (Blow-ups). Payment for removing and disposing of the broken concrete and for preparing subgrade will be at the contract unit bid price, or, if none exists, as approved by the County Engineer. Payment for furnishing, placing, and compacting the asphaltic concrete replacement material will be at the contract unit bid price for the mixture used.

404.19.3 The accepted quantities of asphaltic concrete will be paid for at the unit bid price, to the nearest ton, for each of the pay items included in the contract. The quantity of Type C (BP-1) material used in the wedging or leveling course will not be paid for as a separate bid item, but will be paid for at the unit bid price for the pay item shown as Type C (BP-1) asphaltic concrete.

404.19.4 Payment for fabric material will be made for the surface area covered with fabric, to the nearest square meter (sq. yd.). No additional payment will be made for laps, splices, etc.

404.20 Compensation for Thickness Deficiencies. Cores shall be cut to determine pavement thickness. If any core measurement is less than the thickness indicated on the plans, the contractor will have the option of removing and replacing the pavement at his expense, or will be required to reimburse the County for the deficiencies in thicknesses noted on the schedule. The choice of alternate penalty under category (3) below will be at the sole discretion of the County. The reimbursement amount shall be deposited with the Treasurer of St. Charles County.

<table>
<thead>
<tr>
<th>Deficiency in Thickness</th>
<th>Deduction, Percent of Bid Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 mm to 9 mm (0.1 in. to 0.3 in.)</td>
<td>20</td>
</tr>
<tr>
<td>10 mm to 15 mm (0.4 in. to 0.6 in)</td>
<td>40</td>
</tr>
<tr>
<td>Greater than 15 mm (0.6 in.)</td>
<td>100, or remove and replace</td>
</tr>
</tbody>
</table>

(Estimated cost is computed at the rate per square meter (sq. yd.) of pavement used in
determining the amount of the developer’s escrow deposit. Penalties will be assessed at 30 m (100 ft.) intervals.)

**404.21 Compensation for Density Deficiencies.** Pavement shall be tested in accordance to Sec. 404.10.4 and/or 404.13.1. Density values for each lift of asphaltic concrete will be determined. Pavement that is not compacted to the minimum density requirement specified shall be removed and replaced. If in the judgment of the engineer the inadequately compacted pavement would not seriously impair traffic service, penalties may be assessed for low density results in lieu of the removal and replacement of pavement. Penalties will be assessed at the County Engineer’s option in accordance to Sec. 404.21.1 and 404.21.2.

**404.21.1 Full Depth Asphaltic Concrete Construction and Asphaltic overlays.** At the County Engineer’s option, penalties for inadequate compaction will be assessed as follows:

<table>
<thead>
<tr>
<th>Compaction Results Measured to the Nearest 1%</th>
<th>Deduction in Unit Price Per Ton</th>
</tr>
</thead>
<tbody>
<tr>
<td>Types B &amp; C (BP-1), Slag &amp; Porphyry Asphalt</td>
<td>No Deduction</td>
</tr>
<tr>
<td>96% or Above</td>
<td>5% Reduction</td>
</tr>
<tr>
<td>95%</td>
<td>25% Reduction</td>
</tr>
<tr>
<td>94%</td>
<td>100% Reduction</td>
</tr>
<tr>
<td>Below 94%</td>
<td></td>
</tr>
</tbody>
</table>

Penalties will be assessed at 150 m (500 ft.) intervals.

**404.21.2 New Real Estate Subdivision Asphaltic Concrete Pavement.** At the County Engineer’s option, penalties for inadequate compaction will be assessed as follows:

<table>
<thead>
<tr>
<th>Compaction Results Measured to the Nearest 1% Amount</th>
<th>Deduction in Escrow</th>
</tr>
</thead>
<tbody>
<tr>
<td>Types B &amp; C (BP-1) Asphalt</td>
<td>No Deduction</td>
</tr>
<tr>
<td>96% or Above</td>
<td>5% Reduction</td>
</tr>
<tr>
<td>95%</td>
<td>25% Reduction</td>
</tr>
<tr>
<td>94%</td>
<td>100% Reduction</td>
</tr>
<tr>
<td>Below 94%</td>
<td></td>
</tr>
</tbody>
</table>

Penalties will be assessed at 150 m (500 ft.) intervals.
SECTION 405
BITUMINOUS PAVEMENTS AND BASE

405.1 Description. This work shall consist of a mixture of aggregate, mineral filler and/or hydrated lime if needed, and asphalt cement, prepared in a stationary bituminous mixing plant as specified in Sec. 404, that meets the gradation requirements of the job-mix formula.

405.1.1 Bituminous mixtures are to be hauled, placed, compacted, measured, paid for, and otherwise constructed in accordance to the requirements specified in Sec. 404, unless specified herein.

405.2 Materials. All materials shall conform to Division 1000, Materials Details, and specifically as follows:

<table>
<thead>
<tr>
<th>Item</th>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asphalt Cement (60-70, 85-100) (AC-10, AC-20)</td>
<td>1015.5</td>
</tr>
<tr>
<td>Coarse Aggregate</td>
<td>1004.1</td>
</tr>
<tr>
<td>Fine Aggregate</td>
<td>1004.2</td>
</tr>
<tr>
<td>Screenings</td>
<td>1004.3</td>
</tr>
<tr>
<td>Mineral Filler</td>
<td>1004.4</td>
</tr>
<tr>
<td>Hydrated Lime</td>
<td>1004.7</td>
</tr>
</tbody>
</table>

The grade of asphalt cement will be specified in the contract.

405.3 Composition of Mixtures.

405.3.1 Prior to mixing with asphalt cement the total aggregate, including filler if needed, shall meet the following gradation for the type of mixture specified in the contract.

<table>
<thead>
<tr>
<th>TYPE C (BP-1) BITUMINOUS PAVEMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sieve Size</td>
</tr>
<tr>
<td>Min. - Max.</td>
</tr>
<tr>
<td>-------------------</td>
</tr>
<tr>
<td>19 mm (3/4 in.)</td>
</tr>
<tr>
<td>12.5 mm (1/2 in.)</td>
</tr>
<tr>
<td>9.5 mm (3/8 in.)</td>
</tr>
<tr>
<td>4.75 mm (No. 4)</td>
</tr>
<tr>
<td>2.36 mm (No. 8)</td>
</tr>
<tr>
<td>600 μm (No. 30)</td>
</tr>
<tr>
<td>75 μm (No. 200)</td>
</tr>
<tr>
<td>Sieve Size</td>
</tr>
<tr>
<td>------------------</td>
</tr>
<tr>
<td>12.5 mm (1/2 in.)</td>
</tr>
<tr>
<td>4.75 mm (No. 4)</td>
</tr>
<tr>
<td>2.36 mm (No. 8)</td>
</tr>
<tr>
<td>600 μm (No. 30)</td>
</tr>
<tr>
<td>75 μm (No. 200)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Percent Passing</th>
</tr>
</thead>
<tbody>
<tr>
<td>9.5 mm (3/8 in.)</td>
<td>100</td>
</tr>
<tr>
<td>4.75 mm (No. 4)</td>
<td>90 - 100</td>
</tr>
<tr>
<td>2.36 mm (No. 8)</td>
<td>70 - 90</td>
</tr>
<tr>
<td>600 μm (No. 30)</td>
<td>20 - 40</td>
</tr>
<tr>
<td>75 μm (No. 200)</td>
<td>5 - 15</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Percent Passing</th>
</tr>
</thead>
<tbody>
<tr>
<td>25 mm (1 in.)</td>
<td>100</td>
</tr>
<tr>
<td>12.5 mm (1/2 in.)</td>
<td>60 - 90</td>
</tr>
<tr>
<td>4.75 mm (No. 4)</td>
<td>35 - 65</td>
</tr>
<tr>
<td>2.36 mm (No. 8)</td>
<td>25 - 50</td>
</tr>
<tr>
<td>600 μm (No. 30)</td>
<td>10 - 35</td>
</tr>
<tr>
<td>75 μm (No. 200)</td>
<td>4 - 12</td>
</tr>
</tbody>
</table>

405.3.2 With written approval of the County Engineer, combinations of coarse aggregate, limestone screenings, fine aggregate, and mineral filler or hydrated lime as specified in Sec. 405.2 may be used. Not less than 10, nor more than 20 percent natural fine aggregate, as specified in Sec. 405.2 shall be added as a separate ingredient. Each size and type of aggregate shall be added as a separate ingredient. Each size and type of aggregate shall be kept separate and fed through separate calibrated cold aggregate feeders to insure accurate proportioning. No mixture will be approved which contains less than 30 percent of any one type of coarse aggregate in the combination. In addition all plus 2.36 mm (No. 8) sieve factions shall contain material from each type of coarse aggregate in the approved combination.
405.3.2.1 If gravel, or if flint chat as produced in the Joplin area, is used, not less than 15 percent nor more than 30 percent crushed stone screenings, or dolomite chat screenings as produced in the Southeast Missouri Lead Belt Area, or not less than 4 percent mineral filler by weight shall be added as a separate ingredient. Screenings shall consist of tough durable particles of approved quality, shall be free from dirt or other objectionable material, and shall have 95 percent passing the 9.5 mm (3/8 in.) sieve.

405.3.2.2 The composition of the mixture shall conform to the following limits by weight:

<table>
<thead>
<tr>
<th></th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Mineral Aggregate</td>
<td>92 - 96 %</td>
</tr>
<tr>
<td>Asphalt Cement (Type C (BP-1), D, E Mixtures)</td>
<td>4-8%</td>
</tr>
<tr>
<td>Asphalt Cement (Type X Mixture)</td>
<td>3.5-7%</td>
</tr>
</tbody>
</table>

405.3.3 **Mix Design Parameters.** At least 45 days prior to preparing any of the mixture on the project, the contractor shall obtain, in the presence of the engineer, representative samples of asphalt cement and mineral aggregates for tests. The samples of materials shall be the size designated by the engineer and shall be submitted to the Central Laboratory for testing. The contractor shall also submit for the engineer’s approval, a job-mix formula for each mixture to be supplied for the project. No mixture will be accepted for use until the job-mix formula for the project is approved by the engineer. The job-mix formula shall be within the master range specified for the particular type of asphaltic aggregates, the relative quantity of each ingredient, and shall state a definite percentage for each sieve fraction of aggregate and for asphalt cement. The combined aggregate mix shall, in the judgment of the engineer, plot favorably on the .45 power gradation chart. No job-mix formula will be approved which does not permit, within the limits of the master range, the full tolerances specified in Sec. 405.3.5 for asphalt cement and mineral passing the 75 μm (No. 200) sieve, and not less than 1/2 the tolerance designated for material passing the 2.36 mm (No. 8) sieve. The job-mix formula approved for each mixture shall be in effect until modified in writing by the engineer. When unsatisfactory results or other conditions make it necessary, or should a source of material be changed, a new job-mix formula may be required.

405.3.4 The engineer may make adjustments in the job-mix formula submitted by the contractor in order that 60 to 80 percent of the VMA are filled with asphalt and the ratio of the minus 75 μm (No. 200) material to asphalt cement is between 0.6 and 1.2 for C-mix and 0.6 to 1.5 for X and D mix. The percentage of VMA, and VMA filled with asphalt will be specified by the engineer. Approved mixtures, when compacted and tested in the laboratory in accordance with AASHTO T 245 (50 Blow Marshall), shall yield stability values of 6600 N (1,500 lb.) for Type C (BP-1) and X mixtures, 4400 N (1,000 lb.) for Type D, and 3300 N (750 lb.) for Type E. The flow values for all asphaltic mixes shall be not less than 8 nor more than 16 when measured in 0.25 mm (0.01 in.) gradations. The mixture of aggregates, mineral filler if needed, and asphalt cement shall demonstrate satisfactory cohesion.

405.3.5 **Gradation Control.** In producing mixtures for the project, the plant shall be so operated that no intentional deviations from the job-mix formula are made. Mixtures as produced
shall be subject to the following tolerances and controls:

(a) The total aggregate gradation shall be within the master range specified in Sec. 405.3.1 for the particular grade of mixture specified.

(b) The maximum variation from the approved job-mix formula shall be within the following tolerances:

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Tolerance</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.36 mm (No. 8)</td>
<td>±5.0 percentage points</td>
</tr>
<tr>
<td>75 µm (No. 200)</td>
<td>±2.0 percentage points</td>
</tr>
</tbody>
</table>

(c) The quantity of asphalt cement introduced into the mixer shall be that quantity specified in the job-mix formula. No change may be made in the quantity of asphalt cement specified in the job-mix formula without written approval of the engineer. The quantity of asphalt cement determined by calculation or tests on the final mixture shall not vary more than ±0.5 percentage points from the job-mix formula.

(d) Except when Bituminous Pavement Type E aggregate is specified, the screening unit shall separate the useable heated aggregate into at least three sizes. For Type D Bituminous Pavement Production, aggregate shall be separated into at least two sizes.

(e) One of the aggregate bin sizes produced by the screening unit shall contain not more than 10 percent by weight retained on the 4.75 mm (No. 4) sieve.

405.3.6 The gradations of the total aggregate will be determined from samples taken from the hot bins on batch type or continuous mixing plants or from the combined cold feed on dryer-drum mixing plants.

405.4 Screens. Plant screens shall be maintained and operated in the manner prescribed in Sec. 404.5.6, except that for Type D and Type E bituminous mixtures the screening unit shall be required to separate the useable heated aggregate into at least two sizes.

405.5 Control of Mixing. Mixing procedures for bituminous mixtures shall be set in accordance to Sec. 404.5.10. However, for Type X bituminous base mixtures the dry mixing time during Batch Type Plant Operation may be reduced from 15 to 10 seconds.

405.6 Spreading and Finishing. Bituminous pavement shall be placed in accordance to Sec. 404.9 with each individual layer having a compacted thickness no greater than 50 mm (2 in.) for Type C (BP-1) and D mixtures, and no greater than 100 mm (4 in.) for Type X mixtures.

405.7 Compaction. Bituminous pavement shall be compacted in accordance to Sec. 404.10, except that the minimum density requirements for Type D and Type X mixtures will be 95 percent of a laboratory specimen made in the proportions of the job mix formula which has been approved. The minimum density requirement for Type C (BP-1) mixtures will be 98 percent of a laboratory specimen made in the proportions of the job-mix formula which has been approved.
405.8 Compensation for Density Deficiencies. Pavement shall be tested in accordance to Sec. 404.10.4.1 and/or 404.13.1. Density values for each lift of bituminous concrete will be determined. Pavement that is not compacted to the minimum density requirement specified shall be removed and replaced. If in the judgment of the engineer the inadequately compacted pavement would not seriously impair traffic service, penalties may be assessed for low density results in lieu of the removal and replacement of pavement. Penalties will be assessed at the County Engineer’s option in accordance to Sec. 405.8.1, 405.8.2 and 405.8.3.

405.8.1 Full Depth Bituminous Concrete Construction and Bituminous Overlays. At the County Engineer’s option, penalties for inadequate compaction of pavement will be assessed as follows:

<table>
<thead>
<tr>
<th>Compaction Results Measured to the Nearest 1%</th>
<th>Deduction in Unit Price Per Ton</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type C (BP-1), Bituminous</td>
<td></td>
</tr>
<tr>
<td>98% or Above</td>
<td>No Deduction</td>
</tr>
<tr>
<td>97%</td>
<td>5% Reduction</td>
</tr>
<tr>
<td>96%</td>
<td>25% Reduction</td>
</tr>
<tr>
<td>Below 96%</td>
<td>100% Reduction</td>
</tr>
</tbody>
</table>

Penalties will be assessed at 150 m (500 ft.) intervals.

405.8.2 New Real Estate Subdivision Bituminous Pavement. At the County Engineer’s option, penalties for inadequate compaction of pavement will be assessed as follows:

<table>
<thead>
<tr>
<th>Compaction Results Measured to the Nearest 1%</th>
<th>Deduction in Escrow Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type C (BP-1) Bituminous</td>
<td></td>
</tr>
<tr>
<td>98% or Above</td>
<td>No Deduction</td>
</tr>
<tr>
<td>97%</td>
<td>5% Reduction</td>
</tr>
<tr>
<td>96%</td>
<td>25% Reduction</td>
</tr>
<tr>
<td>Below 96%</td>
<td>100% Reduction</td>
</tr>
</tbody>
</table>

Penalties will be assessed at 150 m (500 ft.) intervals.

405.8.3 Cores from Type X Bituminous Base Pavement shall be tested in accordance to Sec. 404.13.1 and 405.7. Should unfavorable test results be obtained, the engineer will have the option of rejecting all pavement comprised of the inadequately compacted bituminous mix or deducting 100 percent from the contract price or escrow amount of all the material represented by the failed tests.
SECTION 407
TACK COAT

407.1 Description. This work shall consist of preparing and treating an existing bituminous or concrete surface with bituminous material, and blotter material if required, in accordance with these specifications and in conformity with the lines shown on the plans or established by the County Engineer.

407.2 Materials. All materials shall conform to Division 1000, Materials Details, and specifically as follows:

<table>
<thead>
<tr>
<th>Item</th>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liquid Asphalt (RC-70, MC-30, or MC-70)</td>
<td>1015</td>
</tr>
<tr>
<td>Emulsified Asphalt (SS-1, SS-1H, RS-1)</td>
<td>1015.7</td>
</tr>
<tr>
<td>CSS-1, or CSS-1H</td>
<td></td>
</tr>
</tbody>
</table>

Because of variations in weather conditions, the engineer reserves the right to vary the grade of asphalt cement used in the emulsified tack coat from the slow-setting grade in SS-1 H to the rapid-setting grade used in RS-1.

No adjustment will be made in the unit price bid for tack coat, because of this possible variation in asphalt grades.

407.2.1 Aggregate used for sanding tack shall be a fine, granular material naturally produced by the disintegration of rock of a siliceous nature; or fines manufactured from igneous rock, chert gravel, or flint sand.

407.3 Equipment. The contractor shall provide equipment for heating and applying the bituminous material. This equipment shall meet the requirements of Sec. 407.4.3.

407.4 Construction Requirements.

407.4.1 Weather Limitations. Tack coats shall not be normally placed: (1) when either the air temperature or the temperature of the surface on which the mixture is to be placed is below 5°F (40°F), (2) on any wet or frozen surface, (3) when weather conditions prevent the proper handling or finishing, or (4) unless authorized by the County Engineer during critical temperature periods (below 5°F (40°F)).

407.4.2 Preparation of Surface. Existing surfaces shall be free of all dust, loose material, grease, and other petroleum distillates, debris or other foreign material, at the time the tack is applied. The surface shall be dry when the tack is applied, except in the case of emulsified asphalt.
407.4.3 Application. Bituminous material shall be applied uniformly with a pressure distributor at the rate specified in the contract, or as revised by the engineer to be within a minimum of 0.09 L/m² and a maximum of 0.45 L/m² (a min. of 0.02 gal./sq. yd. and a max. of 0.10 gal./sq. yd.). Whenever emulsified asphalt is used, water may be added to the material and mixed therewith in such proportion that the resulting mixture will contain not more than 50 percent of added water, the exact quantity of added water to be determined by the engineer. The application of the resulting mixture shall be such that the original emulsion will be spread at the specified rate. The tack material shall be heated at the time of application to a temperature designated by the engineer in accordance with the limits provided in Sec. 1015.1.5, or as specified in the contract. The tack material shall be properly cured and the tacked surface shall be cleaned of all dirt and surplus sand before the next course is placed. When tack coat is placed by hand methods, a pressurized application system must be used, unless otherwise approved by the engineer.

407.4.3.1 The tack coat shall be applied in such manner as to cause the least inconvenience to traffic and to permit one-way traffic without pickup or tracking of the bituminous material. The application of tack coat will be limited to 175 m (600 ft.) ahead of the spreading machine. Tack coat shall extend 0.3 m (1 ft.) outside of longitudinal joints and 1.5 m (5 ft.) outside transverse joints.

Payment will be made for the quantity of material used at the contract unit price bid.

407.5 Method of Measurement. Measurement of bituminous material will be made to the nearest 50 L (10 gal.). Calibrated measurement of the quantities of asphaltic emulsion will be determined prior to the addition of water. No direct payment will be made for water added to the asphaltic emulsion.

407.5.1 No measurement of material for sanding tack coat will be made.

407.6 Basis of Payment. The accepted quantities of tack coat will be paid for at the unit bid price.
SECTION 408
PRIME COAT

408.1 Description. This work shall consist of preparing and treating an existing surface with bituminous material, in accordance with these specifications and in conformity with the lines shown on the plans or established by the County Engineer.

408.2 Materials. All materials shall conform to Division 1000, Materials Details, and specifically as follows:

<table>
<thead>
<tr>
<th>Item</th>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type RC Liquid Asphalt</td>
<td>1015.2</td>
</tr>
<tr>
<td>Type MC Liquid Asphalt</td>
<td>1015.3</td>
</tr>
<tr>
<td>Emulsified Asphalt</td>
<td>1015.7</td>
</tr>
</tbody>
</table>

The type and grade of bituminous material will be specified in the contract. Liquid asphalt may be changed one grade by the engineer during construction at no change in unit price.

408.3 Equipment. The contractor shall provide equipment for heating and applying the bituminous material. This equipment shall meet the requirements of Sec. 408.4.3.

408.4 Construction Requirements.

408.4.1 Weather Limitations. Prime coats shall not be normally placed: (1) when either the air temperature or the temperature of the surface on which the mixture is to be placed is below 5°C (40°F), (2) on any wet or frozen surface, (3) when weather conditions prevent the proper handling or finishing, or (4) unless authorized by the County Engineer during critical temperature periods below 5°C (40°F).

408.4.2 Preparation of Surface. The surface to be primed shall be shaped to the required grade and cross section, shall be free from all ruts, corrugations, segregated material, or other irregularities and shall be uniformly compacted by rolling. The surface shall be firm and slightly damp when primer is applied. Moisture in excess of that stated in Sec. 304.3.6 will be cause to delay the priming operation. Delays in priming may necessitate reprocessing or reshaping to provide a smooth compacted surface.

408.4.3 Application. Bituminous material shall be applied to the width of the section to be primed by means of a pressure distributor in a uniform, continuous spread. The application rate shall be as specified in the contract or as revised by the engineer between 0.9 and 2.3 liters per square meter (0.2 and 0.5 gallon per square yard). The primer shall be heated at the time of application to a temperature designated by the engineer in accordance with the limits provided in Sec. 1015.1.5, or as specified in the contract. When prime is to be placed by hand methods a pressurized applicator system must be used, unless otherwise approved by the engineer.
408.4.3.1 Care shall be taken that the application of bituminous material at the junctions of spreads is not in excess of the specified quantity. Building paper shall be placed over the end of the previous applications and the joining application shall start on the building paper. Building paper used shall be removed and satisfactorily disposed of. Pools of primer material remaining on the surface after the application shall be removed.

408.4.3.2 When traffic is maintained, not more than one half of the width of the section shall be treated in one application and one-way traffic will be permitted on the untreated portion of the roadbed. As soon as the bituminous material has been absorbed by the surface and will not pick up, traffic shall be routed to the treated portion and the remaining width of the section shall be primed.

408.4.3.3 The primer shall be properly cured for a minimum of 12 hours and the primed surface shall be cleaned of all dirt and surplus sand before the next course is placed.

408.4.4 Application of Blotter Material. If, after the application of the prime coat, the bituminous material fails to penetrate, and the roadbed must be used by traffic, sand blotter material shall be spread in the quantity required to absorb excess bituminous material.

408.5 Method of Measurement. Calibrated measurement of bituminous material to the nearest 50 L (10 gal.) will be made at the job site.

408.5.1 No measurement of material for sanding primer will be made.

408.6 Basis of Payment. The accepted quantities of prime coat will be paid for at the unit bid price for each of the items included in the contract. No direct payment will be made for furnishing or applying any water required for dampening the surface to be primed.
SECTION 409
SEAL COAT

409.1 Description. This work shall consist of the application of bituminous material followed by the application of cover coat material in accordance with these specifications in conformity with the lines shown on the plans or established by the County Engineer.

409.2 Materials. All materials shall conform to Division 1000, Materials Details, and specifically as follows:

<table>
<thead>
<tr>
<th>Item</th>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liquid Asphalt (RC-3000) or (MC-3000)</td>
<td>1015.2, 1015.3</td>
</tr>
<tr>
<td>Asphalt Cement (70-85 Penetration)</td>
<td>1015.5</td>
</tr>
<tr>
<td>Emulsified Asphalt (RS-2, CRS-2, RS-1, or CRS-1)</td>
<td>1015.7</td>
</tr>
<tr>
<td>Aggregate for Seal Coats</td>
<td>1003</td>
</tr>
</tbody>
</table>

The grade of aggregate will be specified in the contract.

409.3 Equipment. The following equipment or its equivalent will be required:

(a) A distributor for heating and applying bituminous material. The distributor shall meet the requirements of Sec. 409.4.3.

(b) A vacuum pickup broom.

(c) A minimum of one oscillating-type pneumatic-tire roller. The pneumatic-tire roller shall be self-propelled, weighing from 4.5 to 7 metric tons (5 to 8 tons). Pneumatic tire rollers shall be operated at a speed not to exceed 8 km/h (5 mph).

(d) A self-propelled aggregate spreader of approved design. The aggregate spreader shall be equipped with a means of applying the larger cover aggregate to the surface ahead of the smaller cover aggregate and with positive controls so that the required quantity of material will be deposited uniformly over the full width of the bituminous material. Other types of aggregate spreaders may be used only with written approval of the engineer.

409.4.1 Weather Limitations. Seal coats shall not be normally placed: (1) when either the air temperature or the temperature of the surface on which the mixture is to be placed is below 21°C (70°F), (2) on any wet or frozen surface, (3) when weather conditions prevent the proper handling or finishing, or (4) unless authorized by the County Engineer during critical temperature periods below 21°C (70°F).
409.4.2 Preparation of Surface. The surface to be treated shall be thoroughly cleaned and swept to remove all mud, matted earth, dust, and other foreign materials.

409.4.3 Application of Bituminous Material. Bituminous material shall be applied by means of a pressure distributor in a slow, uniform, continuous spread, without missing or overlapping, at a truck speed consistent with the placement of the cover aggregate. Unless otherwise provided, the bituminous material shall be applied to one half the width of the surface at a time, with the center lap of the application placed at the lane line of the travelway and kept as narrow as is practicable. The other side of the roadway shall be left open to traffic. The application on one lane shall not exceed that on the adjacent lane by more than 5 km (3 miles). The bituminous material shall be within the temperature range designated by the engineer in accordance with the limits provided in Sec. 1015.1.5, except that asphalt cement shall be between 155\(^{0}\)C and 175\(^{0}\)C (315\(^{0}\)F and 350\(^{0}\)F). The actual quantity of bituminous material to be used per square meter (square yard) shall be as directed by the engineer. The rate of application is based on the specified minimum residual binder content as it applies directly to asphalt cement. The rate of application of liquid asphalt and emulsified asphalt shall be such that the residual binder content is equivalent to asphalt cement.

409.4.3.1 The angle of the spray nozzles and the height of the spray bar shall be set to provide a triple coverage fan pattern. The frame of the distributor shall be blocked or snubbed to the axle of the truck to maintain a constant height of the spray bar above the road surface during discharge of the load. An alternate method of maintaining constant spray bar height may be approved.

409.4.3.2 To insure uniform application of the bituminous material at the beginning of each distributor load, a portion of the roadbed surface shall be covered with building paper. The area covered by the building paper shall be used as the starting point for each distributor load or each part of a load after a temporary delay. If the cut-off is not positive, the use of paper may be required at the end of each spread. The paper shall be removed and disposed of in a satisfactory manner. The distributor shall be moving forward at proper application speed when the spray bar is opened. Any skipped areas or deficiencies shall be corrected. Junctions of spreads shall be carefully made to insure a smooth riding surface. The application of bituminous material on adjacent portland cement or asphaltic concrete pavements, curbs, bridges, or any areas not specified to be sealed shall be avoided. Hand application of bituminous material will only be allowed in isolated or irregular areas, islands, or medians and shall conform to the other requirements of this section.

409.4.3.3 If the seal coat is to be constructed on a bituminous surface in which the binder material was other than asphalt cement, the placing of the seal coat will not be permitted until the underlying bituminous course has cured from 15 to 30 days, as directed by the engineer.

409.4.4 Application of Cover Aggregate. The type of aggregate will be specified in the plans and will be applied at a rate established by the engineer. The aggregate will be free of excess dust and shall be rejected if in the opinion of the engineer improper bonding will occur. In general, the cover aggregate shall be placed within 2 minutes following the application of the bituminous material. Operations shall not proceed in such manner that bituminous material will
be allowed to chill, set up, dry, or otherwise impair retention of the cover material. The cover aggregate shall be spread by means of a self-propelled mechanical spreader accurately measuring and uniformly spreading the material. The actual quantity of cover aggregate to be used per square meter (square yard) shall be as directed by the engineer. Spreading shall be accomplished in a continuous manner, without stopping between trucks, and in such manner that the tires of the trucks or aggregate spreader at no time contact the uncovered and newly applied bituminous material. All portions of the surface not covered by mechanical spreaders shall be hand spotted so that the entire surface will be uniformly covered. Light hand brooming may be necessary to distribute excessive aggregate.

409.4.4.1 If liquid asphalt or asphaltic cement is used, cover aggregate shall be surface dry when applied to the bituminous material. Surface dry shall be that condition when no visible film of water exists on the aggregate. If emulsified asphalt is used, the moisture content of the aggregate shall not exceed 5 percent by weight. If directed by the engineer, the cover material shall be moistened with water to enhance cohesive properties of the emulsion.

409.4.4.2 Initial rolling shall begin immediately behind the spreader and shall consist of two complete coverages with the pneumatic-tire roller. All rolling shall be completed as soon as possible.

409.4.4.3 After the embedded aggregate has set, the surface shall be lightly broomed or otherwise maintained as directed for a period not to exceed 4 days. Maintenance of the surface shall include the distribution of cover aggregate over the surface to absorb any free bituminous material, and the removal of excess aggregate. Generally, the maintenance shall be confined to the cooler hours of the day and shall be conducted so as not to displace embedded material. The surface shall be free of excess aggregate at the time of acceptance of the work.

409.5 Traffic Control. No traffic shall be permitted on the seal coat until all rolling has been completed. The contractor shall control traffic by means of pilot vehicles to a maximum speed of 30 km/h (20 mph) for at least 2 hours after the completion of rolling. The contractor’s supply trucks shall observe these traffic controls. Pilot vehicles shall also be used to maintain one-way traffic through areas of placing and rolling. Pilot vehicles will not be required during sealing operations on shoulders.

409.6 Double Seal Coat. If a double seal coat is a requirement of the contract, a second application of both bituminous material and cover aggregate shall be made following the rolling of the first aggregate application. The second applications shall be made in the same manner as required in Sec. 409.4.3 and 409.4.4.

409.6.1 To avoid an unsatisfactory joint at the lane lines, the first applications of bituminous material and cover aggregate shall be placed for the full width of the surface before proceeding with the second applications. To expose the first seal coat layer the least possible time to the action of any traffic, the contractor shall place the second seal coat layer as soon as practicable. The contractor will not be permitted to place in any one day appreciably more of the first seal coat layer than can be covered by the second seal coat layer the same day.
409.6.2 The second application of cover aggregate shall be rolled, broomed, and swept as required in Sec. 409.4.4.2 and 409.4.4.3.

409.7 Method of Measurement. Calibrated measurement of bituminous material, to the nearest 50 L (10 gal.) in place, will be made on the project site.

409.7.1 Measurement of cover aggregate will be made in accordance with the applicable requirements of Sec. 310.4 and paid to the nearest metric ton (ton).

409.8 Basis of Payment. The accepted quantities of seal coat will be paid for at the unit bid price for each of the pay items included in the contract. No direct payment will be made for anti-stripping agent added to the bituminous material.
SECTION 410
LATEX-MODIFIED SLURRY SEAL
(MICRO-SURFACING)

410.1.0 Description

410.1.1 This work shall consist of the application of micro-surfacing material to asphaltic pavement surfaces. The micro-surfacing shall consist of a mixture of cationic natural latex modified asphaltic emulsion, mineral aggregate, portland cement, set-control additives and water. The micro-surfacing material shall be properly transported, proportioned, mixed and evenly spread on the asphaltic pavement surface in strict accordance with the plans, these specifications and as directed by the Engineer. In some cases more than one lift may be required to obtain the specified thickness.

410.1.2 The cured slurry shall have a uniform and homogeneous appearance, substantially fill all cracks, and adhere firmly to the existing surface. The mix shall be capable of being spread in varying thickness cross-sections (wedges, wheel path depressions, scratch courses and surfaces) which, after curing and initial traffic consolidation, resists compaction throughout the entire design tolerance range of bitumen content and varying thickness to be encountered. The end product shall maintain a friction resistant surface (high wet friction coefficient) throughout the service life of the micro-surfacing.

410.1.3 The completed mixture shall be such that the micro-surfacing mixture has proper workability during lay down and will permit straight running traffic on 12.7 mm (1/2 inch) thick micro-surfacing within one hour after placement at 24°C (75°F) or greater and 50% or lower humidity. Micro-surfacing shall be placed without the occurrence of bleeding, raveling, separation or other distress.

410.1.4 Unless otherwise stated, specification section references are from the current edition of the Saint Charles County Standard Specifications for Subdivision Street Construction and its supplements. Work shall be performed in accordance with the current edition of "Recommended Performance Guidelines for Polymer-Modified Micro-Surfacing" A143 (revised) published by the International Slurry Surfacing Association (ISSA), ASTM D 6372-99a Standard Practice for Design, Testing and Construction of Micro-Surfacing, with the modification specified herein.

410.1.5 The contractor or listed subcontractor shall be experienced and familiar with the application of micro-surfacing.

410.2.0 Application Rate.

410.2.1 Micro-surfacing material shall be applied in one lift of 9.7 kilograms per square
meter (18 pounds per square yard) of the dry mass of the combined mineral aggregate and Wheel Rut Depression micro-surfacing shall be applied at a rate specified in Section 410.13.0.

**410.2.2** On roads carrying large volumes of traffic, micro-surfacing material shall be applied in two (2) lifts of 8.1 kilograms per square meter (15 pounds per square yard) of the dry mass of the combined mineral aggregate and Wheel Rut Depression micro-surfacing shall be applied at a rate specified in Section 410.13.0.

**410.2.3** The County Engineer will make the final determination for the appropriate application rate.

**410.4.0** Materials

**410.4.1** Natural Latex Modified Asphalt Emulsion

**410.4.1.1** The asphalt shall be a natural latex modified grade CSS-1h (cationic) emulsified asphalt. The grade CSS-1h shall be modified with an approved Natural Latex.

**410.4.1.2** The approved natural latex shall be milled into the asphalt emulsion prior to the emulsification process. The asphaltic emulsion manufacturer shall certify that the emulsion contains 3.0% to 5.0% natural latex solids based on the mass of asphalt (asphalt residual) within the emulsion.

**410.4.1.3** The emulsified asphalt content shall be 6.0% to 9.0% as measured by the mass of the dry aggregate or as directed by the Engineer. An approved set-control agent (Ralumac or an approved equal) shall be added in such a quantity as to produce a one hour set and shall not vary more than ±1% of the quantity specified in the mix design. The residual asphalt content shall have a tolerance of ±0.5% from design.

**410.4.1.4** The natural latex modified CSS-1h shall comply with following requirements when sampled in accordance with ASSHTO T-40 and shall comply with the following requirements when tested in accordance with the specified test methods:

<table>
<thead>
<tr>
<th>TESTS ON EMULATION</th>
<th>TEST METHOD</th>
<th>REQUIREMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Viscosity, Saybolt Furol at 77°F</td>
<td>AASHTO T 59</td>
<td>20-100 seconds</td>
</tr>
<tr>
<td>Storage Stability Test (24 hours)</td>
<td>AASHTO T 59</td>
<td>1.0% maximum</td>
</tr>
<tr>
<td>Particle Charge Test</td>
<td>AASHTO T 59</td>
<td>Positive*</td>
</tr>
<tr>
<td>Sieve Test</td>
<td>AASHTO T 59</td>
<td>0.1% maximum</td>
</tr>
<tr>
<td>Distillation: Residue by Evaporation</td>
<td>AASHTO T 59</td>
<td>62% minimum</td>
</tr>
<tr>
<td>Oil Distillate, by volume of emulsion</td>
<td>AASHTO T 59</td>
<td>0.5% maximum</td>
</tr>
</tbody>
</table>
*If the particle charge test is inconclusive, material having a maximum pH value of 6.7 will be acceptable

TESTS ON EMULSION RESIDUE

Penetration, 77\(^0\) F, 100 g, 5 seconds  AASHTO T 49  40-90

Ductility, 77\(^0\) F (25\(^0\) C), 5 cm/min.  AASHTO T 51  70 minimum

Solubility in Trichloroethylene  AASHTO T 44  97 minimum

Softening Point, R & B  AASHTO T 53  140\(^0\) F minimum

Viscosity at 140\(^0\) F (60\(^0\) C), 300 mm Hg vacuum  AASHTO T 202  8,000 Poises min.

410.4.1.4.1 The standard distillation procedure shall be modified as follows: The temperature for this test shall be held at 180\(^0\) F (82\(^0\) C). The sample is oven-evaporated on a glass plate of 77\(^0\) F (25\(^0\) C) for 24 hours (forced draft oven). Material is then removed from the plate with a razor blade tool.

410.4.1.5 The distillation residue of the modified emulsion shall contain 3.0% to 5.0% polymer solids by mass of asphalt, as determined by an analytical method approved by the Engineer.

410.4.1.6 The polymer modified emulsified asphalt shall be so formulated that when the paving mixture is applied with the relative humidity at not more than 50% and the ambient air temperature of at least 75\(^0\) F (24\(^0\) C), the paving mixture will sufficiently cure so that uniformly moving traffic can be allowed in one hour. Additional curing time may be required at locations such as driveways, intersections and where sharp turning movements may take place or where vehicles may accelerate sharply.

410.4.2 Mineral Aggregate

410.4.2.1 The mineral aggregate shall meet Section 1002.1 or as directed by this provision and be composed of clean and durable particles of an approved blend of crushed Porphyry and at least 40 percent crushed air cooled blast furnace steel Slag (ACBFS) at proportions acceptable by the Engineer to achieve the desired gradation. The individual aggregates shall be reasonably uniform in gradation and other qualities; shall be uniformly blended with designated proportions using calibrated cold feeds with controlled feeders into a separate stockpile prior to use; and the proportion shall not change from that used for the mix design during the course of placement. The aggregate shall be free of cemented or conglomerated lumps and shall not have any coatings or injurious material.
410.4.2.2 Aggregate used for this project shall conform to the following requirements when tested in accordance with the specified test methods:

<table>
<thead>
<tr>
<th>TEST</th>
<th>METHOD</th>
<th>REQUIREMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sand Equivalent</td>
<td>ASTM D 2419</td>
<td>65 minimum</td>
</tr>
<tr>
<td>Abrasion Resistance after 500 revolutions*</td>
<td>ASTM C 131</td>
<td>30% maximum</td>
</tr>
<tr>
<td>Moisture content of Aggregate</td>
<td>ASTM C 566</td>
<td>as tested</td>
</tr>
<tr>
<td>Sieve Analysis (individual and combined)</td>
<td>ASTM C 136</td>
<td>as tested</td>
</tr>
<tr>
<td>Material Passing No. 200 Sieve</td>
<td>ASTM C 117</td>
<td>as tested</td>
</tr>
<tr>
<td>Soundness of Aggregates by use of Sodium Sulfate</td>
<td>ASTM C 88</td>
<td>12% maximum</td>
</tr>
<tr>
<td>Soundness of Aggregates by use of Magnesium Sulfate, 5 cycles</td>
<td>ASTM C 88</td>
<td>12% maximum</td>
</tr>
</tbody>
</table>

Combined Aggregate Bulk Specific Gravity

ASTM C 127 as tested

*On parent aggregate before crushing

410.4.2.3 A stockpile of aggregate shall be dedicated for this project. Rejected stockpiles of material may not be reworked or blended. Stockpile tolerances are established from the following gradation:

<table>
<thead>
<tr>
<th>SIEVE SIZE</th>
<th>ISSA Type II Grade</th>
<th>STOCKPILE TOLERANCES</th>
</tr>
</thead>
<tbody>
<tr>
<td>9.5 mm (3/8”)</td>
<td>100</td>
<td>±5%</td>
</tr>
<tr>
<td>4.75 mm (No. 4)</td>
<td>90-100</td>
<td>±5%</td>
</tr>
<tr>
<td>2.36 mm (No. 8)</td>
<td>65-90</td>
<td>±5%</td>
</tr>
<tr>
<td>1.18 mm (No.16)</td>
<td>45-70</td>
<td>±5%</td>
</tr>
<tr>
<td>600µm (No. 30)</td>
<td>30-50</td>
<td>±5%</td>
</tr>
<tr>
<td>330µm (No. 50)</td>
<td>18-30</td>
<td>±4%</td>
</tr>
<tr>
<td>150µm (No. 100)</td>
<td>10-21</td>
<td>±3%</td>
</tr>
<tr>
<td>75µm (No. 200)</td>
<td>5-15*</td>
<td>±2%</td>
</tr>
</tbody>
</table>

* includes mineral filler
410.4.3 Mineral Filler

410.4.3.1 The Portland Cement mineral filler shall be any recognized brand of non-air entrained Type 1 Portland cement that is free from lumps or foreign matter. The amount of mineral filler needed shall be determined by the laboratory mix design and will be considered as part of the mineral gradation requirement. The mineral filler shall be between 1.0% and 3.0% by the weight of dry aggregate. The laboratory mix design percentage of mineral filler can be increased or decreased up to one percent (±1%) when directed by the Engineer as the micro-surfacing is being placed if it is found to be necessary for better consistency or set times.

410.4.4 Water

410.4.4.1 The water shall be potable, free of harmful soluble salts, and shall be added in an amount to provide proper consistency.

410.4.5 Set-control Agent

410.4.5.1 To improve workability a set-control agent that is approved by the Engineer, and will not adversely affect the micro-surfacing, shall be used. The set-control agent (Ralumac or an approved equal) must be included as part of the mix design and be compatible with the other components of the mix. The use of set-control additive shall not vary ±1% of the additive optimum recommended in the highest temperature mix test in the mix design.

410.4.6 Polymer Modifier

410.4.6.1 An approved polymer based modifier that consists of natural latex shall be milled into the asphalt emulsion. This additive shall allow the micro-surfacing mixture to cure sufficiently so that normal traffic can be permitted in one hour after placement of the micro-surfacing mixture, without damage to the new surface.

410.4.7 Composition of Micro-Surfacing Mixtures

410.4.7.1 Mix Design. At least 14 calendar days before micro-surfacing placement commences, the contractor shall submit to the Engineer for approval, a dated laboratory report of tests and a proposed mix design. The date of the mix design will reflect that tests were performed no longer than 30 days prior to the start of paving construction. The recommended percentages of each individual material required shall be shown in the laboratory report. Adjustments of water and set-control agent by the Engineer may be required during construction based on field conditions. The Engineer shall approve the design mix and all micro-surfacing materials and methods prior to use and shall designate the proportions to be used within the following limits:

<table>
<thead>
<tr>
<th>Residual Asphalt</th>
<th>6% to 9% by dry weight of aggregate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mineral Filler</td>
<td>1% to 3% by dry weight of aggregate</td>
</tr>
</tbody>
</table>
Latex-based Modifier 3.0% to 5.0% natural latex solids based on mass of asphalt

Water As required to produce proper specified properties

Set-control Agent Engineer approved system to provide one hour set

410.4.7.2 The mix design shall be performed by a laboratory capable of performing all of the current applicable International Slurry Surfacing Association (ISSA) tests at one location. The Engineer may disqualify any mix design submitted by any laboratory whose capability or experience with micro-surfacing cannot be verified. The proposed latex-modified slurry seal mixture to be used for this project shall conform to the requirements specified when tested in accordance with the following tests:

<table>
<thead>
<tr>
<th>ASTM TEST</th>
<th>DESCRIPTION</th>
<th>REQUIREMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>D 3910</td>
<td>Consistency Test</td>
<td>2-3 cm</td>
</tr>
<tr>
<td>D 3910</td>
<td>Cure time</td>
<td>1 hour maximum</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ISSA TEST</th>
<th>DESCRIPTION</th>
<th>REQUIREMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>TB 139</td>
<td>Wet Cohesion</td>
<td>12 kg-cm minimum</td>
</tr>
<tr>
<td></td>
<td>30 minutes (set time)</td>
<td>20 kg-cm minimum (Or near spin)</td>
</tr>
<tr>
<td></td>
<td>60 minutes (traffic time)</td>
<td></td>
</tr>
<tr>
<td>TB 109</td>
<td>Excess Asphalt</td>
<td>538 g/m² (50 g/ft²) maximum</td>
</tr>
<tr>
<td>TB 114</td>
<td>Wet Stripping</td>
<td>Pass (90% minimum)</td>
</tr>
<tr>
<td>TB 100</td>
<td>Wet Track Abrasion</td>
<td>538 g/m² (50 g/ft²) maximum</td>
</tr>
<tr>
<td></td>
<td>One hour soak, loss</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Six day soak, loss</td>
<td>807 g/m² (75 g/ft²) maximum</td>
</tr>
<tr>
<td>TB 113</td>
<td>Mix Time @ 25⁰ C (77⁰ F)</td>
<td>Controllable to 120 seconds minimum</td>
</tr>
</tbody>
</table>

410.4.7.3 The mix design report shall be reported on the testing laboratory’s letterhead, signed by a manager of the laboratory that performed the tests and shall show the results of each of the required tests compared to the specification values. The contractor name, Saint Charles
County Project Name and Number, date and time of collection and location of sample collection shall be noted on the report. Any test values out of specification shall be clearly noted. The report shall clearly state a recommendation of the proportions of the mineral aggregate, mineral filler, water (minimum and maximum), set-control additive (minimum and maximum), and asphalt solids content (minimum and maximum) based on the dry weight of the mineral aggregate. The laboratory shall also report the quantitative effects of moisture content on the unit weight of the mineral aggregate (bulking effect).

410.4.7.4 Bulk Specific Gravity

410.4.7.4.1 The Bulk Specific Gravity (BSG) of the final combined Mineral Aggregate shall be determined and shown as part of the mix design for an application rate of 9.7 kilograms per square meter (18 pounds per square yard) of the dry mass of the combined mineral aggregate. If the BSG is different from 2.65 by more than 0.5, the above minimum masses shall be adjusted by dividing the specified unit mass by 2.65 and multiply by the new BSG. For example, for a new BSG = 3.15, the new minimum application rate would be 1.15 (18 / 2.65) = 21.4 pounds per square yard. These adjusted values shall be designated on the mix design and shall then be applied in the field.

410.4.7.4.2 For roads requiring a micro-surfacing material application rate specified in Section 410.2.2, the Bulk Specific Gravity (BSG) of the final combined Mineral Aggregate shall be determined and shown as part of the mix design for an application rate of 8.1 kilograms per square meter (15 pounds per square yard) of the dry mass of the combined mineral aggregate. If the BSG is different from 2.65 by more than 0.5, the above minimum masses shall be adjusted by dividing the specified unit mass by 2.65 and multiply by the new BSG. For example, for a new BSG = 3.15, the new minimum application rate would be 1.15 (18/2.65) = 21.4 pounds per square yard. These adjusted values shall be designated on the mix design and shall then be applied in the field.

410.4.7.5 The mix design will further show recommended changes in Portland cement, water and additive proportions for high temperature weather conditions by reporting proportions of materials required for 120 seconds of mix time with materials heated to 38°C (100°F). This elevated temperature mixing report will not be required for night time application nor application where either cool, foggy or overcast conditions will prevent high temperature mixing problems.

410.4.7.6 All of the component materials used in the mix design shall be representative of the materials to be used on the project. Once the proportions of materials to be used are approved by the Engineer, no substitutions of other materials will be permitted, unless the materials proposed for substitution are first tested and a laboratory report is submitted for design approval by the Engineer as specified above. Substituted materials shall not be used until the mix design for those materials is approved by the Engineer.

410.5.1 Material Sampling and Testing Responsibilities

410.5.1.1 The contractor shall submit to the Engineer samples from all suppliers furnishing a minimum of the following materials with corresponding Material Safety Data Sheets
(MSDS) sheets:

4 liters (1 gallon) of the base asphalt

1 liter (2 pints) of the polymer additive (with clear labeling of the polymer type)

4 liters (1 gallon) of the asphaltic emulsion

45 kilograms (100 pounds) of combined microsurfacing mineral aggregate

23 kilograms (50 pounds) of each parent mineral aggregate

3 kilograms (6 pounds) of mineral filler (with supplier label)

410.5.1.2 Extractions of the latex-modified slurry seal shall be made by the engineer for every 5th day of material placed, starting on the first day or as directed by the Engineer. The sampling and testing of the latex-modified slurry seal by the engineer will result in a report submitted to the contractor after the lab has tested the samples. Failure to comply with this requirement shall result in the immediate stoppage of work. Failure of a test report may require removal of material placed or non-payment for the area represented by the test, as directed by the Engineer. Laboratory testing report shall be in accordance with Section 410.4.7.3 of this provision and will determine:

Tests on emulsion / residue as per Section 410.4.1.4

Tests on Mineral Aggregate: Sieve Analysis as per Section 410.4.2.2.

410.5.1.3 Copies of all material load tickets and certified test reports shall be given to the Engineer. A certified analysis (test report) of emulsified asphalt shall accompany each shipment of emulsion to the contractor, and the exact residual asphalt cement content of each tanker shall be plainly marked on the load tickets.

410.5.1.4 The contractor shall furnish to the Engineer an aggregate moisture determination for the stockpile prior to placing the micro-surfacing. This shall be re-tested on delivery of new aggregate to the stockpile or if weather conditions have changed the aggregate moisture content appreciably. Aggregate moisture will be accounted for in determining the aggregate/bitumen ratio to be used during placement.

410.5.1.5 Copies of a daily control log kept in accordance with ISSA Technical Bulletin No. 107 shall be given to the Engineer before start of the next day’s production, or as otherwise directed by the Engineer. The log shall contain tons of dry aggregate consumed that day, tons of asphalt emulsion consumed that day and square yardage covered that day.

410.6.0 Mixing Equipment. The machine shall be specifically designed and
manufactured to lay micro-surfacing. The material shall be mixed by an automatic sequenced, self-propelled micro-surfacing mixing machine, which shall be a continuous flow mixing unit, able to accurately deliver and proportion the aggregate, emulsified asphalt, mineral filler, control setting additive and water to a revolving multi-blade double shafted mixer and discharge the mixed product on a continuous flow basis. The machine shall have sufficient storage capacity for aggregate, emulsified asphalt, mineral filler, control additive and water to maintain an adequate supply to the proportioning controls.

410.6.1 Belt feeder. The aggregate feed to the mixer shall be proportioned using a belt feeder that shall be equipped with a working revolution counter or similar device so that the amount of aggregate used may be determined at any time. The belt feeder shall be operated with an adjustable cutoff gate. The height of the gate opening shall be readily determinable. The belt delivering the aggregate to the pugmill shall be equipped with a device to monitor the depth of aggregate being delivered to the pugmill. Said device for monitoring depth of aggregate shall automatically shut down the power to the aggregate belt feeder whenever the depth of aggregate is less than the target depth of flow. A second device shall be located where it will monitor movement of the aggregate belt by detecting revolution of the belt feeder. The device for monitoring no flow or belt movement, as may be the case, shall automatically shut down the power to the aggregate belt when aggregate belt movement is interrupted. This second device will not be required where the aggregate delivery belt is an integral part of its drive chain. To avoid erroneous shutdown by normal fluctuation, a delay of three (3) seconds between sensing and shutdown of the operation will be permitted.

410.6.2 Positive Displacement pump. The emulsion shall be proportioned by a positive displacement type pump. The pump shall be equipped with a functional revolution counter or similar device so that the amount of emulsion used may be determined at any time.

410.6.3 Calibration of mixer-spreaders truck. The delivery rate of mineral aggregate and emulsion per revolution of the aggregate feeder shall be calibrated at the appropriate gate settings for each mixer-spreaders truck used on the project. The calibration shall demonstrate that the delivery rates of dry aggregate and emulsion residue are within the recommended percentages stated in the laboratory mix design. The procedures for calibration of micro-surfacing equipment shall be as recommended by the current edition of ISSA publication MA-1 "ISSA Inspector’s Manual".

410.7.0 Rate Check-run

410.7.1 Aggregate belt feeder. The aggregate belt feeder shall deliver aggregate to the pugmill with such volumetric consistency that the deviation for any individual aggregate delivery rate check-run shall not exceed 2.0 percent of the mathematical average of three runs of at least three (3) tons in duration each.

410.7.2 Emulsion Pump. The emulsion pump shall deliver emulsion to the pugmill with such volumetric consistency that the deviation for any individual delivery rate check-run shall be within 2.0 percent of the mathematical average of three runs of at least 1,135 liters (300 gallons) each in duration.
**410.7.3 Water Pump.** The water pump shall deliver water to the pugmill with such volumetric consistency that the deviation for any individual delivery rate check-run shall be within 2.0 percent of the mathematical average of three runs of at least 1,135 liters (300 gallons) each in duration.

**410.8.0 Emulsion Storage**

**410.8.1** The emulsion storage located immediately before the emulsion pump shall be equipped with a device which will automatically shut down the power to the emulsion pump and aggregate belt feeder when the emulsion level is lowered sufficiently to expose the pump suction line.

**410.8.2** A temperature-indicating device shall be installed in the emulsion storage tank at the pump suction level. The device shall indicate temperature of the emulsion and shall be accurate to within 0.6°C (5°F). The maximum temperature of emulsion contained in the mixer-spreader truck emulsion storage tank shall be 49°C (120°F). In cases where cool, damp weather conditions are prevalent or night time work is performed, this maximum temperature may be increased to 60°C (140°F) as directed by the Engineer.

**410.9.0 Mixing and Spreading Equipment**

**410.9.1 Mixer-Spreader Trucks**

**410.9.1.1** The micro-surfacing shall be mixed in pugmill mixers of adequate size and power for the type of micro-surfacing to be placed.

**410.9.1.2** Mixer-spreader truck shall be equipped to proportion the mineral aggregate, Portland cement mineral filler, water, set-control additives and emulsified asphalt by weight, to a revolving multi-blade dual mixer, and discharge the thoroughly mixed product. The machine shall have sufficient storage capacity for mineral aggregate, emulsified asphalt, Portland cement mineral filler, water and set-control additive to maintain an adequate supply to the proportioning controls. The machine shall be continuous-loading and be operated in that manner. All rotating and reciprocating equipment on mixer-spreader trucks shall be covered with metal guards. The paddles or augers shall be designed and operated so all fresh mix will be agitated and to create a turbulence or laminar flow to prevent the mixture from setting up in the box, causing side build-ups and lumps. Mobile mixers may be used on streets if approved by the Engineer.

**410.9.1.3** The mixing machine shall be equipped with a water pressure system and a nozzle type spray bar, in good working condition, to provide a uniform water spray to dampen the surface when required immediately ahead of and outside the spreader box. No free-flowing water shall be present.

**410.9.1.4** The mixer-spreader truck shall not be operated unless all low-flow and no-flow devices and revolution counters are in good working condition, functioning and all metal guards are securely in place. All indicators required by these specifications shall be visible while
walking alongside mixer-spreader truck.

410.9.1.5 Mineral aggregate feeders shall be connected directly to the drive on the emulsion pump. The drive shaft of the aggregate feeder shall be equipped with a revolution counter that is in good working condition and reads to the nearest one-tenth of a revolution of the aggregate delivery belt.

410.9.1.6 The identification number of mixer-spreader trucks shall be at least 50.8 mm (2 inches) in height and located in the front and rear of the vehicle.

410.9.1.7 At least two (2) operational spreader trucks shall be available at the job during the spreading operation except when continuous placement type mixer-spreader trucks are used.

410.9.1.8 When construction is being performed under traffic, all equipment, including loading vehicles and supply trucks will be required to operate in a single lane on which the micro-surfacing is being applied. The contractor's equipment for micro-surfacing shall be operated in such a manner that will permit traffic to move safely and expeditiously through and around the work area.

410.10.0 Spreader Boxes

410.10.1 The micro-surfacing mixture shall be spread by means of one of the following controlled spreader box configurations conforming to the following requirements:

410.10.1.1 Full Width Spreader Box. The full width spreader box shall be capable of spreading a traffic lane width and shall have strips of flexible rubber belting or similar material on each side of the spreader box. The box shall be in contact with the pavement to positively prevent the loss of micro-surfacing from the ends of the box and shall be equipped with devices to adjust thickness or grade of the surface. All spreader boxes over 2.28 meters (7.5 feet) in application width shall have baffles, reversible motor driven augers, or other suitable means, to insure uniform application on super-elevated sections and shoulder slopes. Spreader box skids shall be maintained in such a manner as to prevent transverse chatter (wash boarding), tearing or shoving in the finished mat or the mat adjacent to the box. Rear flexible strike-off blades shall make close contact with the pavement, shall be designed and operated to achieve a uniform consistency that provides a free flow of material to the rear strike-off without causing skips, lumps, or tears in the finished surface. A secondary rubber strike-off shall be provided to improve surface texture. The secondary strike-off shall have the same leveling adjustments as the spreader box.

410.10.1.2 Wheel Path Depression (Rut) Box. The wheel path depression box shall be designed as a double chambered box with adjustable screeds to regulate depth and shall be either 1.52 m (5 feet) or 1.81 m (6 feet) in width. Hydraulic augers set at a 45 ("V") degree angle shall move the mixed material from the rear to the front of the filling chamber. The augers shall push the larger aggregate into the center, deeper section of the wheel path depression and send the fine material toward the edges of the pass to act as a mastic and for feathering down the longitudinal joint along the wheel path.
410.10.1.3 Spreader Box Maintenance. The micro-surfacing spreader box in use shall be clean at the start of each work shift. The box shall be cleaned as needed or as directed by the Engineer to prevent excessive broken micro-surfacing from accumulating on the spreader box and adversely affect surface texture during application. A rubber squeegee shall be attached to the adjustable metal plate at the rear of the spreader box, behind the second strike-off, to texture the surface. All strike-off blades (rubber and steel) shall be cleaned or replaced at any time problems with cleanliness and longitudinal scouring occur.

410.11.0 Material Stockpiling and Storage

410.11.1 Aggregate Storage. If the mineral aggregates are stored or stockpiled, they shall be handled in such a manner as to prevent segregation, mixing of the various material, and contamination with foreign materials. The grading of aggregates proposed for use and as supplied to the mixing plant shall be uniform. Suitable equipment of acceptable size shall be furnished by the contractor to work the stockpiles and prevent segregation and excessive breakdown of mineral aggregates. The aggregate shall be passed over a scalping screen, provided by the contractor, prior to transfer to the micro-surfacing mixing machine to remove oversize material.

410.11.1.1 The contractor's material and equipment may be stored at designated areas within a Department’s maintenance facility, as directed by the Engineer. Equipment and materials shall not be stored on the public road right-of-way.

410.11.2 Asphaltic Material Storage. The asphaltic material storage shall be ample to meet the requirements of the plant. All equipment used in the storage and handling of asphaltic material shall be kept in a clean condition at all times and shall be operated in such a manner that there will be no contamination with foreign matter. The storage stability test may be waived provided the asphalt emulsion storage tank at the project site has adequate provisions for circulating the entire contents of the tank, and provided satisfactory field results are obtained.

410.12.0 Construction Methods

410.12.1 Weather Limitations.
The micro-surfacing mixture shall be spread only when:

1. the ambient air temperature is between 15\(^0\) C (60\(^0\) F) and 38\(^0\) C (100\(^0\) F) at the job site.

No mixture shall be placed when:

1. the pavement temperature is 10\(^0\) C (50\(^0\) F) or below,
2. when the ambient air temperature forecast high (as per the National Weather Service) is 18\(^0\) C (65\(^0\) F) or below,
3. when there is a forecast of temperatures (as per the National Weather Service) below
5°C (40°F) within twenty-four (24) hours after mix placement,
4. when the relative humidity is above eighty (80) percent,
5. when it is foggy,
6. when it is raining, or as
7. directed by the Engineer.

410.12.2 Seasonal Limitations. The micro-surfacing mixture shall not be constructed before April 15th or after September 15th without written approval of the Engineer.

410.12.3 Test Strip. Prior to the application of the micro-surfacing mixture, the contractor shall place a test strip, at a location established by the Engineer, to demonstrate the compatibility of the modified emulsion and the mineral aggregate under field conditions. This test strip shall also be used to demonstrate mix uniformity and compliance of the mix to the requirements of proportioning of the asphalt, mineral aggregate, mineral filler, polymer modifier, set-control agent and water. The test strip shall be at least 152 meters (500 feet) in length, and the width of one lane and shall consist of the application courses specified in the contract. The test strip shall be conducted at the same time of day or night the full production will be applied, in the presence of the Engineer, at least forty-eight (48) hours prior to the contractor's intended start-up date. The Engineer shall evaluate the test strip twenty-four (24) hours after its placement to determine that the mix design and materials are acceptable. A new test strip shall be performed when the test strip is deemed unacceptable, a change in the mix design become necessary or as directed by the Engineer. The establishment of a test strip will be considered incidental, however the approved test strip will be measured and paid for in accordance with the contract provisions for the actual square yards of micro-surfacing placed. Failure of the test strip shall require the contractor to completely remove the test strip with no compensation for the labor, equipment or material to place, remove or properly dispose of the failed test strip. Method or equipment substitutions used and approved by the Engineer in the test strip, shall be used in field production.

410.12.4 Resident Notification. The contractor shall be responsible for prior notification of residents for no parking on streets during micro-surfacing operations. Temporary "No Parking" signs noting the time and date of construction activity shall be provided and installed by the contractor at maximum intervals of 30.5 meters (100 feet), 24 hours in advance of work. Should the work not occur on the specified day, a new notification will be distributed by the contractor. The contractor shall distribute letters of notification (to residents) with the phone number of their representative who has authority for correction of concerns that residents may have. Signs shall be removed and disposed of by the contractor at the end of the operation on that street. No additional compensation will be allowed for delays or inconveniences when parked vehicles are encountered.

410.12.5 Surface Preparation. Immediately prior to placement of the micro-surfacing mixture, the contractor shall furnish the proper labor, equipment, materials and small tools to clean the pavement thoroughly and remove all vegetation, loose materials, dirt, mud and other objectionable material that may prevent adhesion of the micro-surfacing to the existing pavement surface and then prewet as required. An Engineer approved power broom shall be used in advance of the micro-surfacing operation. The broom shall have plastic bristles, an approved
suction area and enough air velocity in the nozzles to pick up and remove the above debris. A power blower shall immediately precede the slurry laydown unit.

410.12.5.1 Potable Water used in pre-wetting the surface ahead of the spreader box and shall be applied at such a rate that the entire surface shall be damp and free of ponding or free-flowing water.

410.12.5.2 Utility covers, manholes, grated inlets, curb inlets and traffic device covers located in the roadway to be paved shall be protected from coverage by the micro-surfacing and referenced for prompt location and cleaning following application. The contractor shall be responsible for covering, locating, removing and cleaning of these items following the micro-surfacing application operation. The methods used to protect, reference, locate and clean shall be submitted by the contractor and shall be subject to approval by the Engineer. All such materials shall be removed and properly disposed of by the contractor after the surfacing material has cured. The above items shall be cleaned to their pre-surfacing condition or as directed by the Engineer.

410.12.5.3 All existing thermoplastic pavement striping, stop bars and turn arrows in conflict with the micro-surfacing paving operation shall be completely removed and paid for in accordance with items contained in this contract. The areas where striping and markings have been removed shall be lightly coated with 0.23L/m² (0.05 Gal/s.y.) SS-1h Tack before placement of the micro-surfacing on those areas. The tack shall be allowed to cure sufficiently before the application of micro-surfacing. The cost for this is incidental to the removal of the thermoplastic striping and markings. Thermoplastic removal shall be scheduled by the contractor 48 hours in advance of paving to allow traffic division personnel time to mark the pavement for removal.

410.12.5.4 The engineer shall approve all surface preparation prior to application of the micro-surfacing.

410.12.6 Spreading of Mixture. The micro-surfacing shall be homogeneous during and following mixing and spreading. It shall be free of excess water or emulsion and free of segregation of the emulsion and aggregate fines from the coarser aggregate. A sufficient amount of materials shall be carried to all parts of the spreader at all times so that complete coverage is obtained. Over loading the spreader box shall be avoided. No lumping, balling, or unmixed aggregate shall be permitted. Under no circumstances shall water be sprayed directly into the lay-down box during application of micro-surfacing.

410.12.6.1 The mixture shall be uniform and homogeneous after spreading on the surfacing and shall not show separation of the emulsion and aggregate after setting. Streaks, such as those caused by oversized aggregate, shall be avoided. If excess streaking develops, the job will be stopped by the Engineer until the contractor can demonstrate that the occurrence has been eliminated. Excessive streaking is defined as: more than four (4) drag marks greater than 12.7 mm (one-half inch) wide and/or 100 mm (4 inches) long; or 25.4 mm (1 inch) to 76.2 mm (3 inches) long in any 25 m² (27.3 yd.²) area. No transverse ripples or longitudinal streaks in excess of 6 mm (one-quarter inch) will be permitted when measured by placing a 3 meter (10 foot) straight edge over the surface.
410.12.6.2 Micro-surfacing to be spread in areas inaccessible to the spreader box shall be surfaced using approved hand squeegees to provide complete and uniform coverage. If necessary, the area to be hand worked shall be lightly dampened with potable water prior to mix placement. Care shall be exercised to leave no unsightly appearance from hand work. The same type of finish as applied by the spreader box shall be required.

410.12.6.3 Micro-surfacing shall not be applied over steel expansion plates or bridge decks, unless directed by the Engineer.

410.12.6.4 All excess material that overruns in gutters, on curbs, inlet tops, or on sidewalks shall be removed immediately or squeegeed back onto the surface. All excess material removed from any non-paved area and from the ends of each job site shall be removed immediately. Discolored curbs, inlets and sidewalks shall be immediately cleaned and flushed before the material sets. Any set material left in place will be removed by sand blasting, by the contractor, as directed by the Engineer.

410.12.6.5 Work at intersections shall be done in stages, or blotter materials shall be used, to allow crossing and turning movements. The blotting material shall be the same aggregate used in the micro-surfacing and shall be removed by the contractor when designated by the Engineer. Regardless of the method chosen by the contractor and approved by the Engineer, no marred or streaked sections in excess of that defined in Section 410.12.6.1 will be allowed.

410.12.6.6 Pneumatic Rolling. If a section of pavement is not going to be exposed to traffic within 48 hours, it shall be compacted with a pneumatic tire roller after curing. This pneumatic tire roller shall have a tire pressure of 275 to 400 kPa (40 to 60 psi).

410.13.0 Wheel Path Depressions (Ruts).

410.13.1 When wheel path depressions have a cross section that is deformed 25.4 mm (one inch) or more, the individual wheel paths shall be first filled utilizing a wheel path depression (rut) box before the final surface course is placed.

410.13.1.1 When required on the plans or as directed by the Engineer, but before the final surface course is placed, preliminary micro-surfacing material shall be required to fill ruts, utility cuts, depressions in the existing surface, etc. Wheel path depression spread rates will vary with depression depth. Maximum single application for wheel path depressions shall be 19 mm (three-quarters inch) in depth, or 13.6 kilograms per square meter (30 pounds per square yard) as directed by the Engineer. Greater depths may require multiple applications in each depression.

410.13.1.2 Wheel path depression repair shall be constructed with a slight crown to permit initial traffic compaction of the micro-surfacing. Generally, the depression should be crowned by 1.25 mm to 2.5 mm per 10 mm (one-eighth to one-quarter of an inch per inch) of wheel path depression to allow for compaction under traffic. Excessive crowning (over-filling) shall be avoided.
410.13.1.3 At least 24 hours of traffic compaction shall be allowed on freshly filled wheel path depressions before additional lifts are applied.

410.13.2 If rutting peaks extend more than 12.7 mm (one-half inch) above the existing pavement, they should be milled down at or just below existing pavement surface prior to rut filling and shall be in accordance with Section 410.12.5.4 of this provision.

410.14.0 Paving Courses

410.14.1 Irregular surfaces or pavements with wheel path deformations of less than 12.7 mm (one-half inch) shall require two full width box applications of micro-surfacing. On the County Road System the application of one (1) lift of 9.7 kilograms of dry aggregate per square meter (18 pounds of dry aggregate per square yard) of the dry mass of the combined aggregate will be required. For applications requiring two (2) lifts per Section 410.2.2, two (2) lifts of 8.1 kilograms per square meter (15 pounds per square yard) of the dry mass of the combined aggregate will be required. The completed spread rate shall be ±10% of these rates.

410.14.2 Adequate means shall be provided by the contractor to protect the micro-surfacing from damage by traffic until such time that the mixture has cured sufficiently so that the micro-surfacing mixture will not adhere to and be picked up by the tires of vehicles.

410.15.0 Seams and joints.

410.15.1 No excess buildup, uncovered areas, or unsightly appearance shall be permitted on longitudinal or transverse joints. The contractor shall provide suitable spreading equipment to produce a minimum number of longitudinal joints throughout the project. Half passes and odd width passes will be used only in minimum amounts. If half passes are used, they shall not be the last pass of any paved area.

410.15.1.1 Any necessary longitudinal or transverse joints in underlying layers shall be constructed in accordance with Sec 404.11.2.

410.15.2 Whenever possible the longitudinal joints shall be placed on the lane lines, staggering the underlaying joints by 150 mm (6 inches). The Engineer may permit the contractor to use other patterns of longitudinal joints, if such patterns will not adversely affect the quality of the finished product.

410.15.3 Longitudinal joints common to two driving lanes, shall not overlap more than 76.2 mm (three inches). The resultant joint shall present an elevation difference between driving lanes that is less than 6 mm (one-quarter inch) when measured by placing a 3 meter (10 foot) straight edge over the joint and measuring the elevation drop off. If the Engineer determines that this is exceeded or that the seam is rough enough to cause a noticeable effect on steering of an automobile, the seam shall be removed, and new micro-surfacing patch shall be applied by the contractor. No additional payment shall be granted for this repair.
410.16.0 Workmanship

410.16.1 Edge lines and joints shall be uniform and parallel, radial or perpendicular with the centerline of the roadway. Lines at and through intersections and tapers shall be kept straight and uniform in appearance. The Engineer may require the contractor use a string line or other methods to achieve this. Edge lines should not vary by more than +/- 50 mm (2 inches) horizontal variance in any 30 m (100 feet) of length.

410.16.2 Micro-surfacing material required to repair deficiencies due to unsatisfactory workmanship, as determined by the Engineer, shall not be paid for but shall be entirely at the contractor's expense.

410.17.0 Patching

410.17.1 Patching of damaged micro-surfacing surface shall be made with any of the above described methods. The patch repair shall be made in the same direction as the paver was traveling.

410.18.0 Method of Measurement

410.18.1 Although all materials are required to be measured for quality control purposes, the method of measurement for the bid item "Latex Modified Slurry Seal (Micro-surfacing)", complete and acceptably in place, including any multiple passes or courses will be made to the nearest square meter (square yard). Linear measurements to determine the square meters (square yardage) of surface area shall be made to the nearest 0.3 meter (one foot). Measurement of individual passes or courses will not be made. Final measurement of the completed surface will not be made except for authorized changes during construction, or where appreciable errors are found in the contract quantity. Appreciable error shall be defined as ±2% (two percent) of the total contract quantity. The revision or correction will be computed and added to or deducted from the contract quantity.

410.19.0 Basis of Payment

410.19.1 The accepted quantity of latex-modified asphalt emulsion slurry seal as provided above in the Method of Measurement, shall be paid for at the contract unit price per square meter (square yard) for Latex Modified Slurry Seal (Micro-surfacing). This contract price shall include full compensation for furnishing all labor, materials, tools and equipment for: quality control sampling, testing and mix design; for preparation of the road surface; for supplying, installing and removing temporary "No Parking" signs; for transporting, mixing, applying, blotting (furnishing, placing and removal of material), general clean-up; and other incidentals necessary to complete and warrant the job as specified herein.

410.19.2 Traffic Control Devices in accordance with Sec 612 of the Department’s Specifications will consist of furnishing, constructing and maintaining traffic control and safety devices as directed by the Engineer, shown on the plans or included in the construction contract, addendums or specifications. The accepted quantities for furnishing, installing, maintaining and
removing the contract traffic control devices specified, will be paid for at the unit prices bid for each item in the contract.

References:

International Slurry Surfacing Association
1200 19th Street, N.W., Suite 300
Washington, D.C. 20036-2422
Phone: 1-202-857-1160
Fax: 1-202-223-4579
MICRO-SURFACING (QUALITY CONTROL)
INSPECTOR'S MANUAL

Reed and Graham Laboratory Services
550 Sunol Street
San Jose, California 95126
Phone: 1-408-287-7722
POLYMER MODIFIED SLURRY SEAL
SPECIFICATION GUIDELINE WITH
MATERIALS QUALITY CONTROL PROVISIONS.
SECTION 411
UNDERSEALING PAVEMENT

411.1 Description. This work shall consist of furnishing, heating, hauling, and pumping asphalt filler under a portland cement concrete pavement. Asphalt filler shall be placed prior to any wedging or binder courses.

411.2 Materials. The asphalt filler shall conform to Division 1000, Materials Details, and specifically to Sec. 1015.6.

411.3 Construction Requirements.

411.3.1 Drilling Holes. The engineer reserves the right to modify the drill pattern, but in general, the pattern shall be as follows:

411.3.1.1 When pumping one side of pavement only, the holes through which the asphalt filler is to be pumped shall generally be drilled 600 to 1200 mm (24 to 48 in.) ahead of the crack or joint in the direction of present traffic and 600 to 1200 mm (24 to 48 in.) from the pavement edge. These holes shall be drilled on the outside or traffic lane and where necessary on the inside or passing lane.

411.3.1.2 When pumping both sides of pavement the holes through which the asphalt filler is to be pumped shall generally be drilled along each edge of the pavement, 600 to 1200 mm (24 to 48 in.) ahead of the crack or joint in the direction of present traffic and 600 to 1200 mm (24 to 48 in.) from the pavement edge.

411.3.1.3 The holes shall be 38 mm (1 1/2 in.) in diameter and shall be drilled by using a pneumatic drill or other suitable equipment.

411.3.2 Placing of Asphalt Filler. The material shall be injected under the pavement progressively through the previously drilled holes by means of a pressure asphalt distributor, capable of handling the asphalt filler at a minimum temperature of 200°C (400°F). The distributor unit shall be equipped with the necessary hoses, fittings, valves, etc., including a satisfactory nozzle for injecting the asphalt filler under the pavement without undue leakage at the point of injection.

411.3.2.1 Prior to placing the pumping nozzle in the hole, the pavement around the hole shall be mopped with water to prevent any leakage of asphalt filler from adhering to the pavement. Mopping shall also be done around adjacent open holes where there is the possibility of the filler traveling from hole to hole. Pumping shall continue at each hole until there is indication that voids under the pavement are filled. It is not the intent to raise the pavement. As soon as the pumping has been discontinued a temporary plug shall be inserted in each hole, sufficiently tight to prevent waste of material. If there is an extrusion of asphalt filler through one
or more of the unfilled holes, the holes shall be immediately closed with a temporary plug. Each drilled hole shall be pumped unless extruded material has appeared.

411.3.2.2 Any extruded filler at cracks or joints shall immediately be wet with water, and the injection nozzle closed and not opened until the filler has cooled sufficiently to prevent further extrusion. All extruded material shall be cleaned from the pavement and disposed of by the contractor off the right-of-way.

411.3.2.3 No asphalt filler shall be pumped when the pavement subgrade is frozen or when in the judgment of the engineer, satisfactory results are not obtained.

411.3.3 Placing of Permanent Plugs. When such time has elapsed that the temporary plug may be removed without extrusion of the pumped material, the hole shall be closed by filling with concrete mortar flush with the existing pavement surface.

411.3.4 Handling Traffic. The contractor may use one lane of the pavement for the equipment necessary to perform the work. At least one-way traffic must be maintained at all times.

411.4 Method of Measurement. Calibrated measurement of asphalt filler to the nearest 50 L (10 gal.) will be made. Measurement of drilled holes will be made by counting the number of holes drilled.

411.5 Basis of Payment. The accepted quantities of drilled holes and asphalt filler will be paid at the contract unit bid price for each of the pay items included in the contract.
SECTION 412
PAVEMENT SURFACING AND TEXTURING

412.11 Description. This work shall consist of improving by cold planing the profile, cross slope, and surface texture of the existing pavements to the depths indicated on the plans. The planed surface shall provide a smooth riding surface free from gouges, continuous grooves, ridges, oil film, and other imperfections of workmanship and shall have a uniform textured appearance.

412.12 Equipment. The equipment for removing the pavement surface shall be a power operated self-propelled planing machine or grinder capable of removing, in one pass, a combined thickness of 50 mm (2 in.) or more of asphaltic concrete pavement and 13 mm (1/2 in.) or more of portland cement concrete pavement or as directed by the engineer.

The equipment shall be self-propelled with sufficient power, traction, and stability to maintain accurate depth of cut and slope. The equipment shall be capable of accurately and automatically establishing profile grades along each edge of the machine by referencing from the existing pavement by means of a traveling reference or from an independent grade control and shall have an automatic system for controlling cross slope at a given rate. The forward speed of the machine in relation to the turning speed of the drum shall remain constant throughout the project.

The machine, unless otherwise specified, shall be equipped with an integral loading and reclaiming means to immediately remove material being cut from the surface of the roadway and discharge the cuttings into a truck, all in one operation; and adequate backup equipment (mechanical pick up street sweepers, loaders, water truck, etc.) and adequate personnel will be provided to insure that all cuttings are removed from the street surface daily. The machine shall be equipped with means to control dust created by the cutting action and shall have a manual system providing for uniformly varying the depth of cut while the machine is in motion thereby making it possible to cut flush to all inlets, manholes, or other obstructions within the paved area. The speed of the machine shall be variable in order to leave the desired grid pattern specified under Sec. 412.13.

A smaller machine, without an integral loading and reclaiming means, will be utilized unless otherwise specified in inaccessible areas or when located within 150 mm (6 in.) or less of concrete curbs or other obstructions.

412.12.1 Hauling Equipment. Trucks used for hauling surfaced material shall have tight, metal beds. Each truck shall be equipped with a securely fastened cover of suitable material of such size as to completely cover the loaded bed.

412.12.2 Sweeper. A self-propelled vacuum broom equipped with a watering system capable of suppressing the dust produced by the milling process shall be in operation at all times. Mechanical breakdown of the sweeper will be considered cause to halt the milling operation.
412.13 **Surfacing and Texturing.** The required pavement texture shall be a series of discontinuous longitudinal striations spaced approximately 13 mm (1/2 in.) apart. Individual striations shall be 100 to 200 mm (4 to 8 in.) in length, spaced so as to produce a uniform overall grid pattern. The depth of the striations shall be 3 to 5 mm (1/8 to 3/16 in.) as directed by the engineer. The contractor will be required to perform a test section so as to demonstrate his ability to operate and maintain the machine in the desired pattern.

412.13.1 The portland cement concrete pavement shall be surfaced and textured while controlling the elevation of each end of the milling cutter to follow the existing longitudinal profile. The depth of cut shall be as required to produce a uniform texture across the width of the pass, eliminating cross-slope irregularities due to such causes as wear in the wheel tracks.

412.14 **Construction Methods.** The pavement surface shall be removed to the depth, width, grade and cross section as shown on the plans, or as directed by the engineer. If a broken or worn tooth is to be replaced in a row of teeth, then all the teeth in that row must be of equal height.

412.14.1 The engineer may require that the pavement planing operations be referenced from an independent grade control in those areas where he deems this type of control to be appropriate. For this type of operation, the independent grade control shall be established and maintained by the contractor in a manner acceptable to the engineer, and the final position of same shall be acceptable to the engineer.

412.14.2 In the event the entire pavement width along a section of highway has not been planed to a flush surface by the end of a work period resulting in a vertical or near vertical longitudinal face exceeding 38 mm (1 1/2 in.) in height at the centerline, and 50 mm (2 in.) at shoulders or curb and gutter, this longitudinal face shall be sloped in a manner acceptable to the engineer so as not to create a hazard to traffic using the facility during periods when construction is not in progress. All transverse faces that are present at the end of a working period will be tapered utilizing asphaltic concrete material approved by the engineer to avoid creating a hazard for traffic.

412.14.3 The loose material resulting from the operation shall be disposed of at sites obtained by the contractor and approved by the engineer in writing, in accordance with provisions of Sec. 203.2.16.1. Unless otherwise specified on the plans, the material shall become the property of the contractor. Vertical faces along a cross street at an intersection that are present at the end of a work day shall be tapered to the planed depth by the addition of asphaltic material which will provide a smooth riding surface. The transitional asphaltic material shall be removed before asphalt is laid in this area.

412.14.4 When located within 75 mm (3 in.) of steep curbs, asphaltic concrete that cannot be removed by planing machine shall be removed by other methods acceptable to the engineer and the pavement and curb surfaces shall be cleaned of all debris and left in a neat and presentable condition.
412.15 **Surface Smoothness.** The depth of cut shall be controlled during surfacing and texturing so as to prevent the introduction of bumps or depressions into the existing pavement exceeding 10 mm/3 m (3/8 in./10 ft.). The surface at the edges of adjacent passes shall be matched within plus or minus 3 mm (1/8 in.).

412.16 **Removal of Cuttings.** Effective measures shall be taken to prevent the generation of dust during cutting, loading, and pavement cleaning operations. Cuttings shall be removed immediately behind the texturing equipment and disposed of by the contractor in accordance with the provisions of Sec. 203.2.16.1. Before the textured surface is opened to traffic, the surface shall be cleaned thoroughly of all loose material that would create a hazard, a nuisance, or would be redeposited into the surface texture.

412.17 **Method of Measurement.** The quantity of pavement surfacing and texturing including the removal and disposal of cuttings shall be the number of square meters (square yards) completed. The cost of correcting the longitudinal profile of the asphalt concrete pavement shall be included in the contract unit price for asphalt pavement surfacing and texturing. The number of square meters (square yards) of paved shoulder profile and cross-slope correction shall be measured and paid for as asphalt concrete pavement surfacing and texturing. Asphaltic material used for joint tapers will be Type C (BP-1) Asphalt and will be paid to the nearest metric ton (ton).

412.18 **Basis of Payment.** The work performed as prescribed by this item, measured as provided under Sec. 412.17, Method of Measurement, will be paid for at the unit price bid per square meter (per sq. yd.) for Pavement Surfacing and Texturing of the various items listed under measurement, which price shall be full compensation for removing all material to the depth shown, texturing the pavement surface, loading, hauling, unloading, and satisfactorily disposing of the material, and for all labor, tools, equipment, manipulation and incidentals to complete the work.

Measurement and payment will be based on the maximum thickness indicated for each bid item without regard to the nominal thickness shown on the plans or the number of passes required, with the following exception: Where specifically indicated in the “General Notes” of the plans, payment will be based on the pay items specified within established limits.
Division 500

RIGID PAVEMENTS
SECTION 501
PORTLAND CEMENT CONCRETE

501.1 Description. Portland cement concrete shall consist of a mixture of cement, fine aggregate, coarse aggregate, and water combined in the proportions specified for the various classes of concrete. Admixtures for the purpose of entraining air, retarding or accelerating the set, tinting and other purposes may be added as specifically required or permitted.

501.2 Materials.

501.2.1 All materials shall conform to Division 1000, Materials Details, and specifically as follows:

<table>
<thead>
<tr>
<th>Item</th>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>Portland Cement</td>
<td>1019</td>
</tr>
<tr>
<td>Coarse Aggregate</td>
<td>1005.1</td>
</tr>
<tr>
<td>Fine Aggregate</td>
<td>1005.2</td>
</tr>
<tr>
<td>Concrete Admixtures</td>
<td>1054</td>
</tr>
<tr>
<td>Concrete Tinting Material</td>
<td>1056</td>
</tr>
<tr>
<td>Water</td>
<td>1070</td>
</tr>
</tbody>
</table>

501.2.2 Mix Design. The proportions of cement, fine aggregate, and coarse aggregate for portland cement concrete shall be as specified by the engineer within the applicable limits of the specifications for the class of concrete designated in the contract. The engineer assumes no responsibility for the volume of concrete produced or furnished for the work.

501.2.2.1 The proportions for any mixture of materials obtained from established and approved commercial sources may be obtained by the contractor from the engineer upon request. If the contractor desires to ascertain the mix for a certain combination of aggregates obtained from commercial sources before construction work starts, he shall advise the engineer in writing of the specific source of materials which he desires to use, and the engineer will supply him with the mix for each combination of coarse and fine aggregates for which a specific request is made. If mix design information is desired for bidding, requests for such information may be made to the County Engineer.

The contractor shall make the request as far in advance of the letting as possible to allow the engineer sufficient time to furnish a reply. The mix set by the County Engineer will be based upon the materials designated by the contractor as intended for use in the work and, if sources of supply are changed, the mix may be revised if necessary.

Alterations in the pavement mix design may be allowed at the discretion of the County Engineer to accommodate the early opening of the roadway. Proposals for pavement mix modifications to accomplish accelerated strength gain of the concrete shall be submitted to the Department two weeks prior to the intended pour date for review and approval.
501.2.2.2 For simplicity of design, the various fine aggregates are grouped into four classes and a minimum and maximum cement factor has been established for each class. The cement factor for the individual job may vary within the maximum and minimum limits, depending upon the gradation of the coarse aggregate, the quantity of mixing water used, the quantity of entrained air when air-entrained concrete is specified, and upon changes in proportions which may be necessary to produce satisfactory workability, strength, or entrained air content. The engineer will make such changes in proportions, within the limits of these specifications, as necessary to produce concrete of satisfactory workability and strength.

501.2.2.2.1 Classifications of Fine Aggregate.

Class A sand shall include Meramec, Missouri and Mississippi River sands, having a weight of 1746 kg or more per cubic meter (109 pounds or more per cubic foot).

Class B sand shall include all chert, river, and Crowley Ridge sand having a weight of 1698 kg to 1730 kg inclusive per cubic meter (106 pounds to 108 pounds inclusive per cubic foot), or glacial sand having a weight less than 1730 kg per cubic meter (108 pounds per cubic foot).

Class C sand shall include all chert, river, and Crowley Ridge sand having a weight of 1618 kg to 1682 kg inclusive per cubic meter (101 pounds to 105 pounds inclusive per cubic foot).

Class D sand shall include all sand having a weight of 1602 kg or less per cubic meter (100 pounds or less per cubic foot) and any sand which is produced by the process of grinding and pulverizing large particles of aggregate, or which contains more than 50 percent of material produced by the reduction of coarser particles.

The weight per cubic meter (cubic foot) shall be the dry rodded weight per cubic meter (cubic foot) of the aggregate, determined in accordance with AASHTO T 19.

501.2.2.3 The cement factor or the quantity of cement used in any cubic meter (cubic yard) of concrete shall be the cement content in kilograms per cubic meter (pounds per cubic yard) of concrete as determined from a summation of the absolute volumes of all the ingredients and when air-entrained concrete is specified, the volume of air. The cement requirements in kilograms per cubic meter (pounds per cubic yard) of concrete for the various classes of sand are noted in the chart below.
Cement Requirements

<table>
<thead>
<tr>
<th>Class of Sand</th>
<th>Class A-1 Concrete</th>
<th>Class B Concrete</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Min</td>
<td>Max</td>
</tr>
<tr>
<td></td>
<td>kg/m³</td>
<td>lb/yd³</td>
</tr>
<tr>
<td>A</td>
<td>360</td>
<td>600</td>
</tr>
<tr>
<td>B</td>
<td>380</td>
<td>640</td>
</tr>
<tr>
<td>C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D</td>
<td></td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Class of Sand</th>
<th>Class B-1 Concrete</th>
<th>Class B-2 Concrete</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Min</td>
<td>Max</td>
</tr>
<tr>
<td></td>
<td>kg/m³</td>
<td>lb/yd³</td>
</tr>
<tr>
<td>A</td>
<td>360</td>
<td>610</td>
</tr>
<tr>
<td>B</td>
<td>380</td>
<td>640</td>
</tr>
<tr>
<td>C</td>
<td>390</td>
<td>660</td>
</tr>
<tr>
<td>D</td>
<td>415</td>
<td>695</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Class of Sand</th>
<th>Pavement Concrete</th>
<th>Seal Concrete</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Min</td>
<td>Max</td>
</tr>
<tr>
<td></td>
<td>kg/m³</td>
<td>lb/yd³</td>
</tr>
<tr>
<td>A</td>
<td>335</td>
<td>565</td>
</tr>
<tr>
<td>B</td>
<td>345</td>
<td>585</td>
</tr>
<tr>
<td>C</td>
<td>355</td>
<td>600</td>
</tr>
<tr>
<td>D</td>
<td>380</td>
<td>640</td>
</tr>
</tbody>
</table>

501.2.3 Sampling. Sampling of fresh concrete shall be in accordance with AASHTO T 141, except that for central or truck mixed concrete, the entire sample for slump and air tests, and for molding compressive strength specimens, may be taken at one time after approximately one cubic meter (one cubic yard) of concrete has been discharged instead of at three or more regular intervals during the discharge of the entire batch. Acceptability of the concrete for slump and air content, and when applicable for strength requirements, will be determined by tests on these samples.

501.2.4 Consistency. The slump of the concrete will be designated by the engineer within the following limits for the respective classes of concrete. The concrete shall be uniform in consistency and contain the minimum quantity of water required to produce the designated
slump. The slump and mixing water content of the concrete, when placed in the work, shall not exceed the following limits:

**Slump and Mixing Water Requirements**

<table>
<thead>
<tr>
<th>Class of Concrete</th>
<th>Maximum Slump</th>
<th>Water/Cement Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>mm</td>
<td>Inches</td>
</tr>
<tr>
<td>A-1</td>
<td>90</td>
<td>3 1/2</td>
</tr>
<tr>
<td>B</td>
<td>100</td>
<td>4</td>
</tr>
<tr>
<td>B-1</td>
<td>100</td>
<td>4</td>
</tr>
<tr>
<td>B-2</td>
<td>75</td>
<td>3</td>
</tr>
<tr>
<td>Pavement</td>
<td>100</td>
<td>4</td>
</tr>
<tr>
<td>Seal</td>
<td>200</td>
<td>8</td>
</tr>
</tbody>
</table>

**501.2.4.1** The slump of concrete mixes will be determined as specified in AASHTO T 119. When slip form paving is proposed, the slump allowed for Class B concrete and for Pavement Concrete shall be a maximum of 75 mm (3.0 in.). The quantity of mixing water in the concrete shall be considered the net quantity after proper allowance has been made for absorption by the aggregate.

**501.2.4.2** The minimum cement requirement for slip form subdivision paving is 335 kg/m$^3$ (565 lb/yd$^3$) or 335 kg/m$^3$ (565 lb/yd$^3$) with an approved water reducer. For slip form paving conducted from November 1st to March 15th, the minimum cement requirement will be 335 kg/m$^3$ (565 lb/yd$^3$) with an approved accelerator. The addition of an approved set accelerator may be required by the engineer.

When performing incidental or rail form subdivision paving, the cement requirement shall be a minimum of 345 kg/m$^3$ (585 lb/yd$^3$) or 345 kg/m$^3$ (585 lb/yd$^3$) with an approved water reducer. For incidental or rail form paving conducted from November 1st to March 15th, the minimum cement requirement shall be 345 kg/m$^3$ (585 lb/yd$^3$) with an approved set accelerator. The addition of an approved set accelerator will be at the option of the engineer.

**501.2.4.3** When specified in the contract, all concrete and proportioning shall conform to the Standard Construction Specifications for Sewers and Drainage Facilities of the Metropolitan St. Louis Sewer District, unless otherwise directed.

**501.3 Measurement of Material.** The cement and aggregates for portland cement concrete shall be measured by weight. The weights of coarse and fine aggregates to be used will be calculated from the proportions specified by the engineer. Batches that do not contain the proper quantities of materials shall be wasted at the contractor’s expense.

**501.3.1** The weighing and batching equipment shall be designed and maintained in such condition that the materials for each batch can be quickly and accurately weighed and shall be operated within a tolerance of plus or minus 0.5 percent for cement and plus or minus 1.0 percent
for aggregates. Scales shall be sufficiently free from vibration to permit accurate weighing when the plant is in operation. If, for any reason, equipment previously approved becomes unsatisfactory, it shall be repaired or replaced before proceeding with the work. When stationary mixers larger than 16S are used, storage bins with adequate separate compartments shall be provided for bulk cement when used, for fine aggregate and for each required size of coarse aggregate. The equipment used for delivery to bins shall not permit intermingling of aggregates. Each compartment shall be designed to discharge efficiently and freely into the weighing hopper. Weighing hoppers shall be so constructed that there will be no attachments that might affect the free movement of the weighing mechanism. Weighing hoppers shall discharge completely and there shall be no accumulation of tare materials. Weighing and batching equipment shall be supported on a firm foundation. If necessary, the weighing hopper shall be protected against the wind. Scales for weighing aggregate or cement may be either the beam-type, the springless dial type or electronic digital weight meter type, and shall be of standard make and design. Scales shall be accurate to within 0.4 percent of the net load applied. The change in load required to change the position of rest of the indicating element or elements of indicating scales an observable amount shall not be greater than 0.1 percent of the nominal scale capacity. For this purpose, the contractor shall store on the premises, a set of sensitivity weights that will be readily available to County personnel. Exposed fulcrums, clevises, and similar working parts of the scale shall be kept clean. When beam-type scales are used, a separate beam shall be provided for each type of material to be used and means shall be provided for adjustment of tare. For manually operated plants, provisions shall be made to indicate to the operator that the required load in the weighing hopper is being approached. The device shall indicate at least the last 5 percent of the load weighed on any beam, except that in no case will this increment be required to be greater than 90 kg (200 lbs.). Quantity indicators necessary for batching operations shall be in full view of the operator.

501.3.2 Cement shall be measured by weight. It shall be weighed on a scale separate from those used for other materials.

501.3.3 Mixing water shall be measured by volume or by weight. If measured by weight, scales shall conform to the requirements of Sec. 501.3.1. The device for the measurement shall be readily adjustable, and under all operating conditions shall measure the required quantity within a tolerance of one liter (one quart) or one percent, whichever is greater. The device shall be so arranged that the flow of water is automatically stopped when the required quantity has been delivered. Water measuring devices shall be of adequate capacity to furnish the maximum quantity of mixing water required, and shall be equipped with outside taps and valves to permit their calibration under conditions similar to operating conditions.

501.3.4 Plant Calibration. Personnel, scales, and equipment necessary for calibrating the plant and for verifying the accuracy of proportions shall be furnished by the contractor and shall be available at all times. The equipment shall include standard 20 kg (50 lb.) test weights equal to 20 percent of the net load capacity of the scales, to the nearest 20 kg (50 lb.) increment. However, not more than twenty 20 kg (50 lb.) weights will be required. Calibration by an approved commercial scale service will be required for plants which have large capacity scales greater than 4500 kg (10,000 lbs.) or if scales do not meet calibration tolerances. Weights shall be calibrated by the governing state body of weights and measures in accordance to the
requirements established by the U.S. Department of Agriculture. All equipment shall be calibrated by the contractor in the presence of and subject to the approval of the engineer. Plants shall be calibrated at least once each year, or as directed. Plant certification for calibration and verification will not be required, provided that this certification has been furnished to the State within a twelve (12) month period prior to the time certification is required by the County. A letter of certification to verify this will be required. This does not preclude interim checks by County forces.

501.4 Mixing. The concrete mixer shall be of a type approved by the engineer. Mixers having a production capacity less than either a 27E single drum mixer or a 16E dual drum mixer shall not be used for paving except by consent of the engineer. The mixer used on structural work involving individual pours of 25 m³ (30 cu. yd.) or more shall have a manufacturer’s guaranteed capacity of not less than 0.25 m³ (10 cu. ft.), and for smaller pours the mixer shall have a manufacturer’s guaranteed capacity of not less than 0.15 m³ (5 cubic feet). Mixing time shall be in accordance with Sec. 501.4.1 unless a reduction of mixing time is requested by the contractor. He shall then run the tests required in Sec. 501.5.4.

501.4.1 The mixer shall produce concrete uniform in color, appearance, and distribution of the materials throughout the mass. Variations in the mixed concrete reasonably attributable to worn pickup or throw over blades will be just cause for inspection of such blades. When such inspection reveals the blades to be worn down more than 25 mm (1 in.) below the original height of the manufacturer’s design, the blades shall be repaired or replaced. A copy of the manufacturer’s design, showing dimensions and arrangement of blades, shall be made immediately available to the engineer upon request. The cement, aggregates, and not less than 60 percent of the water shall be mixed at least one minute. The remaining water shall be added within 15 seconds after all other materials for the batch that are in the mixer. If mixers having multiple compartment drums are used, the time required to transfer material between compartments will be considered mixing time. The speed at which the drum shall rotate shall be as designated by the manufacturer. If such mixing does not result in concrete having a uniform and smooth texture, a sufficient number of additional revolutions at the same rate shall be given until a thorough mixing of each batch of concrete is secured. If a mixer having a guaranteed capacity of more than 1 m³ (38 cu. ft.) of mixed concrete per batch is used, the mixing time shall be increased 15 seconds for each additional cubic meter (cubic yard) of capacity, or fraction thereof, except as specifically permitted for central mixers in Sec. 501.5.4. The mixing time shall be measured from the time all cement, aggregates, and 60 percent of the water, are in the drum. The volume of concrete mixed in each batch shall not exceed the manufacturer’s guaranteed capacity. The guaranteed capacity of a mixer shall be considered to be the manufacturer’s rated or nominal capacity plus 10 percent when operating on grades not exceeding 6 percent and provided the mixer is in a condition to properly mix the additional volume.

501.4.2 The mixer shall be equipped with an attachment for automatically timing the mixing of each batch of concrete. The timing device shall consist of an automatic arrangement for locking the discharge chute and a device for warning the operator when all materials have been mixed the required length of time. Should the timing or locking device become broken or fail to operate, the contractor shall immediately place before the mixer operator a clock or watch having a second hand. If the contractor fails to make repairs within 3 days after the timing or
locking device becomes unserviceable, the mixer shall be shut down until the proper repairs are made.

501.4.3 Materials for a batch of concrete shall not be placed in any compartment of the mixing drum until the material for the previous batch has been discharged from that compartment.

501.5 Central and Truck Mixed Concrete. The following additional requirements shall apply to central and truck mixed concrete.

501.5.1 All central mixers, truck mixers, and agitators shall comply with the requirements of these specifications prior to use, and inspections of the equipment will be made periodically during the work. Only equipment found acceptable in every respect and capable of producing uniform results will be permitted.

501.5.2 When the concrete is to be used in bridge construction, the contractor shall furnish and conform to a schedule of delivery which provides that all batches receive essentially the same amount of mixing and agitation. Failure to deliver consistently uniform concrete will be cause for its rejection and the contractor will be required to furnish concrete produced by a stationary mixer on the job site without any adjustments in the contract unit bid price.

501.5.3 Storage facilities for all materials shall be designed to permit the engineer to make necessary inspections prior to the batching operations. The facilities shall also permit identification of approved materials at all times and shall be designed to avoid any mixing with, or contaminating by, unapproved materials. Coarse and fine aggregate shall be so furnished and handled that variations in the moisture content affecting the uniform consistency of the concrete will be avoided. Any aggregate fractions used which vary more than plus or minus one percentage point from the mean moisture content established near the start of the day’s operations on the structure section, when delivered to the weighing hopper during any one pour of concrete, will be subject to rejection. The engineer may permit a change in the mean moisture content, and the moisture content of the aggregate shall then vary not more than plus or minus one percentage point from the newly established mean. These provisions shall in no way alter the slump and mixing water requirements of the specifications for concrete. The fine aggregate bin or weighing hopper shall be equipped with a moisture sensing device which shall consistently indicate the moisture content within 0.5 of one percent of the dry weight of the aggregate. The indicator shall be in such position that it may be readily observed by the operator during batching operations. These requirements for specific limits on moisture variation and for a moisture sensing device are not applicable to pavement concrete.

501.5.4 Central mixed concrete shall be mixed in a stationary mixer in accordance with the requirements specified herein. Except as otherwise permitted in Sec. 501.5.11, it shall be transported to the point of delivery in a truck mixer operating at agitating speed, or in an agitator truck. For mixers having a nominal capacity greater than 1 m³ (38 cubic feet) the concrete shall be mixed not less than 60 seconds. The mixing time shall be as necessary to produce concrete which meets uniformity criteria when tested as prescribed in Sec. 10.3 of ASTM C 94 with the following additions and exceptions:
(1) The two samples shall be obtained within an elapsed time of not more than 15 minutes.

(2) The air content, slump, and mix proportions of the concrete tested shall meet the requirements of Sec. 501 for that class of concrete or the uniformity test shall be invalid.

(3) The use of a 0.007 m³ (one-quarter cubic foot) measure will be permitted in determination of unit weight.

(4) Cylinders may be cured in damp sand after the first 48 hours.

The contractor may designate the mixing time for which uniformity tests are to be performed, provided it is not less than 60 seconds nor more than the time determined in accordance with requirements of Sec. 501.4.1. The maximum mixing time shall not exceed the mixing time established by uniformity test by more than 60 seconds for air-entrained concrete. The mixed concrete shall meet the uniformity requirements specified above before any concrete may be used for pavement or structures. However, the engineer may allow the use of the test concrete for appropriate incidental construction. Labor, sampling, sampling equipment, and material required for uniformity test of the concrete mixture shall be furnished by the contractor. The tests will be performed by the engineer, or by the contractor, with approval by the engineer. No direct payment will be made for the labor, equipment, materials, or testing. After operational procedures of batching and mixing are thus established, no changes in procedure will be permitted without re-establishing procedures by uniformity tests.

501.5.4.1 Measurement of mixing time shall start at the time all the solid materials are in the drum and shall end at the beginning of the next sequential operation. The batch shall be so charged into the mixer that some water enters in advance of the cement and aggregate and all water is in the drum by the end of the first one-fourth of the specified mixing time. Mixer performance tests shall be repeated whenever the appearance of the concrete or the coarse aggregate content of samples selected as set out in ASTM C 94, as modified above indicates that adequate mixing is not being accomplished.

501.5.5 Truck mixed concrete shall be mixed at the proportioning plant and the mixer shall operate at agitating speed while in transit. However, truck mixed concrete may be mixed at the point of delivery provided the cement, or cement and mixing water, are added at that point. Mixing of truck mixed concrete shall commence immediately after the introduction of the mixing water to the cement and aggregates, or the introduction of the cement to the aggregate.

501.5.6 A truck mixer shall consist of a watertight revolving drum suitably mounted and fitted with adequate blades, and equipped with a device for determining the number of mixing revolutions. Truck mixers shall produce a thoroughly mixed and uniform mass of concrete, and shall discharge the concrete without segregation. A truck agitator shall consist of a watertight revolving drum or a watertight container suitably mounted and fitted with adequate revolving
blades and a removable cover. Truck agitators shall transport and discharge the concrete without segregation. At suitable intervals, mixers and agitators shall be cleaned of accumulations of hardened concrete or mortar.

501.5.7 Except as hereinafter permitted, each truck mixer shall have permanently attached to it a metal rating plate issued by and in accordance with the capacity requirements of the Truck Mixer Manufacturers Bureau, as approved by NRMCA, on which is stated its maximum capacity in terms of volume of mixed concrete for the various uses to which the equipment is applicable. It shall also have attached a manufacturer’s data plate which shall state the actual capacity as an agitator, the maximum and minimum mixing and agitating speeds, and any other data desired by the manufacturer. When truck mixers are used for mixing or agitating, the volume of concrete in each batch shall not exceed the maximum capacity shown on the metal rating plate issued by the Truck Mixer Manufacturers Bureau, as approved by NRMCA, except that if a lower capacity for agitating is shown on the manufacturer’s data plate, that lower capacity shall govern. If the equipment does not have attached such a rating plate, the batch volume when the equipment is used as a mixer and as an agitator, shall not exceed 57.5 percent and 80.0 percent of the gross interior volume, respectively. The minimum batch size for truck mixers shall be 1 m³ (one cubic yard). The right is reserved to reduce the batch size, or reject use of any truck mixer that does not produce concrete uniform in color, appearance, and distribution of materials throughout the mass. A quantity of concrete that results in axle and gross loads in excess of statutory limits will not be permitted.

501.5.8 Truck mixers and agitators shall be operated at the speed of rotation designated by the manufacturer of the equipment, provided such speeds are within the following limits. Mixing speed for the revolving drum type of mixer shall be not less than 6 nor more than 18 revolutions of the drum per minute. Agitating speed for both the revolving drum mixers and revolving blade type agitators shall be not less than 2 nor more than 6 revolutions per minute of the drum or of the mixing blades. Truck mixed concrete shall initially be mixed not less than 70 nor more than 100 revolutions of the drum at mixing speed after all of the ingredients, including water, are in the mixer except that when the batch volume does not exceed 57.5 percent of the gross volume of the drum or 91 percent of the rated maximum capacity, the number of revolutions required for mixing shall be not less than 50 nor more than 100. When a truck mixer or truck agitator is used for transporting concrete that has been completely mixed, agitation of the concrete shall continue during transportation at the speed designated by the manufacturer of the equipment as agitating speed. Water may be added to the mixture not more than two times after initial mixing is completed. Each time water is added, the drum shall be turned an additional 30 revolutions or more if necessary, at mixing speed, until uniform mixing is accomplished. All water added will be included in determining the effective water in the mixture.

501.5.9 Water measuring equipment at the plant or central mixer shall meet the requirements of Sec. 501.3.3. If the truck mixer is not equipped with a tank and an automatic water measuring device, a calibrated tank or a meter shall be installed on the truck or at the job site for measuring additional water used to obtain satisfactory workability of dry batches. Each increment of water used shall be measured within a tolerance of one percent of the total effective water for the batch. Water used to wash the drum of the mixer shall not be used as mixing water.
501.5.10 Central or truck mixed concrete shall be delivered to the site of the work and discharge shall be completed within one hour for concrete used for bridge deck surface slabs, and within 1-1/2 hours for all other concrete, after the beginning of mixing operations. In hot weather or under conditions contributing to quick stiffening of the concrete, the time shall be reduced as directed by the engineer. Concrete shall be discharged without delay and the time required between the start and completion of discharge shall not exceed 15 minutes for bridge deck slabs. Discharge time for other concrete pours shall not exceed 15 minutes, except that in the case of small pours the discharge time may be extended as necessary to provide for proper placing and inspection procedures provided the total mixing, delivery, and discharge time does not exceed that specified. A small concrete pour will be hereby defined as pours for curbs, curb and gutters, sidewalk, paved drainage, and paved approach for private entrances. The 15 minutes discharge time will be enforced for all pavement and structural pours.

501.5.11 Consideration will be given to permitting the use of non-agitating equipment for the transportation of central mixed concrete, but approval of this procedure, except as qualified in Sec. 502.3.2.1 for use in portland cement concrete pavement, may be granted only when the quantity of concrete is small, the length of haul short, and its use does not require high structural strength for satisfactory performance. The discharge of concrete, for other than pavement, transported in non-agitating equipment shall be completed within 45 minutes after introduction of the mixing water to the cement and aggregates. When hauling heated concrete, or under other conditions contributing to quick stiffening of the concrete, the time shall be reduced as directed by the engineer.

501.5.11.1 Bodies of non-agitating hauling equipment shall be smooth, mortar-tight, metal containers capable of discharging the concrete at a satisfactory, controlled rate without segregation. If unloading the concrete is accomplished by tilting the body, baffles may be required to retard the discharge.

501.5.11.2 Non-agitating flatbed dump trucks shall be equipped with protective covers that encompass the entire open portion of the bed. A backup tailgate latching system shall be utilized to prevent accidental discharge of material during transport. Tailgates shall be equipped with rubber gaskets to restrict seepage of mortar between the lip of the truck bed and the closed gate. Grout, seal concrete, and other high slump materials shall not be transported by flatbed dump trucks.

501.5.12 During the time that concrete is being discharged for pours requiring more than one load of concrete, facilities shall be provided to permit immediate radio communication between the site where the concrete is being placed and the proportioning plant.

501.5.13 Inspection. Proper facilities shall be provided for the engineer to inspect ingredients and processes used in the manufacture and delivery of the concrete. Laboratory space shall be provided at plant sites for use by the County for the duration of contracts. The space provided shall contain at least 11 m² (120 sq. ft.) of work area, and be equipped with a sink with faucet and running water, desk, lighting facilities of an approved type, and three electrical outlets with 110 volt, 60 cycles current. The laboratory area shall be air conditioned or heated, as required, to maintain an interior ambient temperature of 22⁰ C (72⁰ F). This facility is subject to
the approval of the engineer.

**501.5.14 Delivery Ticket.** The manufacturer of truck or central mixed concrete shall furnish to the engineer with each truck load of concrete before unloading at the site, a delivery ticket, stamped by a bonded weighmaster on which is shown information concerning the concrete as follows:

(a) Name of concrete plant.  
(b) Serial number of ticket.  
(c) Date and truck number.  
(d) Name of contractor.  
(e) Specific project, route, and county designation.  
(f) Specific class of concrete.  
(g) Quantity of concrete in cubic meters (cubic yards).  
(h) Time when batch was loaded, or of first mixing of cement and aggregates.  
(I) Arrival time on project.  
(j) Time when truck has finished discharging load.  
(k) Any additional water added at jobsite to attain pouring consistency, unless otherwise specified under Special Provisions.

**501.6 High Early Strength Concrete.** The condition under which high early strength concrete may be used must either meet the written approval of, or be specified by, the engineer. When Type III, high early strength cement is used, the concrete shall be proportioned in accordance with the requirements of Sec. 501.2 for the various classes of concrete. When Type I portland cement is used to obtain high early strength concrete, the proportions shall be determined by the engineer.

**501.7 Air-entrained Concrete.** Air-entrained concrete shall be used for the construction of the following items:

(1) All retaining walls and all bridge units, including culvert type structures and excepting seal courses.  
(2) Concrete median barriers.  
(3) All piles.  
(4) Concrete pavement.  
(5) Approach slab and paved approach.  
(6) Concrete median and median strip.  
(7) Sidewalk.  
(8) Curb, gutter, curb and gutter, and surface drain basins and drains.

At the contractor’s option, all other concrete may be air-entrained but only in accordance with the requirements of these specifications.

**501.7.1 When air-entrained concrete is used, the quantity of air by volume shall be as follows:**
There shall be no intentional deviation from the designated air content. An occasional deviation in air content exceeding the operating tolerance may be permitted if, in the judgment of the engineer, the deviation is such that it will not seriously affect the serviceability of the concrete.

501.7.2 To avoid wide fluctuations in air content, the contractor shall maintain close control over uniformity of cement, aggregates, consistency of the concrete, operation of proportioning and mixing equipment, and mixing time. Air entrainment shall be obtained by use of an approved air-entraining admixture added in the quantity required to obtain the designated air content. It shall be the contractor’s responsibility to determine and use the quantity of admixture necessary to obtain the designated air content within the permitted operating tolerance.

501.7.3 Air-entraining admixtures shall be added to the concrete during the process of mixing. The admixture shall be of such volume and strength that it can be accurately measured and dispensed by means of an approved mechanical dispenser which will gradually discharge the required quantity of material into the stream of mixing water. The entire quantity of air-entraining admixture shall be fully discharged before all of the mixing water has entered the drum of the mixer. The device shall be so arranged that the flow of air-entraining admixture will be automatically stopped when the required quantity has been delivered. The dispenser shall be so constructed that it can be accurately calibrated at various settings and shall be provided with means by which the discharge can be readily diverted from the stream of mixing water to a container for measurement. The dispenser shall consistently deliver the required quantity of admixture within a tolerance of plus or minus three (3) percent.

501.7.4 Concrete Admixtures for Retarding Set, Accelerating Set and Water Reduction. If specified in the contract, an approved admixture shall be provided and incorporated into the concrete. If not specified in the contract, the use of an approved admixture may be permitted upon written request by the contractor. The use of any admixture will be by approval of the engineer and contingent upon satisfactory performance on the work and permission for its use may be withdrawn at any time that satisfactory results are not obtained. The use of a retarder for extending the delivery or discharge time of the concrete, or for modifying temperature requirements for placement, will not be approved. Admixtures shall be added in accordance with Sec. 501.7.3 by means of a dispenser conforming to the requirements of that section. If both admixtures and air-entraining agents are used, the sequence and rate of discharge of all materials shall be as specified by the engineer. No direct payment will be made for furnishing the admixture, incorporating it into the mix, or for placing or finishing the concrete involved.

501.8 Prior to placement of any concrete in the work, the contractor may be required to prepare trial batches of concrete for tests. The mixing equipment, mixing time, materials, proportions, slump, and batch size shall be the same as those to be used during the construction.
The batches shall be agitated in such manner to simulate the proposed time of haul and discharge. The volume of all concrete prepared for trial batches which are not used in the work will be determined from the summation of the absolute volumes of all ingredients, and the volume of entrained air when used. Payment will be made at 50 percent of the contract unit bid price for the class of concrete for which the trial batches were prepared.

501.9 Calcium Chloride. The use of calcium chloride in concrete mixtures will be permitted in special cases only by approval of the engineer.

501.10 Tinted Concrete. Where the contract requires concrete to be tinted, the tinting materials used shall meet the requirements of Sec. 1056.

501.11 Concrete shall be tinted by applying the tinting material uniformly over, and working it into, the surface of the fresh concrete to a depth of 3 to 6 mm (1/8 to 1/4 in.) in a manner and quantity required to obtain a uniform color density meeting the approval of the engineer, after which the final finishing operations shall proceed. The tinting mixture shall be a 2 to 1 blend of tinting material to cement. This mixture shall be applied at the rate of approximately 20 kg/9 m² (45 lb./100 sq. ft.) of surface. The actual quantity required to obtain the desired color density may vary from this estimated quantity. Tinted concrete shall be cured in accordance with the curing requirements for the contract item for which tinting is specified, except that white pigmented membrane curing material shall not be used. When the contractor elects to use membrane curing for those items where its usage is permitted, it shall be of the clear or transparent type.

501.12 Concrete meeting the material and proportioning requirements for Class B concrete will be acceptable as an approved commercial mixture and may be certified to as such.
SECTION 502
PORTLAND CEMENT CONCRETE PAVEMENT

502.1 Description. This work shall consist of a pavement composed of portland cement concrete, with or without reinforcement as specified, constructed on a prepared subgrade in accordance with these specifications and in conformity with the lines, grades, thicknesses, and typical cross sections shown on the plans or established by the engineer.

502.2 Materials. All materials shall conform to Division 1000, Materials Details, and specifically as follows:

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<th>Item</th>
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<td>1036.2</td>
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All materials, proportioning, air-entrainment, mixing, slump, and transporting for portland cement concrete shall be in accordance with Sec. 501.

502.3 Equipment. Equipment and tools including portable mixers necessary for handling materials and performing all parts of work shall be approved by the engineer as to design capacity, and mechanical condition. The equipment shall be at the job site sufficiently ahead of the start of construction operations to be examined thoroughly for approval and shall comply with the following requirements.

502.3.1 Batching Plant and Mixer. The mixer, water measuring equipment, and weighing and batching equipment shall conform to the requirements of Sec. 501, Portland Cement Concrete.

502.3.1.1 Central or truck mixed concrete shall be produced and delivered from not more than three (3) plants per day for any individual project or subdivision. This restriction will not apply to material suppliers who qualify as “Disadvantaged Business Enterprises”, when D.B.E. participation is stipulated in the construction contract.

502.3.2 Hauling. Batch trucks used for transporting unmixed batches from the plant to the paver shall have compartments of size and construction adequate to prevent loss of material and spillage or contamination from one compartment to the other. Cement shall be handled in such manner as to prevent loss during the loading, hauling, and unloading process. To prevent loss of cement, the material shall be transported by:

(a) batch trucks equipped with separate metal or metal-lined bulk cement containers kept closed while the material is in transit, or
(b) batch truck compartments equipped with rigid, tight-fitting covers to be kept closed while the material is in transit and opened when the batches are being discharged, and in which at least a portion of the aggregate is placed prior to placing the cement, or

c) placing the cement on the coarse aggregate and adequately covering with sand when rigid compartment covers or separate cement containers are not used, or

d) other methods specifically approved by the engineer.

502.3.2.1 Trucks for transporting mixed concrete shall meet the requirements of Sec. 501. Consideration will be given for the use of an approved type of non-agitating equipment for transporting central mixed concrete provided the discharge of the concrete is completed within 30 minutes after the introduction of the mixing water to the cement and aggregates. Bodies of non-agitating hauling equipment shall be smooth, mortar-tight, metal containers capable of discharging the concrete at a satisfactory, controlled rate without segregation. Covers shall be provided when needed for protection or to comply with Statutes.

502.3.3 Forms. Side forms, except as otherwise permitted, shall be of metal, of an approved section, with a base width not less than the height, except a 225 mm (9 in.) base width will be permitted for 250 mm (10 in.) pavement. The height shall be equal to the edge thickness of the pavement. Each form section shall be straight and free from bends and warps. No section shall show a variation greater than 3 mm/3 m (1/8 in./10 ft.) from the true plane surface on the top, and 6 mm/3 m (1/4 in./10 ft.) along the face of the form. The method of connecting form sections shall insure a tight, neat joint. Built-up metal forms when allowed may be used by rigidly attaching a wood or metal section of suitable width and thickness to the bottom of the form providing an increase in depth of not more than 20 percent. Each 3 m (10 ft.) form will be securely held in position by a minimum of three approved form pins.

502.3.3.1 Forms for curved form lines shall comply with the grade and alignment requirements of Sec. 502.5.2, except that straight steel form sections 3 m (10 ft.) or less in length may be used for form lines having a radius greater than 60 m (200 ft.). Special forms of wood or steel will be permitted for curved form lines having a radius of 60 m (200 ft.) or less, and may be permitted if approved by the engineer in other special cases where it is not practicable to use standard pavement forms. Straight steel form sections 1.5 m (5 ft.) in length will be acceptable for curved form lines having a radius of not less than 30 m (100 ft.). Forms shall be of sufficient rigidity to prevent distortion in edge alignment due to pressure of the concrete. Wood forms may be used with a minimum thickness of 25 mm (1 in.). Radius of 10 m (32 ft.) or less will be formed with segmented steel or wood forms with a minimum thickness of 25 mm (1 in.) and will be held securely with approved form pins as required by the engineer. Wood forms shall not be used as a track for operating paving and finishing equipment. All forms will be set on compacted subgrade without support devices.

502.3.4 Form Line Grader. Except as considered impracticable by the engineer for the type or quantity of work involved, the form line for all forms supporting mechanical finishing equipment shall be excavated substantially to line and grade by a machine designed for this purpose. In lieu of the form line grader, consideration will be given for granting approval for use
of other methods producing similar results.

502.3.5 Mechanical Form Tamper. Except as considered impracticable by the engineer for the type or quantity of work involved, a mechanical form tamper constructed in such manner that each side of the form will be tamped simultaneously shall be used on all forms supporting mechanical finishing equipment.

502.3.6 Subgrade Machine. The subgrade machine shall be of an approved type. Written approval may be given by the engineer for the use of a subgrade planer in lieu of the subgrade machine if the planer is considered adequate for the particular work involved, except as considered impracticable by the engineer for the type or quantity of work involved.

502.3.7 Subgrade Planer. An approved subgrade planer rolling on the side forms should be provided, except as considered impracticable by the engineer for the type or quantity of work involved.

502.3.8 Check Template. An approved heavy metal check template rolling on the side forms shall be provided. The template shall have a square edge for checking the subgrade surface. Scratch templates with spikes or teeth will not be permitted. In instances of small concrete pavement pours, the use of a string line or an approved portable template to check the subgrade may be used with the approval of the engineer.

502.3.9 Strike-off for Reinforcement. An approved strike-off template to level the concrete prior to placing wire fabric reinforcement or tie bars shall be provided when a mechanical concrete spreader is not used.

502.3.9.1 Placement of Reinforcement. In lieu of the strike-off template, an approved mechanical installer of a depressor type may be used for the installation of the wire fabric. This machine shall vibrate the fabric into the required position without subsequent displacement. Hand placement of fabric will be permitted with engineer’s approval by placing fabric between alternate lifts of designated thickness.

502.3.10 Vibrators. Vibrators, for full width vibration of the concrete, may be either the surface pan-type or the internal-type with either tube or multiple spuds. They may be attached to the spreader or the finishing machine, or may be mounted on a separate carriage. They shall not come in contact with the reinforcement, load transfer devices, subgrade, or side forms. Vibrating equipment shall be operated in accordance with the manufacturer’s recommendation at a frequency to provide satisfactory results, but the frequency of the surface vibrators shall not be less than 3600 impulses per minute and the frequency of the internal-type shall not be less than 4500 impulses per minute. Hand vibrators shall have a frequency of not less than 4500 impulses per minute. The contractor shall have a satisfactory tachometer available at all times for checking the vibration frequency.

502.3.13.1 Wire Comb. A wire comb shall be not less than 3 m (10 ft.) long with a single line of wires exposed to a length of approximately 100 mm (4 in.). The wire shall be blue tempered and polished spring steel with nominal dimensions of 0.71 mm (0.028 in.) thick and
2.54 to 3.18 mm (0.100 to 0.125 in.) wide. The wires shall be spaced to provide 13 mm (1/2 in.)
clear space between wires and securely mounted in a rigid head with the width of each wire
parallel to the longitudinal center line of the head. The wire comb shall be mechanically operated
with the length of the comb parallel to the pavement centerline and capable of transversing the
full width of pavement in a single pass at a uniform speed and at a uniform depth. Final approval
of the wire comb will be based on satisfactory performance during actual use. Texturing
equipment, other than a wire comb, may be approved provided it produces a texture equivalent to
that produced by a wire comb and upon satisfactory performance during actual use. Hand use of
a wire comb of standard dimension will be permitted with prior approval of the engineer. An
unsatisfactorily combed area will be refloated and textured.

502.3.14 Concrete Saw. When sawed joints are required, equipment complete with
either an abrasive wheel or a diamond-edge water-cooled blade capable of providing a groove of
the specified dimensions in the hardened concrete shall be provided.

502.3.15 Equipment for Sealing Joints. An approved double boiler-type heating kettle
equipped with a mechanical agitator and a satisfactory temperature indicating device will be
required. The equipment shall be capable of heating the joint sealing material uniformly without
damage.

502.3.16 Auxiliary equipment shall be available at all times as follows:

(a) Two footbridges so designed that they can be readily transported from place to place
and which have no part in contact with the pavement. Contractors performing paving
in residential subdivisions will be permitted to proceed without footbridges if they
choose.

(b) Two or more 3 m (10 ft.) straightedges of an approved type. The blades will be
composed of aluminum or magnesium, reinforced on the upper edge and rigidly
jointed to the handle. The blades shall be capable of producing the proper section and
slope. Blades shall be replaced when edges become wavy or warped.

(c) Long-handled floats, each having a blade of 1 m (3 ft.) in length and 150 mm (6 in.) in
width.

(d) Metal dies with beveled face numerals not less than 75 mm (3 in.) nor more than 125
mm (5 in.) high and thick enough to make an indentation of 6 mm (1/4 in.). A
satisfactory die shall be used for marking the point designated by the even station
number and all equations. This equipment is required for arterial road pavement only.

(e) Sufficient burlap, waterproof paper, or plastic film for the protection of the pavement
in case of rain or breakdown of the curing equipment.

(f) A manually operated long-handled wire comb approximately 0.6 m (2 ft.) wide with
wire size and spacing in accordance with the requirements of Sec. 502.3.13.1. For
residential subdivision paving a burlap drag finish is required.
502.4 Weather Limitations. Concreting operations shall not normally continue:

(a) when either the air temperature or the temperature of the surface on which the mixture is to be placed is below $2^0 \text{C} (35^0 \text{F})$,

(b) on any wet or frozen surface,

(c) when weather conditions prevent the proper handling or finishing of the mixture, or

(d) unless authorized by the engineer during critical temperature periods (below $2^0 \text{C} (35^0 \text{F})$). If approval has been granted for the contractor to place the concrete while the ambient temperature is at or lower than $5^0 \text{C} (40^0 \text{F})$, the contractor shall take precautionary measures to prevent damage by freezing, such as heating mixing water, heating aggregates, or applying heat directly to the contents of the mixer. Aggregates shall not be heated higher than $65^0 \text{C} (150^0 \text{F})$ and the temperature of the aggregates and mixing water combined shall be not higher than $38^0 \text{C} (100^0 \text{F})$, when the cement is added. Unless otherwise authorized, the temperature of the mixed concrete when heating is employed shall not be less than $10^0 \text{C} (50^0 \text{F})$ and not more than $27^0 \text{C} (80^0 \text{F})$ at the time of placement. Cement or fine aggregate containing lumps or crusts of hardened material or frost shall not be used. Under no condition shall the mix be used when mix temperature is over $38^0 \text{C} (100^0 \text{F})$ at time of placement.

502.4.1 Subdivision concrete paving from November 1st to March 15th will not commence unless approved by the Engineer. Pouring operations will not begin until the ambient air temperature has reached $2^0 \text{C} (35^0 \text{F})$ and rising with a predicted high temperature of over $5^0 \text{C} (40^0 \text{F})$ and will discontinue operations when the ambient temperature falls to $5^0 \text{C} (40^0 \text{F})$.

502.4.2 Protection. All concrete shall be effectively protected from freezing for a period of at least five (5) days after it has been placed and until a minimum compressive strength of 20 700 kPa (3000 psi) has been attained. Protection will be required for not more than ten (10) days. Regardless of precautions taken, the contractor shall assume all risks, and all frozen concrete shall be removed and replaced at his expense.

502.4.3 Newly completed subdivision pavement placed between November 1st and March 15th shall be blocked off from all vehicle and construction traffic after paving is completed for a period of three (3) weeks or 21 days. At no time will any vehicle equipment or construction materials, paving forms, etc. be allowed on the new pavement during the three (3) week period specified above. If any violation of the protective specifications as modified relating to concrete placed between November 1st and March 15th is observed or detected, the penalty for such violation will be the full escrowed amount per square meter (square yard), or the violated area shall be removed and replaced.

502.5 Setting Forms. Forms shall be set so that they rest firmly throughout their length upon the thoroughly compacted subgrade. Any subgrade which is more than 13 mm (1/2 in.) below the established grade at the form line shall be brought to grade for a sufficient width, outside the area required by the pavement, to support the forms adequately, and shall be
compacted to specified density. Any variations, whether below or above grade, shall be brought to true grade.

502.5.1 Forms shall be staked into place with not less than three pins for each 3 m (10 ft.) section. A pin shall be placed at each side of every joint. Form sections shall be tightly locked, free from play or movement in any direction. If the subgrade becomes soft and yielding after the forms have been set and before the concrete is placed, the forms shall be reset on a stable foundation.

502.5.2 Both straight and curved forms shall be supported in such position that the face of the form shall be vertical on tangents and perpendicular to the superelevated section on curves. The top of the form shall not vary more than 3 mm (1/8 in.) from the true grade line during placing, compacting, and finishing operations. The form alignment shall not vary more than 6 mm (1/4 in.) from the true alignment.

502.5.3 Unless otherwise permitted, sufficient forms shall be provided so that at least 150 m (500 ft.) of forms on each side of the roadbed are accurately set at all times in their required final position in advance of the point where concrete is being placed. Each time forms are used, they shall be cleaned thoroughly and oiled before reuse.

502.6 Conditioning of Subgrade. When forms have been securely set to grade, the subgrade shall be brought to proper cross section in accordance with Sec. 209, Earth Subgrade Preparation. The final checking for proper crown and elevation of the subgrade by means of the check template required in Sec. 502.3.8 shall be performed in the presence of the engineer after all equipment traffic on the subgrade has ceased and as close as is practicable to the area of current concrete placement. If calibrated rod measurements taken when the surface of the pavement has been finished indicate that pavement thickness is less than specified on the plans, the subgrade planer and template shall be immediately adjusted.

502.6.1 Low areas of treated bases shall be filled only with concrete integral with the pavement. No direct payment will be made for the concrete used to fill these low areas.

502.7 Proportioning and Mixing Concrete. Concrete shall be proportioned and mixed in accordance with Sec. 501, by one of the following methods:

(a) Paving Mixers. Semi-automatic control will be required for cement and aggregate batching for concrete mixed in paving mixers at the point of deposition. This shall consist of controlling the flow of material by means of gates or valves that may be separately and manually opened to allow material to be weighed, but which are closed automatically when the pre-determined weight of each material is reached. The batching equipment shall be interlocked so that (1) The charging mechanism of any weigh hopper cannot be opened until the scale has returned to zero and the discharge mechanism of the weigh hopper has closed; (2) the discharge mechanism of the weigh hopper cannot be opened if the charging mechanism is open; (3) The discharge mechanism cannot be opened until all ingredients have been batched to their designated weights, within the specified tolerances; (4) If separate aggregate
components are weighed cumulatively in a single hopper, the aggregates will be weighed in the selected sequence and the cement weighed in a separate hopper. The cement shall be kept separate from the aggregates until the batch ingredients are released for discharge.

(b) Truck or Central Mixers. In addition to the above requirements, automatic, fully interlocked, batching control will be required for concrete mixed in truck or central mixers and hauled to the point of deposition as a mixed product. This shall consist of batching all aggregate, cement, and water by means of automatic or metering, with all additives dispensed automatically and interlocked with the automatic weighing or metering controls. For central mixed concrete, the mixing cycle shall be timed and interlocked with the weight batch cycle. The weight-setting controls shall be suitably enclosed in a compartment equipped so that it may be locked when directed by the engineer. The automatic batching equipment shall be capable of conversion to manual operation if necessary. In the event of an automatic equipment breakdown, manual operation of the plant will be permitted until the end of the workday.

502.7.1 Mixers will not be permitted to operate on any existing or newly constructed rigid type pavement except as specified herein, and then only if damage does not occur. A 16E mixer may be operated on existing pavement if it is supported on rubber tires of such size and number that it will operate within the legal load limit requirements and does not conflict with the prescribed requirements for handling traffic. If the concrete being mixed is for concrete pavement resurfacing or for the purpose of widening existing pavement that is to be resurfaced with either asphaltic or portland cement concrete, any mixer may operate on the existing pavement provided the gross weight does not exceed 34,000 kg (75,000 lb.) and delivery of concrete from mixer to its place of use is such that it will eliminate the concentration of the load on the mixer tracks that is generally created by use of a bucket operating on a boom. A method of delivery shall be developed that will be free of segregation tendencies.

502.8 Placing Concrete. The concrete shall be deposited full depth over the entire width of the subgrade between forms in such manner as to require as little rehandling as practicable. Where concrete is being placed for mainline pavement, mechanical spreading equipment shall be required. Concrete shall be thoroughly vibrated along the forms or sides and along expansion and key type longitudinal joints. Attachments on finishing machines to vibrate the concrete adjacent to forms and longitudinal joints will be permitted provided satisfactory results are attained. Care shall be taken that the vibrator does not penetrate the subgrade or dislodge or move the joints. The vibrating shall be sufficient to produce a smooth pavement edge. Honeycombed edges may be cause for rejection of the pavement.

502.8.1 Subdivision Paving. The concrete shall be deposited full depth over the entire width of the subgrade between forms in such manner as to require as little rehandling as practicable. Where concrete is being placed for non-arterial mainline slip form paving, the concrete may be directly deposited from trucks onto the subgrade providing the paving equipment is capable of properly spreading the concrete.

502.9 Strike-off of Concrete and Placement of Reinforcement. Following the placing
of the concrete, it shall be struck off so that when the concrete is properly consolidated and finished, the surface of the pavement will be at the proper elevation and cross section. When reinforced concrete pavement is placed in two layers, the entire width of the bottom layer shall be struck off to such length and depth that the sheet of wire fabric may be laid full length on the concrete in its final position without further manipulation. The reinforcement shall be placed directly upon the concrete and the top layer of the concrete placed, struck off, and screeded. Any portion of the bottom layer of concrete which has been placed more than 30 minutes without being covered with the top layer shall be removed and replaced with freshly mixed concrete at the contractor’s expense. When reinforced concrete is placed in one layer, the reinforcement shall be positioned on the plastic concrete and vibrated into correct position by means of a reinforcement installer.

502.9.1 Tie bars shall be supported in the proper position by chairs driven into the subgrade, or may be placed by approved mechanical methods prior to the consolidation of the concrete after it has been struck-off.

502.9.2 Wire fabric and tie bars shall be free from dirt, oil, paint, grease, loose mill scale, and thick rust that could impair bond of the steel with the concrete. Thin, powdery rust need not be removed.

502.9.3 Keyway shall be placed to the proper height as shown in the plans and supported by attached legs resting on the subgrade. The keyway must be held firmly against the form to prevent infiltration of mortar or misalignment. Keyway sections will be butted tightly except at expansion or contraction joints where they will be gapped. Infiltration mortar shall be removed to produce a clean, fillable joint.

502.10 Final Strike-off, Consolidation, and Finishing. Machine finishing by vibrating and screeding processes will be required for all pavement except as permitted by Sec. 502.10.9. After the final course of the concrete has been placed it shall be struck off and thoroughly vibrated until concrete of a uniform and satisfactory density is obtained. The surface of the pavement shall be screeded as many times and at such intervals as necessary to leave a surface of uniform texture to the proper grade and typical section. Excessive screeding over a given area shall be avoided. Finishing machines shall be kept in satisfactory repair and adjustment and shall be operated without lift, wobbling, or other variation tending to affect a precision finish. While operating, a roll of concrete shall be maintained in front of the full length of all screeds so that the vibrating and screeding work will be fully effective.

502.10.1 Consolidation. Concrete shall be consolidated by vibrating the mass promptly following placement. Vibrating tubes shall extend into the concrete the distance necessary to provide adequate consolidation. Approved pan-type vibrators operated on the surface of the concrete may be used in lieu of tube-type internal vibrators. Vibrators shall be operated only when the machine to which they are attached is moving.

502.10.2 Machine Floating. After the finishing machine operations have been completed, the concrete surface on arterial roadway pavement shall be smoothed and consolidated by mechanical floating, either longitudinal or transverse, leaving the pavement
finished to the required cross section, elevation and surface smoothness. Mechanical floats shall be adjusted and so operated that the float or screed will have a small quantity of concrete in front of its full length at all times for filling depressions. The screed or float shall not be raised or lowered for the purpose of maintaining the proper quantity of concrete in front of the float. The longitudinal float shall pass over each area of pavement. Manually operated floating will be required following machine floating and in advance of straightedge testing.

**502.10.3 Added Finishing Water.** Added finishing water shall be applied only as ordered by the engineer and only in the form of a fine pressure spray by hand methods. Under normal working conditions moisture shall not be applied to the surface of the pavement in any form.

**502.10.4 Straight-Edge Testing and Surface Correction.** Immediately following the machine floating and while the concrete is still plastic, the contractor shall test the slab surface for trueness by means of a 3 m (10 ft.) straightedge as specified in Sec. 502.3.16 (b). Straightedging shall be done by holding the straightedge in contact with the concrete surface, parallel to the road centerline, and drawing the straightedge lightly across the surface. Advance along the road shall be in successive stages of not more than one-half the length of the straightedge. All variations shall be eliminated by filling depressions with freshly mixed concrete or striking off projections, and the areas so corrected shall be consolidated and refinished by means of a long-handled float. The surface shall again be checked by the contractor by means of the 3 m (10 ft.) straightedge and any irregularities eliminated.

**502.10.5 Surface Finish.**

**502.10.5.1 Non-Tinted Concrete.** After surface irregularities have been removed, the concrete shall be given a uniformly roughened surface finish by use of a wire comb or other approved texturing device which produces a texture similar to that produced by a wire comb. The texturing operation shall be executed so that the transverse corrugations will be uniform in appearance. Successive passes of the comb or other approved device shall be overlapped the minimum necessary to obtain a continuously textured surface. The surface texture produced shall have the characteristics of a texture produced using a wire comb as specified in Sec. 502.3.13.1, and which has an average texture depth of approximately 3 mm (1/8 in.). Texturing shall be completed while the concrete is in such condition that it will not be torn or unduly roughened, and before it has attained its initial set. The texturing device shall be cleaned or replaced as often as necessary to obtain the required surface texture. Upon completion of texturing, the pavement surface shall be uniform in appearance and free from surplus water, rough or porous spots, irregularities, depressions, and other objectionable features. Small or irregular areas, or areas not suitable for machine texturing when adjacent surrounding concrete is ready for texturing, shall be textured with a hand operated device producing a textured surface equivalent to that required for machine combing. Subdivision pavement shall be surface textured with a wet burlap drag unless otherwise directed by the engineer.

**502.10.5.2 Tinted Concrete.** If the contract requires concrete to be tinted and after surface irregularities have been removed, the concrete shall be given a uniformly roughened surface finish by the use of a fabric drag or a broom. The damp fabric drag shall be dragged in a
longitudinal direction. Brooms shall be drawn across the surface from the centerline toward each edge with the broom held perpendicular to the surface, each stroke slightly overlapping the preceding stroke. The brooming operation shall be executed so that the corrugations will be uniform in appearance and not more than 1.5 mm (1/16 in.) deep. A machine capable of producing a finished surface similar to that required for hand brooming may be used. Brooming or dragging shall be completed before the concrete is in a condition that it will be torn or unduly roughened and before the concrete has attained its initial set. The brooms or the fabric shall be cleaned or replaced as often as necessary to attain the required surface texture. Upon completion of brooming or dragging, the surface of the pavement shall be uniform in appearance and shall be free from surplus water, rough or porous spots, irregularities, depressions, and other objectionable features.

502.10.6 Edging at Forms and Joints. After the final finish, but before the concrete has taken its initial set, the edges of the pavement along each form line, and of each side of transverse expansion joints and construction joints shall be worked with an edging tool having a radius of approximately 10 mm (3/8 in.). A well-defined and continuous radius having a smooth, dense finish shall be produced. The surface of the slab shall not be unduly disturbed by tilting of the tool during use. Tool marks on the slab shall be eliminated by floating. In doing this, the rounding of the corner of the slab shall not be disturbed. All concrete on top of the joint filler shall be completely removed. All joints shall be tested with a straightedge before the concrete has set, and correction made if one side of the joint is higher than the other.

502.10.7 Station Numbers. The contractor shall stencil station numbers into all arterial roadway pavement immediately following the final finishing operations and before the concrete takes its final set. The numbers shall be placed at alternating full stations as ascertained by measurements determined by the engineer. Equations in stationing shall also be marked in the pavement. On undivided pavement, the station numbers shall be on the left side of the pavement with respect to the ascending stationing and shall be on the pavement edge unless an integral curb is involved, in which case the numbers shall be placed on the face of the curb. On divided pavement, station numbers shall be placed on the median side of each pavement. The numbers shall be placed facing the centerline of the pavement, or the centerline of each pavement in the case of divided pavements. The numbers shall be placed on a troweled area of the finished surface. No direct payment will be made for marking station numbers.

502.10.8 Modified Machine Finishing. For isolated pavement lanes less than 300 m (1000 ft.), all machine finishing equipment will be required except that a manually operated longitudinal float may be used in lieu of the machine float.

502.10.9 Hand Finishing. Compacting and finishing pavement by hand methods will be permitted:

(a) For all curves having a form line radius of less than 60 m (200 ft.) or where wood forms are used.

(b) For all tapered and irregular shaped areas.
(c) For isolated pavement lanes when approved by the engineer.

(d) For pavement lanes of less than 2.4 m (8 ft.) in width and 60 m (200 ft.) in length.

(e) When a breakdown of the mechanical compacting and finishing equipment occurs or in the event of some other emergency. After a breakdown, only material that has already been proportioned which is within time limits as determined by time stamped on material ticket, and which may become unsatisfactory for use may be finished by hand.

(f) For bridge approaches and pavement to first expansion joint.

Hand finishing shall consist of all operations required under Sec. 502.10 except mechanical finishing equipment will not be required. If the mechanical finishing machine is not used, a vibrating screed or a tamping template, the face of which is at least 100 mm (4 in.) wide, having a length slightly in excess of the width of the pavement, and having sufficient rigidity to maintain the true cross section of the pavement shall be used. If a mechanical float is used, a manually operated longitudinal float worked from each side of the pavement shall be used.

In irregular shaped areas of subdivision paving such as “cul-de-sacs”, “eyebrows” and the handwork portion of “Tee” intersections the contractor will be allowed to use a 3 m (10 ft.) long float to strike off and finish the concrete surface.

The contractor will be required to use a vibratory screed in subdivision pavement widenings and taper lanes adjacent to mainline pavement. The screed shall also be used on any mainline pavement not poured with a slip form paver other than in the irregular shaped areas mentioned above.

502.11 Joints. Joints shall be of designated type and dimensions, and constructed at the locations shown on the plans or as approved by the engineer. Where joints are preformed, the form or joint shall be set and securely fastened to insure the joint being in the required position when the concrete is finished. Dowels and tie bars in their final position shall be parallel to the subgrade and perpendicular to the line of the joint. Dowel supporting assemblies shall conform to one of the types shown on the plans. The concrete shall be placed so that it will not displace or disarrange the joint installations.

Transverse grooving for subdivision streets shall be allowed provided the groove is a minimum of 30 mm (1 1/4 in.) deep and that all concrete deposited above the level of the finished pavement surface, due to the grooving procedure, be refinished. The engineer shall have the option of requiring sawcut joints in subdivision paving wherever deemed necessary.

502.11.1 Expansion Joints. Expansion joints shall extend for the full cross section and full depth of the concrete pavement. The filler shall be premolded. Filler placed prior to the placement of the concrete shall be installed with a removable cap or edging bar to serve as a guide for edging the joint and protection for the filler during the placing and finishing of the concrete. Joints constructed after the placement of concrete shall be sawed full depth and the
exposed edges shall be ground to a chamfer of 10 mm (3/8 in.). The filler shall rest snugly on the subgrade from form to form. The joints shall be sealed as required in Sec. 502.11.4. Upon removal of the forms, any struts or fins of concrete extending across the joint shall be removed to the full width of the joint and the full thickness of the pavement.

**502.11.2 Construction Joints.** Construction joints shall be made at the close of each day’s work or when the work is stopped or interrupted for more than 30 minutes. No transverse construction joint shall be constructed within 3.0 m (10 ft.) of an expansion or contraction joint. Construction joints shall be constructed perpendicular to the top surface and the centerline of the pavement. Construction headers at the end of the day will always be placed at a contraction joint containing a load transfer device. The joint shall be so formed as to consist of a two piece header of 50 mm (2 in.) nominal wood or a standard paving form which will produce a smooth face on a vertical joint and shall be firmly held in place with approved staking pins placed on an interval which will rigidly hold the form in place. The required header shall conform to the cross section of the pavement. Before paving operations are resumed, the header shall be removed carefully and all surplus concrete and other refuse shall be removed from the subgrade. Construction joints at all other locations will be so formed as to produce a vertical smooth joint and shall be composed of a nominal 50 mm (2 in.) thick wooden or standard paving form predrilled for 16 mm (5/8 in.) diameter deformed reinforcing steel dowels 750 mm (30 in.) in length embedded 375 mm (15 in.) into the proposed slab. An alternate construction joint may be obtained by placing bent bars in position against a vertical form of required dimension. Both methods will incorporate a keyway in combination with the dowels.

**502.11.3 Sawing.** Unless otherwise provided, all transverse contraction and all longitudinal joints in the pavement and curbs shall be sawed with the joint groove cut to the dimensions shown on the plans. When the groove for poured type transverse joints is cut prior to removal of the forms, the groove shall be cut as close as is practicable to the pavement edge, and the resulting crescent shaped plug in the groove, immediately adjacent to the form, will be acceptable. For intersections and irregular pavement, joints shall be sawed at locations as directed by the engineer. Sawing of the joints shall commence as soon as the concrete has hardened sufficiently to permit sawing without excessive raveling. All joints shall be sawed before uncontrolled shrinkage cracking takes place. The sawing of any joint shall be omitted if a crack occurs at or near the joint location prior to the time of sawing. Sawing shall be discontinued when a crack develops ahead of the saw. In general, all joints should be sawed in sequence unless otherwise directed. The County reserves the right to have the contractor install premolded type joints on multiple width construction when the use of sawed joints fails to prevent random cracking. Construction joints may be formed by full depth sawing.

**502.11.4 Sealing Joints.** All sawed contraction joints and sawed or formed expansion joints shall be sealed with joint sealing material before the pavement is opened to traffic, including construction traffic, and as soon after completion of a minimum curing period of 72 hours providing vehicles are not placed on the pavement when performing the sealing operation. Immediately prior to sealing, the joints shall be thoroughly cleaned and dried. The sealing material shall be heated to the pouring temperature recommended by the manufacturer. Any material that has been heated above the maximum safe heating temperature will be rejected. The sealing mixture material shall be installed in such a way as to fill the joint opening completely.
and uniformly from the bottom to the top, and any excess material shall be removed from the pavement surface. Sawed joints in vertical curb shall be sealed with gray colored silicone caulk.

502.11.5 Adding New Pavement. New pavement constructed parallel to existing pavement shall be tied to the existing pavement with the existing longitudinal tie bars. The tie bars shall be straightened and incorporated into the new abutting slabs. Where tie bars do not exist, a 25 mm (1 in.) minimum hole will be drilled 450 mm (18 in.) deep on 750 mm (30 in.) centers into the existing pavement. New 15 mm (5/8 in.) diameter bars, 750 mm (30 in.) long, will be grouted into place 24 hours in advance of paving operations. The grout will meet specifications of Sec. 1066. Existing pavement joints shall be duplicated in the abutting slabs. No direct payment will be made for the work.

The contractor will be permitted to place tie bars the day of the pour provided an approved epoxy bonding material is used in lieu of the grout The diameter and depth of the drilled hole shall be in accordance with the manufacturer’s recommendation for a 15 mm (5/8 in.) tie bar. The contractor shall submit in advance, for approval, the information on the epoxy bonding material proposed for use.

502.12 Curing. Immediately after the finishing operations have been completed and as soon as marring of the concrete will not occur, the entire surface of the newly placed concrete shall be covered and cured in accordance with one of the following methods. The concrete shall not be left exposed for more than 1/2 hour between stages of curing or during the curing period.

502.12.1 White Pigmented Membrane. After the free water has left the pavement surface, the entire surface shall be sealed by hand or machine spraying having a uniform pressure capable of providing a uniform application of white pigmented membrane curing material. The contractor shall provide satisfactory equipment to insure uniform coverage of curing material, without loss, on the pavement at the rate of 1 L/3 .5 m² (1 gal. / 150 sq. ft.). If rain falls on the newly coated pavement before the film has dried sufficiently to resist damage, or if the film is damaged in any other way, the contractor will be required to apply additional curing material to the affected portions. All areas cut by finishing tools subsequent to the application of the curing material shall immediately be given new applications at the rate specified above. If hair-checking develops before the membrane can be applied, the concrete shall be initially cured with wet burlap as specified in Sec. 502.12.4 before the membrane is placed. Red pigmented membrane shall not be used on arterial roadways unless approved by the engineer.

502.12.2 Waterproofed Paper, Polyethylene Sheeting, and Polyethylene--Burlap Sheeting. As soon as the concrete has set sufficiently to prevent marring, the top surface of the pavement shall be covered with units of waterproofed paper, white polyethylene sheeting, or white polyethylene-burlap sheeting, which shall be lapped not less than 450 mm (18 in.). If polyethylene-burlap sheeting is used, the burlap shall be thoroughly dampened prior to placing and shall be placed next to the concrete. All coverings shall be so placed and weighted that they remain in contact with the pavement surface and edges for not less than 72 hours after the concrete has been placed. If hair-checking develops before the covering can be applied, the concrete shall be initially cured with wet burlap as specified in Sec. 502.12.4 before the covering is placed.
502.12.3 Mats of Jute or Cotton. New mats of jute or cotton, and any such mats that have been used for purposes other than curing of concrete, shall be thoroughly washed before being used. The use of mats contaminated with earth or other deleterious substances will not be permitted. The top surface of the pavement shall be completely covered with mats as soon as the concrete has set sufficiently to prevent marring of the surface. Prior to being placed, the mats shall be damp throughout and shall be placed with the wettest side down. The mats shall be handled in such manner that contact with earth or other deleterious substances is avoided, and they shall be so placed that they remain in contact with the pavement surface and edges. The covering shall be kept wet and maintained in position for not less than 72 hours after the concrete has been placed. If hair-checking develops before the mats can be applied, the concrete shall be initially cured with wet burlap as specified in Sec. 502.12.4 before the mat covering is placed.

502.12.4 Burlap. The top surface of the pavement shall be temporarily covered with thoroughly damp burlap after the concrete has set sufficiently to prevent marring of the surface. Burlap shall be handled in such manner that contact with earth or other deleterious substances will be prevented. All new or contaminated burlap and all burlap that has been used for purposes other than the curing of concrete shall be thoroughly washed before being used. The burlap shall be kept thoroughly wet until removed for application of the final curing material. Neither the top nor the edge of the pavement shall be left unprotected for more than 1/2 hour. When the burlap is removed, curing shall be continued by one of the approved methods.

502.12.5 Straw. The pavement shall be initially cured with wet burlap. As soon as the burlap is removed, the surface shall be covered with not less than 150 mm (6 in.) of straw, the thickness being measured after wetting. The straw shall be kept saturated for not less than 72 hours after the concrete has been placed. When removed, the straw shall be disposed of so as to leave the road in a sightly condition, but shall not be burned on the pavement or in close proximity to the edges.

502.13 Removing Forms. Forms shall be removed carefully so as to avoid damage to the pavement. Removed forms will not be placed on pavement during the 72 hour curing period. Honeycombed areas will be considered as defective work and shall be immediately repaired. If the forms are removed prior to 72 hours after placing concrete, the sides of the slab shall be cured by one of the methods specified above. Any trench excavated for the forms shall be entirely backfilled so no water will stand next to the pavement.

502.14 Surface Test. As soon as practicable, the pavement surface shall be thoroughly tested by profilographing or straightedging as indicated. Testing applicable to this specification, except straightedging, shall be performed by the contractor in the presence of the engineer.

502.14.1 Profilographing. Profilographing is applicable to the surface of all mainline paving, auxiliary lanes, turning lanes and ramps. Specifically excluded are:

a) Subdivision paving.
b) Bridge decks and their approach slabs.
c) Pavement on horizontal curves with centerline radius of curve less than 300 m (1000

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feet) and pavement within the superelevation transition of such curves.

d) Contracts or stages of construction with less than 0.8 kilometers (one-half mile) of continuous concrete pavement.

e) Width transitions.

f) Fifteen meters (50 ft.) in direction of travel on each side of utility appurtenances such as manholes and valve boxes.

g) Fifteen meters (50 ft.) in direction of travel on each side of intersection routes with special grade transition.

h) Portland cement concrete shoulders.

i) Any portland cement concrete lane that abuts an existing lane not constructed under the same contract.

502.14.1.1 Pavement profiles shall be taken 1 m (3 ft.) from and parallel to each edge of pavement for pavements 3.5 m (11 ft.) wide. If pavement is placed at a greater width than 3.5 m (11 ft.), the profile shall be taken 1 m (3 ft.) from and parallel to each edge and 1 m (3 ft.) to one side of each plan longitudinal joint as directed by the engineer.

502.14.1.2 Additional profiles shall be required only to define the limits of an area representing deviations greater than 10 mm (0.40 in.), except as required in Sec. 14.6.4.

502.14.1.3 A profilogram shall be made for each continuous section of 15 m (50 ft.) or more for each day’s placement. A section is defined where paving begins and terminates at a days work joint, a bridge or other interruption designated by the engineer. Sections will be divided into segments of 0.1 km (0.1 mile) with the exception of the last segment that normally will be less than 0.1 km (0.1 mile).

502.14.1.4 Individual sections shorter than 15 m (50 ft.) and the last 5 m (15 ft.) of any section where the contractor is not responsible for the adjoining surface, will be straightedged in accordance with Sec. 502.14.2.

502.14.1.5 If there is a segment of 75 m (250 ft.) or less in length at the end of a section, the profilogram for that segment shall be included in the evaluation of the adjacent segment in that section.

502.14.1.6 If there is an independently placed section of a length between 15 and 75 meters (50 and 250 ft.), a profilogram shall be made for that section and included in the evaluation of the most recently placed adjacent segment.

502.14.1.7 The contractor shall furnish the profilogram and its evaluation to the engineer. The testing shall be done by a trained operator in the presence of the engineer. The testing procedure and the evaluation of the profilogram shall be done in accordance with this specification and MoDOT Test Method T59. The profilogram and evaluation shall be furnished to the engineer not later than the end of the next day worked following placement of the pavement and within two days after corrective grinding.

502.14.1.8 The engineer may also test the surface or re-evaluate the profilogram for
comparison and assurance purposes. If these tests or re-evaluations indicate the contractor-furnished profilograms are not accurate within 45 mm per km (3.0 in./mile), the engineer may test the entire project length. If the entire project length is tested, the contractor will be charged for this work at the rate of $310 per lane kilometer ($500.00 per lane mile). Furnishing inaccurate test results may result in disapproval of the operator.

502.14.1.9 The contractor shall use a software package to interpret the profilograph results. If not available, the contractor may outline on the profilograph with a contrasting color. This outlining procedure will remove spikes and minor deviations caused by rocks, texturing, dirt or transverse grooving. This outline will be referred to as the profile trace in these specifications.

502.14.1.10 A profile index will be calculated from the profilogram for pavements of 15 m (50 ft.) or more in length. The profile index is calculated by summing the vertical deviations of the profile trace outside a 5 mm (0.20 in.) blanking band. The units of this measure are millimeters per kilometer (in./mile).

502.14.1.11 Bumps shall be separately identified. These appear as high points on the profile trace and correspond to high points or bumps on the pavement surface. They are identified by locating vertical deviations greater than 10 mm (0.40 in.) for a 7.622 m (25-ft.) span, as indicated on the profile trace.

502.14.2 Straightedging. As soon as practicable, the engineer will straightedge all segments of the paved surface not profilographed, including shoulder areas between rumble strips, and mark any variations exceeding 3 mm in 3 m (1/8 in. in 10 ft.). Areas more than 3 mm (1/8 in.) high shall be removed by an approved device as listed in Sec. 502.14.6.3.

502.14.2.1 On subdivisions streets (up to 7.9 m [26 ft.] in width), testing in accordance to Sec. 502.14.2 will be performed, except that surface variations exceeding 13 millimeters in 3 meters (1/2 in. in 10 ft.) will be plainly marked. Areas of pavement that exceed this tolerance will be removed and replaced to the nearest sawcut joint. On subdivision streets exceeding 7.9 m (26 ft.) the provisions of 502.14.2.2 shall apply.

502.14.2.2 Surface Tolerance. On subdivision collector streets all variations exceeding 10 mm/3 m (3/8 in./10 ft.) will be plainly marked. At transverse joints, all surface variations exceeding 6 mm/3 m (1/4 in./10 ft.) will be marked. Areas of pavement that exceed these allowable tolerances shall be removed by an approved device as listed in Sec. 502.14.6.3. In areas where conditions necessitate that surface grinding be performed to a depth that leaves the final pavement more than 8 mm (0.3 in.) deficient from plan thickness, the effected slab(s) will be removed and replaced in their entirety.

502.14.3 Equipment. The profilograph shall be a California type as approved by the engineer. The equipment furnished shall be supported on multiple wheels having no common axle. The wheels shall be arranged in a staggered pattern such that no two wheels cross the same bump at the same time. The pavement profile is recorded from the vertical movement of a sensing wheel attached to the frame at midpoint and is in reference to the mean elevation of the
12 points of contact with the road surface established by the support wheels. The profilogram is recorded with a scale of one millimeter equals one millimeter (one in. equals one in.) vertically and one millimeter equals 300 millimeters (one in. equals 25 ft.) longitudinally.

**502.14.4 Calibration.** All profilographs used shall be calibrated at least annually on a test section established by MoDOT. The contractor’s calibration profile index shall not vary more than 30 mm/km (2.0 in./mile) from a standard profile index produced by a MoDOT profilograph.

**502.14.4.1** Longitudinal calibration consists of pushing the profilograph over a pre-measured test distance and determining the scale factor by dividing the premeasured test distance by the length of the paper in millimeters (inches). This factor shall be 300 (25), 25 mm equals 7.622 m (one in. equals 25 ft.). If not, the machine shall be adjusted until the scale factor is 300 (25) plus or minus 0.2 percent.

**502.14.4.2** Vertical calibration consists of sliding a pre-measured calibration block, measured to the nearest 0.25 mm (0.01 in.), under the sensing wheel while the profilograph is stationary. The measurement of the vertical trace line from the base line to the peak and return shall be the same as the calibration block. The trace line must return to the base line. No tolerance will be allowed.

**502.14.4.3** A profilograph equipped with automatic profile trace reduction capabilities shall be checked by comparing the machine’s results with the results obtained by the engineer. This shall be done for the profile trace obtained on the MoDOT test section. The results and the profilogram shall be submitted to the engineer. The results of the comparison may not differ by more than 30 mm/km (2.0 in./mile).

**502.14.4.4** The contractor shall furnish certification that the 7.622-meter (25-foot) profilograph test and evaluation was conducted by an operator trained in the use of profilograph equipment and with sufficient experience to demonstrate the operator’s competence.

**502.14.5 Test Procedures.** Smoothness will be tested by measurement with a profilograph. The device produces a profilogram of the surface tested.

**502.14.5.1** All objects and foreign material on the pavement surface, including protective covers, if used, shall be removed by the contractor prior to testing and, if appropriate, protective covers shall be properly replaced by the contractor after testing.

**502.14.5.2** The profilograph shall be propelled at walking speed in the paths indicated in Sec. 502.14.1.1. for each section of pavement. Propulsion may be provided by personnel pushing manually or by a suitable propulsion unit.

**502.14.5.3** A location indicator for lateral placement is mandatory. More than one person may be required to hold the back end of the profilograph exactly in the required path on horizontal curves except as stated in Sec. 502.14.1 (c).
502.14.5.4 Walking speed shall be decreased if excessive spikes are encountered.

502.14.5.5 The sensing wheel shall be lifted, rotated to take slack out of the linkage, and lowered to the pavement surface at the starting point prior to testing.

502.14.5.6 The actual stationing shall be noted on the profilogram at least every 50 m (200 ft.). Station referencing is used to accurately locate deviations greater than 10 mm (0.40 in.).

502.14.5.7 Both ends of the profilogram shall be labeled with the stationing, lane designation, position on the pavement and the direction the pavement was placed. A report form furnished by the engineer shall be completed and placed with the profilogram.

502.14.5.8 When operating the profilograph, all wheels shall be on the new pavement for which the contractor is responsible.

502.14.6 Surface Corrections. Bump correction or smoothness correction or both may be required.

502.14.6.1 If an average profile index of 237 mm/km (15 in./mile) is exceeded in any daily paving operation, the paving operation will be suspended and will not be allowed to resume until corrective action approved by the engineer is taken by the contractor.

502.14.6.2 All bumps greater than 10 mm (0.40 in.) in height over a 7.622-meter (25-foot) span, as indicated on the profile trace, shall be corrected. The corrected bumps will be considered satisfactory when measurements by the profilograph show that the bumps are 10 mm (0.40 in.) or less in height over a 7.622-meter (25-foot) span.

502.14.6.3 Corrective action to improve the average index shall be accomplished either transversely or longitudinally by approved diamond grinding or an approved device consisting of multiple saws designed for that purpose. The device shall be designed to improve the profile of the rising surface. The use of a bush hammer or other impact device will not be permitted.

502.14.6.4 After removing all individual deviations greater than 10 mm (0.40 in.), additional correction shall be performed if necessary to reduce the average profile index to 237 millimeters or less per kilometer (15 in./mile). All corrective work shall be completed prior to determination of pavement thickness. On pavement segments where corrections are necessary, additional profiles shall be made to verify that the corrections have produced an average profile index of 237 mm or less per kilometer (15 in./mile).

502.14.6.5 If the initial average profile index of any segment is less than 190 mm/km (12 in./mile), only the areas representing greater than 10 mm (0.40 in.) deviations shall be retested for correction verification.

502.14.6.6 The final surface of the corrected concrete pavement shall be such that the texture is comparable to adjacent sections that do not require correction. Satisfactory longitudinal
grinding is acceptable as the final surface of the corrected pavements.

502.15 Opening to Traffic. The concrete pavement shall not be opened for light traffic or construction traffic until the concrete is at least 72 hours old and has attained a minimum compressive strength of 20700 kPa (3000 psi). The pavement shall not be opened to all types of traffic until the concrete is at least 120 hours old and has attained a minimum compressive strength of 24150 kPa (3500 psi). If high early strength concrete is used, the pavement may be opened to all types of traffic when the concrete has attained a minimum compressive strength of 24150 kPa (3500 psi). In either case an ultimate strength of 27600 kPa (4000 psi) must be obtained for all concrete pavement. Compressive strength will be determined by tests made in accordance with St. Charles County Highway Department methods. Pavement shall be cleaned and joints sealed prior to opening to traffic.

502.15.1 On subdivision streets, the pavement shall not be opened to all types of traffic until the concrete is at least 14 days old and has attained a minimum compressive strength of 27600 kPa (4000 psi).

502.16 Slip-Form Construction. At the option of the contractor, pavement may be constructed by the use of sliding form methods. All applicable provisions of Sec. 502, Portland Cement Concrete Pavement, shall be followed. In addition, the following provisions shall apply.

502.16.1 Subgrade and Base. Where an aggregate base course is required for the pavement, it shall be constructed in accordance with the requirements of Sec. 304, Aggregate Base Course. The slip-form paver shall operate on the aggregate base. After the grade or base has been placed and compacted to the required density, the areas that will support the paving machine shall be cut to the proper elevation by means of an approved machine. The subgrade on which the pavement is to be constructed shall be brought to the proper profile by means of an approved subgrade machine or subgrade planer. An approved check template shall be used to determine if the finished subgrade conforms to the required cross section. The use of a check template may be waived by the engineer when the subgrade is prepared by full-width equipment using automatic controls operating from an established grade reference line on both sides of the machine.

502.16.2 Placing Concrete. A self-propelled concrete spreader equipped with a power-driven device for spreading the concrete uniformly across the subgrade transversely shall be used to place the concrete. The spreader shall also be equipped with an adjustable strike-off blade capable of striking off the surface of the concrete in the longitudinal direction of the pavement at any required elevation. For isolated pavement lanes over 60 m (200 ft.) long but less than 600 m (2000 ft.) long, a mechanical spreader will not be required. The final surface texture may be applied manually with a wire comb meeting the requirements of Sec. 502.3.16. Concrete can be placed directly on subgrade only with 24 hour prior approval of the engineer. A mechanical spreader will not be required in subdivision paving operations.

502.16.3 Consolidating and Finishing Equipment. The concrete shall be consolidated and finished by an approved slip-form paver designed to spread, consolidate, and shape the concrete in one complete pass of the machine in such a manner that a minimum of hand finishing
will be necessary to provide a dense and homogenous pavement in conformance with the plans and specifications. The slip-form paver shall be fully energized, self-propelled, and crawler mounted. It shall be of sufficient weight and power to construct the maximum specified concrete paving lane width as shown on the plans at an adequate forward speed, and without transverse, longitudinal, or vertical instability or displacement. Automatic controls operating from grade reference lines located on both sides of the paver shall be used to establish finished pavement elevations. The slip-form paver shall provide one oscillating transverse belt or other approved device that will produce a surface reasonably free of surface voids and tears. The machine shall vibrate the concrete for the full width and depth of the pavement being placed. Such vibration shall be accomplished with vibrating tubes or arms working in the concrete or with a vibrating screed or pan operating on the surface of the concrete. The sliding forms shall be rigidly held together laterally to prevent spreading of the forms. The forms shall trail behind the paver for such distance that no apparent slumping of the concrete will occur. The slip-form paver shall be operated with as nearly a continuous forward movement as possible and all operations of mixing, delivering, and spreading concrete shall be so coordinated as to provide uniform progress with stopping and starting of the paver held to a minimum. If, for any reason, it is necessary to stop the forward movement of the paver, the vibratory and tamping elements shall also be stopped immediately.

502.16.4 Forms. Unless otherwise permitted by the engineer, approved side forms will be required 6 to 9 m (20 to 30 ft.) back and ahead of transverse expansion and construction joints. The forms shall incorporate a keyway where required and shall be sufficiently rigid to produce a pavement with plan section.

502.16.4.1 Longitudinal tongue and groove joints of the designated type and size shall be constructed at locations indicated by the plans or approved by the engineer. Groove type joints shall be formed with approved metal forms that will produce a keyway with plan location and dimensions. The form shall remain in place for sufficient time to prevent slump and may be left in place with permission of the engineer.

502.16.4.2 Where tie bars are required, they shall be used with groove type joints. The bars shall be machine positioned before pavement consolidation. Hand placing of tie bars after consolidation of concrete will not be allowed. At contractor’s option, drilling and grouting of the tie bars will be permitted after 72-hour curing period in accordance with Sec. 502.11.5.

502.16.5 Protection Against Rain. In order that the concrete may be properly protected against the effects of rain before the concrete is sufficiently hardened, the contractor will be required to have available at all times materials for the protection of the edges and surface of the unhardened concrete. Protective material may consist of sheets of burlap, paper, or plastic film. Planks or other material with suitable stakes that can be used as temporary forms shall also be on hand. It will be the contractor’s responsibility to protect the pavement from damage due to rain. Failure to properly protect unhardened concrete may constitute cause for the removal and replacement of defective pavement at the contractor’s expense.

502.17 Tolerance in Pavement Thickness. It is the intent of these specifications that pavement shall be constructed strictly in accordance with the thickness shown on the plans. The
thickness of the pavement will be measured, and where any pavement is found deficient in thickness, it may be compensated for at an adjusted unit price per square meter (square yard), or shall be removed and replaced with satisfactory pavement.

502.17.1 Metal plates will be placed on the subgrade at points selected by the engineer in areas where the planer has cut or leveled off the subgrade or at any points where conditions are conducive to deficient pavement thickness. When the surface of the pavement has been finished to final grade, the engineer will, for informational purposes, check the thickness of the completed pavement by measuring the distance from the surface of the pavement to the metal plates by use of a calibrated rod. The engineer reserves the option to place and stick plates if he deems necessary. The placing of plates does not obligate the engineer to stick any or all plates. The surface of the pavement shall be satisfactorily restored by the contractor after thickness measurements have been made. The contractor shall, if necessary, furnish a bridge to facilitate the taking of the measurements. The engineer reserves the right to core drill the finished pavement to determine the thickness of the pavement. Cores may be drilled at the same locations as rod measurements or at any other locations. The contractor may require check cores to verify thicknesses determined by the engineer, and all costs of check core drilling shall be borne by the contractor. If the check cores requested by the contractor indicate that the engineer’s measurement would have erroneously resulted in deductions for, or removal of, thin pavement, the cost of drilling the check cores will not be charged to the contractor.

502.17.2 For the purpose of determining the constructed thickness of the pavement, four (4) cores per 300 m (1000 ft.) will be taken at random intervals for each centerline mile, for each pavement pour. In addition, cores will be taken at all locations where thickness measurements taken during construction indicate a thickness deficiency sufficient to justify a deduction from the escrow or the contract unit bid price, or at any other locations as may be determined by the engineer. When the measurement of any core is deficient in excess of 8 mm (0.3 in.) from the plan thickness, additional cores will be taken at 6 m (20 ft.) intervals parallel to centerline ahead and back of the affected location until the extent of the deficiency has been determined.

502.17.3 It will be assumed that each core is representative of the pavement thickness for a distance extending one-half the distance to the next core, measured along centerline, or in the case of a beginning or ending core, the distance will extend to the end of the pavement section. Cores shall be 100 mm (4 in.) diameter units capable of being used to test the in place strength of the pavement. The drilling of cores in irregular areas, or on projects involving less than 2000 m² (2500 sq. yd.) of concrete pavement, may be waived by the engineer. In this case the designed thickness will be considered as the measured thickness.

502.18 Method of Measurement. Pavement areas will be computed to the nearest 0.10 m² (nearest 1/10 sq. yd.). Final measurement of the completed pavement will not be made except for authorized changes during construction, or where appreciable errors are found in the contract quantity. The revision or correction will be computed and added to or deducted from the contract quantity.

502.19 Basis of Payment.
502.19.1 If any core thickness measurement is deficient, from the design thickness, the County will have the option of having the contractor remove and replace the pavement at his expense or allow the contractor to leave the pavement in place and receive the following deductions in payment.

For all pavement constructed, other than that constructed by residential developers for residential areas:

<table>
<thead>
<tr>
<th>Deficiency in Thickness</th>
<th>Deductions, Percent of Bid Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 mm to 5 mm (0.00 in. to 0.20 in.)</td>
<td>None</td>
</tr>
<tr>
<td>Over 5 mm to 10 mm (Over 0.20 in. to 0.40 in.)</td>
<td>15</td>
</tr>
<tr>
<td>Over 10 mm to 15 mm (Over 0.40 in. to 0.60 in.)</td>
<td>60</td>
</tr>
<tr>
<td>More than 15 mm (More than 0.60 in.)</td>
<td>100 or remove and replace</td>
</tr>
</tbody>
</table>

For all pavement constructed by residential developers in residential areas:

<table>
<thead>
<tr>
<th>Deficiency in Thickness</th>
<th>Deductions, Percent of Escrow</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 mm to 8 mm (0.00 in. to 0.30 in.)</td>
<td>None</td>
</tr>
<tr>
<td>Over 8 mm to 13 mm (Over 0.30 in. to 0.50 in.)</td>
<td>20</td>
</tr>
<tr>
<td>Over 13 mm to 25 mm (Over 0.50 in. to 1.00 in.)</td>
<td>40</td>
</tr>
<tr>
<td>More than 25 mm (More than 1.00 in.)</td>
<td>100 or remove and replace</td>
</tr>
</tbody>
</table>

502.19.2 Deficiencies in Compressive Strength. - The compressive strength of concrete pavement will be determined through testing of cylinders and/or cores at frequencies determined by the engineer. The core or set of cylinders will represent the compressive strength for a distance extending one-half the distance to the next core (or set of cylinders), measured along centerline, or in the case of a beginning or ending core (or set of cylinders), the distance will extend to the end of the pavement section. If any compressive strength measurement is deficient from the design compressive strength, the County will have the option of having the contractor remove and replace the pavement at his expense or allow the contractor to leave the pavement in place and receive the following deductions in payment:
Compressive Strength | Deductions, Percent of Bid Price or Escrow Amount
--- | ---
26 000 kPa (3800 psi) or more | None
25 300 kPa (3367 psi) to 25 999 kPa (3799 psi) | 20
23 000 kPa (3331 psi) to 25 999 kPa (3666 psi) | 40
Less than 23 000 kPa (3331 psi) | 100 or remove and replace

Any pavement, for which the sum of deductions for thickness and compressive strength exceeds 100 percent of the bid price, or escrow amount, shall be removed and replaced.

**502.19.3** In removing pavement, it shall be removed from the edge to a longitudinal joint, or between longitudinal joints, and on each side of the deficient pavement until no portion of the exposed cross sections is more than 8 mm (0.3 in.) deficient, except that there shall not be less than 3 m (10 ft.) of pavement removed. If there remains less than 3 m (10 ft.) of acceptable pavement between the section that has been removed and a transverse contraction, expansion, or construction joint, the contractor shall remove the pavement to the joint.

**502.19.3.1** In removing residential subdivision pavement, it shall be removed from the edge to a longitudinal joint, or between longitudinal joints, and on each side of the deficient pavement until no portion of the exposed cross sections is more than 8 mm (0.3 in.) deficient, except that there shall not be less than 2.4 m (8 ft.) of pavement removed. If there remains less than 2.4 m (8 ft.) of acceptable pavement between the section that has been removed and a transverse contraction, expansion, or construction joint, the contractor shall remove the pavement to the joint.

**502.19.4** For marred surface areas or slightly damaged concrete that remains in the completed pavement, a minimum deduction of 20 percent of the contract unit bid price or escrow will be made for the areas affected. The deduction will be applied to a section of pavement extending from edge of the pavement to a longitudinal joint or between longitudinal joints in that section of pavement affected. If the length of the section affected is less than 3 m (10 ft.), the deduction will be computed for 3 m (10 ft.).

A marred surface is any surface that has not been properly finished as required by these specifications. Pavement that has been rained on; pavement that has not reached its initial set and has had water flow on its surface washing away cement; pavement that has had plastic placed on it wherein the plastic has actually caused indentations and random patterns; pavement that has been walked on by humans or animals or driven on by any type of vehicle; or pavement that has had curing compound sprayed on it before the initial set, resulting in pitting marks. Areas corrected for smoothness will not be considered marred surfaces.

**502.19.5** Based on the final profile index of any segment after bump correction, the Contract price per square yard for Portland cement concrete pavement will be adjusted according to the following schedule.
<table>
<thead>
<tr>
<th>Final Profile Index - Inches Per Mile</th>
<th>Percent of Contract Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>12.0 or less</td>
<td>100.0</td>
</tr>
<tr>
<td>12.1 to 13.0</td>
<td>98.0</td>
</tr>
<tr>
<td>13.1 to 14</td>
<td>96.0</td>
</tr>
<tr>
<td>14.1 to 15.0</td>
<td>92.0</td>
</tr>
<tr>
<td>15.1 or more</td>
<td>Corrective work required or replaced</td>
</tr>
</tbody>
</table>

502.19.5.1 Segments with an initial profile index of 15.1 or greater shall be corrected as specified in Sec. 502.14.6 until the profile index is reduced to a profile index of 15.0 or less per mile (237 mm/km), or at the Contractor’s option, the segment may be removed and replaced at no additional cost to the contract.

502.19.5.2 On sections where corrections are made, the pavement will be tested by the contractor to verify that the corrections have produced a profile index of 15.0 inches or less per mile (237 mm/km).

502.19.5.3 The contractor will not be allowed to make corrective grinding to increase the percent in pay when the final profile index is 15.0 inches per mile (237 mm/km) or less.

502.19.6 If the profile index, after bump correction, is greater than 15.0 inches per mile (237 mm/km) and the contractor elects to remove and replace the segment, the contractor will be paid the percent of the contract price that corresponds to the replaced segment’s final profile index.

502.19.7 The contract unit price for portland cement concrete pavement will be considered as full compensation for all material, including reinforcement, dowels, dowel supports, tie bars and any other items entering into the construction of the traveled way pavement or portland cement concrete shoulders, and for the cost of smoothness testing. No additional compensation will be allowed for any excess thickness.

502.19.8 The accepted quantities of portland cement concrete pavement will be paid for at the contract unit bid price per square meter (per sq. yd.), with proper allowance made for any deductions for deficiency in thickness, smoothness, or marred surface.

502.19.9 When paving widths are greater than the travel lane widths, profiling and payment for profiling will apply to the traffic lane design driving width only, normally 3.6 meters (12 ft.). Random lane coring for thickness or required lane replacement will include the full paved lane width to the longitudinal joints or edge of shoulder, whichever is first.
SECTION 503
BRIDGE APPROACH SLAB

503.1 Description. This work shall consist of a reinforced concrete bridge approach slab constructed on a prepared subgrade in accordance with these specifications, and in conformity with the lines, grades, thicknesses, and typical cross sections shown on the plans or established by the engineer.

503.2 Materials. All materials shall conform to Division 1000, Materials Details, and specifically as follows:

<table>
<thead>
<tr>
<th>Item</th>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reinforcing Steel for Concrete Structures</td>
<td>1036.1</td>
</tr>
<tr>
<td>Concrete Curing Material</td>
<td>1055</td>
</tr>
<tr>
<td>Materials for Joints</td>
<td>1057.1</td>
</tr>
</tbody>
</table>

All materials, proportioning, air-entrainment, mixing, slump, and transporting for portland cement concrete shall be in accordance with Sec. 501, Portland Cement Concrete. Approach slabs may be constructed of Class B-1 or Pavement Concrete. Coarse aggregates for Class B-1 Concrete used for approach slabs shall consist of crushed limestone. When mudjacking approach slab, the contractor will provide a mix design for approval 14 days prior to intended date of use.

503.3 Construction Requirements. Bridge approach slabs shall be constructed in accordance with the applicable requirements of Sec. 502. The reinforcement shall be supported and held securely in place by approved metal bar supports. The approach slab and the contiguous pavement to the first expansion joint, as shown on the plans, shall be placed as a continuous or monolithic unit of the same concrete mixture.

503.3.1 Voids Under Completed Approach Slabs. Prior to acceptance of the work, all mud-jacking holes shall be opened by the contractor to permit investigation by the engineer. Any voids or cavities found shall be filled by the contractor with a slurry pumped under pressure to fill voids and cavities. Care shall be taken during pumping to produce a uniform pressure that will correct any settlement. At completion of the investigation or mud pumping, the holes shall be filled with sand to within 25 mm (1 in.) of the top and the remainder filled with joint sealing material.

503.4 Method of Measurement. Approach slab areas will be computed to the nearest 0.10 m² (nearest 1/10 sq. yd.). The section of contiguous pavement placed continuous with the approach slab will not be measured as approach slab. Final measurement of the completed bridge approach slab will not be made except for authorized changes during construction, or where appreciable errors are found in the contract quantity. The revision or correction will be computed and added to or deducted from the contract quantity.
503.5 Basis of Payment. The accepted quantity of bridge approach slabs will be paid for at the contract unit bid price.

503.5.1 No direct payment will be made for the reinforcing steel for bridge approach slabs. Also, no direct payment will be made for investigating void conditions under the completed slab, for filling any voids found, nor for correcting settlement.
Division 600

INCIDENTAL CONSTRUCTION
SECTION 602
MARKERS AND MONUMENTS

602.1 Description. This work shall consist of constructing markers, of the type required by the contract, at the locations shown on the plans or as directed by the engineer. Markers will be as follows:

(a) Drain Marker
(b) Steel Right-of-Way Marker
(c) Concrete Right-of-Way Marker

602.1.1 Monuments shall be installed, where required, in accordance with the Unified Development Ordinance of St. Charles County.

602.2 Materials.

602.2.1 All materials shall conform to Division 1000, Materials Details, and specifically as follows:

<table>
<thead>
<tr>
<th>Item</th>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steel Post for Marker</td>
<td>1015.5</td>
</tr>
</tbody>
</table>

602.2.2 Right-of-way and drain marker plaques and fasteners will be furnished at the job site by the County at no cost to the contractor.

602.2.3 Concrete for setting drain markers and steel right-of-way markers shall be subject to the approval of the engineer and shall have a cement content of not less than 280 kg/m$^3$ (470 lb./yd$^3$) of concrete. Concrete right-of-way markers shall be constructed of Class A, A-1, B, or B-1 concrete.

602.3 Construction Requirements.

602.3.1 Steel markers shall be set with the legend facing the centerline of the highway. Posts may be driven, set in concrete, or set with a quick setting polyurethane foam in accordance with Sec. 607.23.3. Posts having battered or mushroomed tops will not be accepted. Posts shall be set vertical at locations shown on the plans or as designated by the engineer and the plaques firmly attached.

602.3.2 Concrete right-of-way markers shall be constructed to the design and dimensions shown on the plans. Markers shall be set vertical, with the top flush with the finished ground surface or pavement surface. Where markers are located within or adjacent to an area paved with portland cement concrete, the marker shall be separated from the paved area with 6 mm (114 in.) preformed bituminous filler extending the full depth of the paved area.
602.4 Basis of Payment. The accepted quantity of markers will be paid for at the unit bid price for each of the pay items included in the contract. No direct payment will be made for concrete, polyurethane, or for grout when required.
SECTION 606
GUARD RAIL, GUARD CABLE,
AND GUARD FENCE

606.1 Description. This work shall consist of furnishing and erecting guard rail, guard cable, and chain-link guard fence in conformity with the lines and grades shown on the plans or established by the engineer.

606.2 Materials. All materials shall conform to Division 1000, Materials Details, and specifically as follows:

<table>
<thead>
<tr>
<th>Item</th>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>Guard Materials</td>
<td>1040</td>
</tr>
<tr>
<td>Chain-Link Fence</td>
<td>1043.2</td>
</tr>
</tbody>
</table>

Guard rail beams shall be galvanized steel unless specified otherwise in the contract. The contractor may select either zinc-coated, aluminum-coated, or vinyl coated steel fencing material, except that the same kind of material shall be used throughout the project.

606.3 Construction Requirements.

606.3.1 Guard rail shall be of the type specified and shall be placed at locations designated on the plans. All guard rail will be firmly attached to the steel posts by means of one or more steel blocks or mounting connectors or brackets. All steel posts, blocks, mounting connectors, mounting brackets, shims, backup plates, bolts, nuts, and accessories shall be hot dipped galvanized coated. Posts may be cut to length, where required, by sawing or flame cutting. Cut ends will be acceptable painted with zinc rich or zinc oxide paints. Bolts for use in guard rail will be button head 16 mm (5/8 in.) diameter with oval shoulder to prevent turning and will be of sufficient length to properly secure the rail to the post or block. Washers shall be used at all post connections, between the bolt head and rail, and shall conform in shape for a snug fit. Backup plates shall be used between rail and post at all non-splice posts, excluding Type C guard rail.

606.3.2 Beams, channels where required, posts, and appurtenances for guard rail shall not be field punched, reamed, or drilled except as may be approved by the engineer to provide for lapped beams, or for changes in location of splices necessitated by field clearances. The beams shall be spliced by lapping in the direction of traffic. The use of 7.6 m (25 ft.) sections of beam rails, and channels if required, will be permitted for terminal sections and bridge anchor sections, and elsewhere where true line and grade can be maintained. Beams for terminal sections may be either shop or field twisted and bent. Deformation shall be such that the beam will retain the required shape in a relaxed condition. Galvanized material shall be handled in a manner to avoid damage to the surfaces. Any galvanized material on which the spelter coating has been bruised or
broken will be rejected or may, with approval of the engineer, be repaired. Unless otherwise shown, rail beam will be maintained at a uniform height of 0.53 m (1 ft. 9 in.) above the surface, at the location installed, to the center of the rail.

606.3.3 Guard rail post will be driven or set in concrete, as necessary, and at the designated locations in a vertical position and true to the line and grade. Posts for Type A and D guard rail will be 1.83 m (6 ft.) in length, and for Type B will be 1.83 m (6 ft.) in length. When, due to obstructions, it is not possible to drive guard rail posts, the posts may be shortened and set in a concrete anchor 0.6 m (2 ft.) deep and 0.9 m (3 ft.) in diameter. If the post must be set in rock, a pocket must be produced in the rock a minimum of 0.6 m (2 ft.) deep and a minimum of 51 mm (2 in.) larger than the largest diagonal dimension of the shortened post section. This pocket will be filled with concrete. In both cases concrete will meet the requirements of Class B concrete and will be finished to an elevation a minimum of 152 mm (6 in.) below top of ground elevation. Where posts will be surrounded by concrete surfacing at a later date, a 125 by 200 mm (5 by 8 in.) blockout must be employed. Mushrooming of the end of a driven guard rail post will be cause for rejection.

606.3.3.1 Unless a concrete traffic barrier is provided between the installed posts and the adjacent travel or auxiliary lane, and when that lane will be open to traffic during non-working hours, the contractor shall schedule guard rail installation or replacement to assure that guard rail beam is fully attached to all installed posts at the end of each workday.

606.3.4 The various types of guard rail are defined as follows:

Type A guard rail will consist of 12 gage rail beam mounted with blocks as necessary to steel posts centered at 1.9 m (6 ft. 3 in.) intervals including all necessary appurtenances.

Type B guard rail will consist of 12 gage rail beams mounted with blocks to both sides of the flanges of the steel posts centered at 1.9 m (6 ft. 3 in.) intervals, including all the necessary appurtenances.

Type D guard rail will consist of 12 gage rail beam mounted with blocks as necessary to steel posts centered at 3.81 m (12 ft. 6 in.) intervals, including all necessary appurtenances.

606.3.5 In addition to the above mentioned construction, appurtenant sections will be used with the various types of guard rail installation. An end section will be required at all rail beam termini on Type A guard rail. The end section will be 12 gage galvanized steel and will be included in the price of the Type A guard rail. A 12 gage galvanized buffer end section will be required at the rail beam termini on all Type B guard rail installations.

606.3.6 Terminal sections of guard rail will be placed at the locations shown on the plan or designated by the engineer. These terminal sections will be composed of a minimum of 7.6 m (25 ft.) of galvanized rail beam of the type specified, a minimum of three line posts and connectors driven to the height necessary to produce the required slope transition and a terminal post driven so that the bottom of the rail beam will contact the ground at the high side of transition slope, an end section at the termini, and such other hardware as may be required.
606.3.7 Bridge Anchor Sections are of two varieties depending on the type of attachment to the structure. The first connection is to a safety barrier curb on the bridge and the second connection is to a three beam rail on the bridge. Both varieties utilize a terminal connector of 10 gage galvanized steel equipped with slotted expansion connection holes to which two sections of the three beam rail, one set inside the other, is attached. The terminal connector is positively attached to the bridge by a five-bolt connection system composed of 22 mm (7/8 in.) diameter bolts. Holes in the superstructure elements for this connection will be 25 mm (1 in.) in diameter and will be produced by a prefabricated galvanized template unit or other approved forming method. Connections to existing concrete elements in the superstructure will be made by drilling, utilizing a 16 mm (5/8 in.) bearing plate and connector plate system securely attached to prevent spalling of the backface of the element.

606.4 Method of Measurement.

606.4.1 Measurement of guard rail will be made to the nearest 0.25 m (nearest 0.5 linear ft.) for each increment along a line passing through the centerline of each post, and totaled to the nearest 0.5 linear meter (nearest linear ft.) for the sum of the increments on the project. The length will be measured separately for each type from the center of the end post to the center of end post, excluding bridge anchor sections and terminal sections. This item will include all rail beams, posts, brackets, connectors, and other necessary appurtenances.

606.4.1.1. No measurement will be made for rock removal in post holes and additional material required or time required to span obstructions or utilities. Special appliances or brackets needed will not be a basis for claim for additional compensation.

606.4.2 Terminal sections complete in place will be measured per each in accordance with Sec. 606.4.1.1.

606.4.3 Bridge Anchor Sections complete in place will be measured per each in accordance with Sec. 606.4.1.1.

606.5 Basis of Payment. The accepted quantities of guard rail, terminal sections, and bridge anchor sections, complete in place, will be paid for at the unit bid price for each of the pay items included in the contract. No direct payment will be made for end sections and buffer ends. No direct payment will be made for fabricating radius steel rail beams, nor for additional labor or materials required for installation.

606.20 Guard Cable and Guard Fence.

606.20.1 Guard cable shall be erected at the location shown on the plan or designated by the engineer. Guard cable shall consist of expansion or screw anchors, steel line posts, turnbuckles, clamps and cable required to complete the installation. All posts, cable, anchors, and hardware shall be hot dipped galvanized coated.

606.20.2 Unless otherwise indicated, the standard guard cable installation will consist of
75 mm x 8.5 kg/in (3 in x 5.7 lb./ft.) steel posts, 1.52 m (5 ft.) in length with 0.61 m (2 ft.) of the post exposed above the finished grade. Posts will be placed on 3.81 m (12 ft. 6 in.) centers either driven or set in concrete, in accordance with the provisions of Sec. 606.3.3, and will be plumb and true to line and grade. The anchoring device will be of a screw type or expandable type on a 25 mm (1 in.) diameter rod equipped with a standard turnbuckle threaded to provide for post tensioning and plumbing of the end posts. The anchor shall be set to the depth shown on the plans and at each end of cable installations of 90 m (300 ft.) or less. Where cable installations will exceed 90 m (300 ft.) intermediate anchors will be required. The anchor will be secured to the end post or intermediate post with flat washer and hex nut. The cable will be 13 mm (1/2 in.) in diameter and shall be strung directly from the reel and shall be pulled tight after the initial anchoring. The cable shall then be attached to the second anchor assembly with all turnbuckles fully opened. The cables shall be completely anchored before being attached to the line posts. The cable will be anchored to the end or intermediate post by means of a standard, 25 mm (1 in.) diameter turnbuckle secured by flat washer and hex nut. The cable shall be passed through a thimble and attached to the turnbuckle eye by means of a minimum of three cable clamps, securely attached. The cable shall be secured to the line posts by means of a 32 mm (1 1/4 in.) clamp bolted to each post. One line splice will be permitted between anchors and must be made between line posts only. No splice will be permitted in spans adjacent to an anchor or cable end. Cable line splices will be made by using a minimum of three cable clamps spaced at 200 mm (8 in.) intervals.

606.20.2.1 Unless a concrete traffic barrier is provided between the installed posts and the adjacent travel or auxiliary lane, and when that lane will be open to traffic during non-working hours, the contractor shall schedule guard cable installation or replacement to assure that guard cable is fully attached to all installed posts at the end of each work day.

606.20.3 Method of Measurement. Guard cable complete in place will be measured per meter (per linear ft.) from center of end post to center of end post and will include all items necessary to complete the installation.

606.20.4 Basis of Payment. The accepted quantity of guard cable will be paid at the contract unit bid price.

606.20.4.1 Rock encountered while placing posts or anchors will not be paid for, as stipulated in Sec. 606.4.1.1.

606.20.10 Guard fence will be constructed at the locations shown on the plans or as established by the engineer. Guard fence will consist of a standard chain link fence mounted to posts that are an integral part of a guard cable system. The guard cable system shall consist of an anchor assembly as described in Sec. 606.20.2 or as shown on the plans. When mounted atop a retaining wall, the anchors will be cast into the wall stem. The anchor shall be connected to the cable by means of a 25 mm (1 in.) turnbuckle. Each cable shall have its own anchor and shall be attached to all posts by means of a U-bolt clamp. The fence fabric shall be positively attached to a stretcher bar incorporated into the end posts. Line post connections to fence will be as provided in Sec. 607. A 25 mm (1 in.) diameter intermediate turnbuckle will be incorporated into the cable to maintain tension in the cable span between end posts. This intermediate turnbuckle will be
attached to each of the 19 mm (3/4 in.) diameter cables positioned on either side of the line posts and at a height of 0.76 m (2 ft. 6 in.) above the finish grade. A single uninterrupted 19 mm (3/4 in.) diameter cable shall be secured to all posts at a height of 225 mm (9 in.) above the finish grade, and a tension wire (9 gage) will be attached to the top of the fence for support. Unless otherwise shown on the plans, the fence fabric will be 9 gage galvanized, knuckled top and bottom, and the posts will be 51 mm x 57 mm (2 in. x 2 1/4 in.) H section post weighing 6.1 kg/m (4.10 lbs./ft.) mounted on a base plate for retaining walls.

606.20.11 Method of Measurement. Guard fence complete in place will be measured to the nearest meter (nearest linear ft.) from the center of end post to the center of end post and will include all items necessary to complete the installation.

606.20.12 Basis of Payment. The accepted quantity of guard fence will be paid at the contract unit bid price.
SECTION 607
FENCING

SECTION 607.10 CHAIN-LINK FENCE

607.11 Description. This work shall consist of furnishing and erecting chain-link fence and gates, complete in place, in conformity with the lines shown on the plans, or as established by the engineer.

607.12 Materials. All materials shall conform to Division 1000, Materials Details, and specifically as follows:

<table>
<thead>
<tr>
<th>Item</th>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chain-Link Fence</td>
<td>1043.2</td>
</tr>
<tr>
<td>Pipe Handrails</td>
<td>1043.4</td>
</tr>
<tr>
<td>Wrought Iron Handrails</td>
<td>1043.5</td>
</tr>
</tbody>
</table>

The contract will specify either zinc-coated steel, aluminum-coated steel, aluminum alloy, or vinyl coated steel fencing material, except that the same kind of material shall be used throughout the project. Walk gates and drive gates, if required, shall be of the same kind of material as that selected for the fence.

607.13 Construction Requirements.

607.13.1 The contractor shall fill, cut, or trench where necessary to produce a smooth and uniform ground surface so the bottom of the fabric is not more than 75 mm (3 in.) above the finished ground line. Posts shall be set plumb, true to line and grade in concrete footings, and shall be located as shown on the plans or as directed by the engineer. Footings shall be of Class B concrete, concrete of a commercial mixture, or quick setting polyurethane foam. The concrete shall be of a uniform thickness around the post, and the footings shall have cone or dome shaped tops. The contractor may, at his option, use a quick setting polyurethane foam in accordance with Sec. 607.23.3 for line posts in lieu of concrete. The contractor may, at his option, drive line posts in lieu of setting in concrete or polyurethane. If the contractor elects to drive line posts, they shall be of the length and driven to the depth shown on the plans. If posts cannot be driven to depths indicated because of rocky soils or other conditions, they shall be removed and placed in footings. Post tops shall be protected against damage and all posts damaged during installation shall be removed and replaced.

607.13.2 Fabric shall not be attached to posts until the concrete in the footings is at least 5 days old, and shall be attached to the posts on the side indicated on the plans. Fabric shall be securely attached to end, corner, gate, and pull posts in accordance with manufacturer’s recommendations. It shall be attached to top rails and line posts with wire ties or bands, and spaced in accordance with manufacturer’s recommendations. All fabric shall be taut before it is
attached to line posts or top rails. Top rails shall be continuous from terminal post to terminal post, connected with self centering couplings, every fifth one of which in any continuous length shall be a slip coupling.

607.13.3 Walk gates and drive gates complete with hinges, latches, braces, stops, and locking devices shall be installed at locations shown on the plans. Drive gates shall have an approximate 180° opening swing. Walk gates shall have positive stops to prevent the gates from swinging into the right-of-way.

607.14 Method of Measurement. Measurement of chain-link fence will be made to the nearest meter (nearest linear ft.) measured along the slope of the fabric but shall not include gates. Gates will be paid at contract unit price per each.

607.15 Basis of Payment. The accepted quantity of chain-link fence, complete in place, will be paid for at the unit bid price for each of the pay items included in the contract. No direct payment will be made for concrete footings or for post hole excavation or for excavation and embankment necessary to smooth the area under the fence.

SECTION 607.20 WOVEN WIRE FENCE

607.21 Description. This work shall consist of furnishing and erecting woven wire fence, complete in place, in conformity with the plans, and at locations as designated on the plans or established by the engineer.

607.22 Materials. All materials shall conform to Division 1000, Materials Details, and specifically as follows:

<table>
<thead>
<tr>
<th>Item</th>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>Woven Wire Fence</td>
<td>1043.3</td>
</tr>
</tbody>
</table>

607.23 Construction Requirements.

607.23.1 Wood corner, end, brace, and pull posts shall be set in drilled or dug holes. At the option of the contractor, steel or wood line posts may be set in drilled or dug holes, or may be driven into place provided the method of driving meets the approval of the engineer and does not damage the post. All wood posts set in drilled or dug holes shall have the butt end down, and shall be backfilled with suitable material thoroughly tamped. Wood line posts that are to be driven shall have the butt end machine pointed at the plant before being treated.

607.23.2 If surfaces of treated wood posts have been damaged, or if framing at the site is required, such injuries or cuts shall be field treated with two liberal brush coats of commercially available preservative of the same type used for the original treatment. The second coat shall be applied after the first coat is absorbed.

607.23.3 Posts shall be set plumb, true to line and grade. Corner post assemblies shall be set at all horizontal angle points greater than 15 degrees in the line of fence. Pull post assemblies
shall be set at all vertical angle points greater than 15 degrees but at not greater than 201 m (660 ft.) intervals. Footings for steel posts and braces shall be of Class B concrete, concrete of a commercial mixture, or, at the contractor’s option, quick setting polyurethane foam for footings. The foam shall have a minimum compressive strength of 550 kPa (80 psi) in the direction of rise, when tested in accordance with ASTM D 1621 and shall have a minimum density of 64 kg/m$^3$ (4 lb./cu. ft.) when tested in accordance with ASTM D 1622-63. The foam shall not be placed in water. Polyurethane foam, when used, shall be per manufacturer’s instructions.

607.23.4 Fabric and barbed wire shall be pulled taut by approved hand powered mechanical means before they are attached to any line post. The bottom of the fabric shall be not more than 75 mm (3 in.) above the ground at any point, and necessary excavation along the fence shall be performed to obtain the specified clearance. Filling of depressions will not be permitted except where old channels are backfilled after drainage has been relocated. Any space left by depressions shall be filled by spacing strands of barbed wire as indicated on the plans.

607.23.5 Walk gates and drive gates complete with hinges, latches, braces, stops, and locking devices shall be installed at locations shown on the plans. They shall be constructed in accordance with the requirements of gates for chain-link fence, except the filler shall be woven wire fabric of the same kind as used for the fence. Direction of swing of gates shall be as indicated on the plans or as directed by the engineer.

607.23.6 Water gates shall be installed at locations shown on the plans and the contractor shall modify the typical installation to fit the conditions encountered.

607.24 Method of Measurement. Measurement of woven wire fence will be made to the nearest meter (nearest linear ft.) measured along the slope of the fabric, but shall not include gates. Gates will be paid at contract unit bid price per each.

607.25 Basis of Payment.

607.25.1 The accepted quantity of woven wire fence, complete in place, will be paid for at the contract unit bid price per meter (per linear ft.) which will include all materials, excavating for posts, backfilling, clearing of fence row, trenching for fabric, placing extra strands of barbed wire for depressions, and all other incidental work or material.

607.25.2 The accepted walk gates and drive gates, complete in place, will be paid for at the unit bid price for each of the pay items included in the contract.

607.25.3 No direct payment will be made for construction or installation of water gates.

SECTION 607.30 HANDRAILS.

607.31 Description. This work shall consist of furnishing and erecting galvanized pipe handrails and wrought iron handrails, complete in place, in conformity with the plans and at locations as established on the plans or designated by the engineer.
607.32 **Materials.** Pipe shall be galvanized pipe of sizes as detailed. Wrought iron railing shall be constructed of bar sections as detailed.

607.33 **Construction Requirements.** When anchor bolts are required for handrail posts, they will be poured in place using a template provided by the engineer; at contractor’s option, holes for rail post may be formed or drilled. Rails shall be installed as detailed using aluminum oxide mortar grout meeting the requirements of Sec. 1066.1.4. A commercial expansive grout will be permitted with prior approval of the engineer.

607.34 **Method of Measurement.** Measurement of handrails will be made to the nearest meter (nearest linear ft.) measured along the slope of the rail.

607.35 **Basis of Payment.** The accepted handrail, complete in place, will be paid for at the contract unit bid price per meter (per linear ft.) which will include all rail, grout, labor, and all other incidental work or material.
SECTION 608
CONCRETE MEDIAN, MEDIAN STRIP, SIDEWALK, STEPS, AND PAVED APPROACHES

608.1 Description. This work shall consist of constructing concrete medians, median strips, sidewalks, steps, and paved approaches in conformity with the lines, grades, dimensions, and typical sections indicated on the plans, or as directed by the engineer. Concrete median shall consist of a paved median constructed on a prepared subgrade. Concrete median strip shall consist of a paved median strip laid over and dowelled to a previously constructed pavement.

608.2 Materials. All materials shall conform to Division 1000, Materials Details, and specifically as follows:

<table>
<thead>
<tr>
<th>Item</th>
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</thead>
<tbody>
<tr>
<td>Reinforcing Steel for Concrete Structures</td>
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</tr>
<tr>
<td>Steel Wire Fabric for Concrete Pavement</td>
<td>1036.2</td>
</tr>
<tr>
<td>Materials for Joints</td>
<td>1057.1</td>
</tr>
</tbody>
</table>

608.2.1 Concrete sidewalks and steps shall be constructed of Class B or pavement concrete. All other items shall be constructed of concrete using crushed limestone coarse aggregate and shall be either Class B concrete or pavement concrete. Materials, proportioning, air-entrainment, mixing, slump, and transporting of portland cement concrete shall be in accordance with Sec. 501. Concrete shall be placed, finished, and cured in accordance with the applicable provisions of Sec. 502 and 703. Pipe handrails indicated at step locations shall be constructed of 50 mm (2 in.) galvanized schedule 40 pipe and anchored as indicated.

608.3 Construction Requirements.

608.3.1 All items shall be constructed on a subgrade compacted to the required density of the applicable subgrade material. The subgrade shall be checked by means of a template prior to placing concrete. Large rocks and boulders found in the subgrade shall be removed to a minimum of 150 mm (6 in.) below the proposed concrete, and the space shall be refilled with suitable materials. Forms shall be metal or sound, dressed lumber, straight, free from warp, of sufficient strength to resist springing during construction, and of a height equal to the full depth of the item to be constructed. Wood forms shall have a minimum nominal thickness of 50 mm (2 in.) except where flexible forms are used. Flexible metal forms or wood forms having a nominal thickness of 25 mm (1 in.) will be required for all curved form lines, except that straight steel form sections 3 m (10 ft.) or less in length may be used for form lines having a radius greater than 60 m (200 ft.). Straight steel form sections 1.5 m (5 ft.) in length will be acceptable for form lines having a radius of not less than 30 m (100 ft.). The forms shall be thoroughly cleaned, well oiled securely staked, braced, and held to the required line and grade.
608.3.2 Required reinforcement and tie bars shall be held in the designated position by bar chairs or other approved devices during the placing of concrete.

608.3.3 Concrete median strip shall be doweled to the pavement with tie bars as shown on the plans. When the median strip is to be built on pavement constructed on a previous project or on pavement that has been used by traffic before the median strip is placed, the contractor shall drill 25 mm (1 in.) diameter holes, 150 mm (6 in.) deep on 0.6 m (24 in.) centers using 250 mm (10 in.), No. M15 (No. 5) dowels grouted in place 24 hours in advance of placing concrete. Where the median strip is included with the paving contract and will be constructed before the pavement is opened to traffic, the contractor may insert the tie bars into the pavement immediately after it has been finished or may preform the holes and grout in the tie bars when the median strip is constructed. The holes shall be thoroughly cleaned just before the tie bars are grouted in place.

608.3.4 Joints for all items shall be constructed at such intervals and locations as shown on the plans or as directed by the engineer.

608.3.4.1 Transverse joint for concrete median shall be sawed joints of the same dimensions as required for concrete pavement spaced approximately the same as transverse joints in non-reinforced concrete pavement. Load transfer devices will not be required. Longitudinal joints between the median and curb shall be constructed of 13 mm (1/2 in.) non-extruding preformed joint material. Sawed joints shall be sealed in accordance with Sec. 502.11.4.

608.3.4.2 Transverse joints in concrete median strip shall be constructed of 13 mm (1/2 in.) non-extruding preformed joint material extending from top to bottom. Joints shall be constructed over each joint and major crack in the pavement, but at not less than 3 m (10 ft.) intervals.

608.3.4.3 Transverse joints for concrete sidewalks shall be 13 mm (1/2 in.) deep dummy joints made with a finishing tool. Preformed fiber joints shall be at 6 m (20 ft.) intervals. Regardless of other details and notes shown on the plan, a mastic joint will be required in all new sidewalk construction at the right-of-way line. Other plans and specification requirements regarding joint placement may be varied as directed.

608.3.5 Concrete shall be placed on the prepared and sprinkled subgrade and shall be compacted and struck off to the required thickness. Mechanical compacting and finishing equipment may be used provided satisfactory results are obtained. The concrete shall be tamped or vibrated sufficiently to eliminate all voids and to bring the mortar to the top after which the surface shall be uniformly finished. All edges shall be rounded with an edging tool having a 6 mm (1/4 in.) radius. After free water has left the surface, a hand broom finish will be applied. After finishing, the concrete shall be cured in the same manner as required for concrete pavement except that transparent membrane shall be used in lieu of pigmented membrane.

608.3.6 Where the plans indicate concrete construction to be tinted, it shall be done in accordance with the requirements of Sec. 501.11.
608.3.7 After the concrete has sufficiently set, the forms shall be removed and where necessary, the area adjacent to the concrete shall be backfilled with suitable material, compacted and finished in a satisfactory manner.

608.3.8 During cold weather, the limitations and protection requirements of Sec. 502.4 and 502.4.1 shall apply to this work.

608.4.1 Measurement of concrete median and median strip will be made to the nearest 0.10 m² (1/10 sq. yd.) or to the nearest meter (linear ft.) as indicated in the contract. Final measurement of the completed concrete median and median strip will not be made except for authorized changes during construction, or where appreciable errors are found in the contract quantity. The revision or correction will be computed and added to or deducted from the contract quantity.

608.4.2 Concrete sidewalk will be measured to the nearest 0.10 m² (1/10 sq. yd.). No additional payments will be made for constructing handicap ramps.

608.4.3 Paved approach will be measured from the beginning of the return on one side of the approach to the end of the return on the other side of the approach to the nearest 0.10 m² (nearest 1/10 sq. yd.). Integral curb constructed on paved approaches will not be measured and paid for separately, but will be included in the contract unit price for paved approaches. Final measurement of the completed paved approach will not be made except for authorized changes during construction or where appreciable errors are found in the contract quantity. The revision or correction will be computed and added to or deducted from the contract quantity.

608.4.4 All excavation and all work necessary in preparing the subgrade and backfilling will be paid for as one or more of the classifications of roadway excavation. Final measurement of excavation will not be made except as set out in Sec. 203.7.1.

608.5 Basis of Payment

608.5.1 The accepted quantity of concrete steps will be measured and paid for to the nearest 0.10 m² (1/10 sq. ft.) or as:

(a) Class B concrete that will be constructed in accordance with Sec. 703 for miscellaneous concrete and paid per cubic meter (cu. yd.).

(b) Reinforcing steel shall be constructed in accordance with Sec. 706 and paid per kg (lb.).

608.5.2 The accepted quantities of concrete median, median strip, sidewalk, and paved approach, complete in place, will be paid for at the unit bid price for each of the pay items included in the contract. No direct payment will be made for furnishing or installing reinforcement. No direct payment will be made for constructing joints in sidewalks.
608.6 Asphaltic Concrete Audio Median. The audio median shall be constructed of Type C (BP-1) asphaltic concrete as indicated on the plans. Serrations, as indicated, shall be formed with wood or metal forms while the asphaltic concrete is warm enough to be pliable. Payment for this work will be made at the unit bid price.
SECTION 609
PAVED DRAINAGE

SECTION 609.10 CONCRETE CURB, GUTTER AND PAVED DITCH.

609.11 Description. This work shall consist of constructing curb, gutter, or combination curb and gutter, and paved ditches in conformity with the lines, grades, dimensions, and typical sections indicated on the plans, or as directed by the engineer.

609.12 Materials. All materials shall conform to Division 1000, Materials Details, and specifically as follows:

<table>
<thead>
<tr>
<th>Item</th>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reinforcing Steel for Concrete Structures</td>
<td>1036.1</td>
</tr>
<tr>
<td>Materials for Joints</td>
<td>1057.1</td>
</tr>
</tbody>
</table>

Materials, proportioning, air-entraining, mixing, slump, and transporting of portland cement concrete shall be in accordance with Sec. 501. Concrete shall be Class B or pavement concrete and shall be placed, finished, and cured in accordance with the applicable provisions of Sec. 703. Concrete used for paved ditches and channels shall be MSD Class A and should be placed, finished, and cured in accordance with the applicable provisions of Sec. 703.

609.13 Construction Requirements.

609.13.1 These items shall be placed on a prepared subgrade of uniform density. Forms shall be metal or sound, dressed lumber, straight, free from warp, of sufficient strength to resist springing during construction, and of a height equal to the full depth of the item to be constructed. Wood forms shall have a minimum nominal thickness of 50 mm (2 in.) except where flexible forms are used. Flexible forms of metal or wood (with a nominal thickness of 25 mm (1 in.)) will be required for all curved form lines, except that straight steel form sections 3 m (10 ft.) or less in length may be used for form lines having a radius greater than 60 m (200 ft.). Straight steel form sections 1.5 m (5 ft.) in length will be acceptable for form lines having a radius of not less than 30 m (100 ft.). The forms shall be thoroughly cleaned, well oiled, securely staked, braced, and held to the required line and grade. Hangers used for face forms on curb must be entirely supported from the back form.

609.13.1.1 In lieu of the forming requirements specified in Sec. 609.13.1 slip form methods may be used for placement of concrete curb, concrete gutter, curb and gutter, and paved ditch providing proper lines, grades and typical sections are maintained. Paving requirements will be the same as Sec. 502.16.

609.13.2 Required reinforcement and tie bars shall be held in the designated position during the placing of concrete by bar chairs or other approved devices. For paved ditch and creek
channels, reinforcing steel will be firmly supported on full size concrete brick or block. No additional payment will be allowed for meeting this requirement. Joints shall be constructed at intervals and locations shown on the plans or as directed by the engineer. 13 mm (1/2 in.) expansion joints will be provided in curbs or curb and gutter sections at 6 m (20 ft.) centers or as otherwise indicated.

609.13.3 Concrete shall be placed on the prepared and sprinkled subgrade, compacted and struck off to the required thickness. Concrete shall be tamped or vibrated sufficiently to eliminate all voids and to bring mortar to the top, after which the surface shall be finished smooth and even. All edges shall be rounded with an edging tool having a 6 mm (1/4 in.) radius. Faces of curb shall be rounded at the top and bottom, by means of an approved tool, to the radius shown. The curb face forms will be stripped when the concrete is sufficiently set and the face of the curb will be rubbed using grout necessary to fill any voids and air bubbles. After the rubbing operation, a brush finish will be applied. After finishing, concrete shall be cured in the same manner as required for concrete pavement except that transparent membrane shall be used on paved ditch.

609.13.3.1 The finished curb shall be true to line, grade, and cross section, with the top and face finished smooth and brushed. The top edges of the curb shall be rounded with an approved edging tool. Curing shall be accomplished in the same manner as required for concrete pavement. At 18 m (60 ft.) intervals, joints of preformed material shall be placed through the curb to within 6 mm (1/4 in.) of the top and face of the curb. At all other joint locations, a matching saw joint will be allowed, provided that it is completely sawed through and sealed.

609.13.4 During cold weather, the limitations and protection requirements of Sec. 502.4 and 502.4.1 shall apply to this work.

609.13.5 Curb straightedged parallel to the centerline shall not show a variance greater than 13 mm (1/2 in.) from a 3 m (10 ft.) straightedge. Failure to comply with this provision will require complete removal and replacement of the affected area. No area less than 3 m (10 ft.) will remain in place.

609.14 Method of Measurement.

609.14.1 Curb, gutter, and combination curb and gutter will be measured to the nearest 0.5 m (nearest linear ft.) along the curb face or along the flowline of gutters. Unless otherwise specifically provided for in the contract, the quantities shown for combination curb and gutter have been carried across private and commercial concrete entrances and include the gutter pan shown in the Standard Drawings. However, if the gutter pan section is constructed monolithically with the paved approach, it will be added to the approach quantity for payment with a corresponding amount deducted from the curb, and curb transitions on paved approaches will not be measured nor paid for separately, but will be considered a part of the paved approach. Curbs carried full height on paved approaches will be measured and paid for under the applicable curb item. No deductions will be made for wheelchair ramps.

609.14.2 Paved ditches will be computed by measuring from the top of the exposed
surface on the slope to the bottom of exposed surface on the slope to the nearest 0.10 m² (nearest 1/10 sq. yd.).

609.15 Basis of Payment. The accepted quantities of curb, gutter, curb and gutter, and paved ditch, complete in place, will be paid for at the unit bid price for each of the pay items included in the contract. No direct payment will be made for excavation, nor for any work necessary for preparing the subgrade and backfilling the completed item. No direct payment will be made for furnishing or installing reinforcement, nor for excavating toewall.

SECTION 609.20 INTEGRAL CURB.

609.21 Description. This work shall consist of curb constructed on the edge of concrete pavement in conformity with the typical section shown on the plans.

609.22 Materials. All materials shall conform to Division 1000, Materials Details, and specifically as follows:

<table>
<thead>
<tr>
<th>Item</th>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>Material for Joints</td>
<td>1057.1</td>
</tr>
</tbody>
</table>

Integral curb shall be constructed of concrete conforming to that required for concrete pavement except that coarse aggregate of the classification required for pavement but conforming to the gradation requirements of Sec. 1005.1.5 may be used. The quantity of coarse aggregate in the mix may be reduced to obtain better workability.

609.23 Construction Requirements.

609.23.1 The curb is to be an integral part of the supporting concrete pavement and may be placed immediately after all slab finishing operations have taken place and before the slab has taken its initial set, or tie bars may be set in the freshly finished slab to serve ultimately as a tie between the slab and the curb, which may be constructed later. When necessary for paving equipment to be backed up near a construction joint, the relatively short distance will be drilled and curb dowels will be grouted 24 hours prior to placing curb. All curb will be constructed 150 mm (6 in.) in height unless otherwise specified.

609.23.2 Metal forms joined neatly and tightly, set accurately to alignment and grade, and securely held in place by connections and bracing shall be used for this work. Forms for curved form lines shall be provided in a manner similar to that required for concrete pavement in Sec. 502.3.3.1

609.23.2.1 In lieu of the forming requirements of Sec. 609.23.2 slip form methods may be used for placement of integral curb providing all other requirements of Sec. 609.23 are met.

609.23.3 The finished curb shall be true to line, grade, and cross section, with the top and face finished smooth and brushed. The top edges of the curb shall be rounded with approved edging tools. Curing shall be accomplished in the same manner as required for concrete
609.23.4 Where the tie bars are set in the freshly finished pavement surface, and membrane curing is used on the pavement, care shall be taken to avoid spraying the membrane on the protruding tie bars or the area on which the integral curb is to be placed. Another of the alternatives of Sec. 502.12 shall be used for curing this area of the pavement.

609.23.5 Integral curb straightedged parallel to the center line shall not show a variance greater than 13 mm (1/2 in.) from a 3 m (10 ft.) straightedge. Failure to comply with this provision will require complete removal and replacement of the affected area. No area less than 3 m (10 ft.) will remain in place.

609.24 Method of Measurement. Integral curb will be measured to the nearest 0.5 m (nearest linear ft.) along the curb face, exclusive of paved approaches. Final measurement of the completed integral curb will not be made except for authorized changes during construction, or where appreciable errors are found in the contract quantity. The revision or correction will be computed and added to or deducted from the contract quantity.

609.25 Basis of Payment. The accepted quantity of integral curb, complete in place, will be paid for at the unit bid price for each of the pay items included in the contract. Payment for curb constructed on paved approaches will be included in the unit bid price for paved approaches.

SECTION 609.30 Asphalt Curb

609.31 Description. This work shall consist of constructing a curb of asphaltic concrete in conformity with the lines, grades, and dimensions shown on the plans or established by the engineer. All applicable provisions of Sec. 405, Bituminous Pavements and Base, shall apply to this construction.

609.32 Materials. All materials shall conform to Division 1000, Materials Details, and specifically as follows:

<table>
<thead>
<tr>
<th>Item</th>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asphalt Cement (AC-20)</td>
<td>1015.5</td>
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<tr>
<td>Coarse Aggregate</td>
<td>1002.1</td>
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<tr>
<td>Fine Aggregate</td>
<td>1002.2</td>
</tr>
<tr>
<td>Mineral Filler</td>
<td>1002.3</td>
</tr>
</tbody>
</table>

609.33 Composition of Mixture. The asphaltic concrete mixture shall consist of aggregates, filler if needed, and asphalt cement combined in such proportions that the composition by weight of the finished mixture shall be within the limits specified for Type C (BP-1) or D mixture in accordance with Sec. 405.3.1. The contractor shall submit in writing, for approval, the job mix he proposes to use for asphalt curb. The Type C (BP-1) job mix approved for asphaltic concrete pavement shall not be used for asphalt curb.
609.33.1 An approved commercial mixture may be used as approved by the engineer. If the contractor elects to use such a mixture, he shall furnish the engineer, for approval, a statement setting out the source and the job mix formula of the mixture he proposes to furnish. If the proposed mixture and plant are approved by the engineer, the component materials and the mixture delivered will be accepted or rejected by visual inspection. The supplier shall furnish a certification in triplicate that the material and mixture are in conformance with the approved proposal.

609.34 Construction Requirements.

609.34.1 The curb shall be placed in position on a clean, tacked surface by means of an approved automatic curb machine that shapes and compacts the mixture to the designated cross section. The placement temperature of the mixture shall be approximately 1250°C (2600°F). Any required joints shall be carefully made in such manner as to insure a continuous bond between the old and new sections of the curb.

609.34.2 The newly laid curb shall be protected from traffic by barricades or other suitable methods until the heat of the asphalt mixture has dissipated. Immediately after the asphalt curb has hardened, it shall be backfilled where required with suitable material.

609.34.3 If painting of the asphalt curb is required by the contract, a light coat of commercial grade asphalt base aluminum paint shall be first applied.

609.35 Method of Measurement. Asphalt curb will be measured to the nearest linear 0.5 m (nearest linear ft.).

609.36 Basis of Payment. The accepted quantity of asphalt curb will be paid for at the contract unit bid price. No direct payment will be made for cleaning and priming prior to placing of the curb, nor for painting the completed curb.

SECTION 609.40 DRAIN BASIN

609.41 Description. This work shall consist of constructing a drain basin in conformity with the lines, grades, thicknesses, and typical sections shown on the plans or directed by the engineer.

609.42 Materials.

609.42.1 Drain basins shall be constructed of concrete or bituminous mixtures meeting the requirements of any one of the following specifications:

609.42.1.1 Bituminous. Bituminous mixtures used for construction of drain basins shall meet the requirements of one of the following specifications:
It

Section

Bituminous Pavements and Base (Type C (BP-1) or D or X)  405

609.42.1.1.1 The bituminous mixture shall consist of aggregates, filler if needed, and bitumen combined in such proportions that the composition by weight of the finished mixture shall be within the designated limits of the material selected for use, except that if asphalt cement is used the quantity of bitumen shall be increased approximately 2 percentage points above that required for the selected mixture.

609.42.1.1.2 The contractor shall submit in writing, for approval, the mixing formula he proposes to use. If a commercial mixture is proposed for use, the contractor shall furnish the engineer, for approval, a statement setting out the source and the job-mix formula. If the proposed mixture and plant are approved by the engineer, the component materials and the mixture delivered will be accepted or rejected by visual inspection.

609.42.1.2 Concrete. Concrete mixtures used for construction of drain basins will be Class B concrete.

609.43 Construction Requirements.

609.43.1 The excavating shall be done in such manner to permit the placement of the material to the proper section. The surface shall be primed or watered to the satisfaction of the engineer. The drain basin shall be formed on the surface to the shape shown on the plans and shall be firmly compacted in a neat workmanlike manner to insure a dense mixture, free from low points, and uniformly shaped to drain properly.

609.43.2 As soon as practicable, the drain basin shall be backfilled around the edges where required with suitable material, and the affected shoulder and slope areas finished to the satisfaction of the engineer.

609.44 Basis of Payment. The accepted drain basins will be paid for at the contract unit bid price per each. No direct payment will be made for excavating, priming, watering, nor backfilling, nor for the finishing of the affected shoulder or slope.

SECTION 609.60 DITCH LINER.

609.61 Description. This work shall consist of constructing ditch liner at the locations indicated on the plans, or as directed by the engineer.

609.62 Materials. All materials shall conform to Division 1000, Materials Details, and specifically as follows: Concrete shall be Class B meeting the requirements of Sec. 501. Air entrained concrete will be required. Direct placement of concrete by pumping equipment acceptable to the engineer will be permitted. To facilitate pumping, an increase in the percentage of fine aggregate will be allowed.
**609.63 Construction Requirements.**

**609.63.1** Ditch liners shall be constructed by placing concrete directly on the prepared subgrade.

**609.63.2** The ditch liner shall be placed on a subgrade of reasonably uniform density to the thickness shown on the plans.

**609.63.3** Forms will not be required. Concrete shall be consolidated and struck off to the required thickness and shape.

**609.63.4** Weather limitations and protection requirements of Sec. 502.4 and Sec. 502.4.1 shall apply to the placing of concrete and grout.

**609.63.5** Concrete shall be cured in the same manner as required for concrete pavement except that transparent membrane may be used in lieu of pigmented membrane.

**609.63.6** After the concrete has sufficiently set the contractor shall, where necessary, backfill adjacent to the ditch liner with suitable material, compacted and finished in a satisfactory manner.

**609.64 Method of Measurement.** Ditch liner will be measured to the nearest square meter (nearest sq. yd.) of surface.

**609.65 Basis of Payment.** The accepted quantity of ditch liner, complete in place, will be paid for at the contract unit bid price. No direct payment will be made for excavation below the upper surface of the ditch liner, nor for any work necessary for preparing the subgrade and backfilling the completed item.

**SECTION 609.70 ROCK LINING.**

**609.71 Description.** This work shall consist of constructing rock lining at the locations indicated on the plans or as directed by the engineer.

**609.72 Materials.** The materials for rock lining shall meet the requirements of Sec. 611.30 for Type 2 rock blanket.

**609.73 Construction Requirements.** The rock lining material shall be placed by dumping, and shall be left in a rough condition to the approximate shape of the channel flow line.

**609.74 Method of Measurement.** Measurement will be made to the nearest cubic meter (cubic yard) of material in place in the completed rock lining. Final measurement of the completed rock lining will not be made except for authorized changes during construction, or where appreciable errors are found in contract quantity. The revision or correction will be computed and added to or deducted from the contract quantity.
609.75 Basis of Payment. The accepted quantity of rock lining in place will be paid for at the contract unit price. No direct payment will be made for any excavation required to place the rock lining.
SECTION 611
EMBANKMENT PROTECTION

SECTION 611.10 ROCK FILL.

611.11 Description. This work shall consist of constructing fill of rock or broken concrete for protection of embankment.

611.12 Materials. The material for rock fill shall be durable stone or broken concrete containing a combined total of not more than 10 percent of earth, sand, shale, and non-durable rock. It is intended that the material be similar to quarry-run stone graded from coarse to fine with a minimum of voids. The coarse stone shall be as large as can be conveniently handled, but at least 25 percent of the weight shall be of pieces having a volume of 0.03 m$^3$ (1 cu. ft.) or more. Acceptance of quality and size of material will be made by visual inspection at the job site.

611.13 Construction Requirements. Successive horizontal layers of stone or broken concrete not exceeding 600 mm (24 in.) in thickness shall be spread over the area of the rock fill. The larger pieces shall be well distributed and the interstices filled with smaller pieces. Each layer shall be spread in accordance with the methods specified in Sec. 203.2.18. Where rock fill is placed as a portion of embankment with controlled density, the material shall be compacted in accordance with the requirements of Sec. 203.3.5. The fill shall conform to the elevations and dimensions shown on the plans, and the slopes shall present a dense, finished appearance free from segregation and with a proportionate amount of the large pieces showing. Rock fill shall be underlain with an approved geotextile fabric if directed by the Engineer.

611.14 Method of Measurement. Measurement will be made to the nearest cubic meter (nearest cu. yd.) of material in place in the completed fill.

611.15 Basis of Payment.

611.15.1 Payment for furnishing and placing rock fill will be made at the contract unit bid price per cubic meter (per cu. yd.).

SECTION 611.20 FULLY GROUTED ROCK FILL.

611.21 Description. This work shall consist of furnishing and constructing a fully grouted rock fill as shown on the plans or as directed by the engineer.

611.22 Materials.

611.22.1 All materials shall conform to Division 1000, Materials Details, and specifically as follows:
611.22.2 The stone or broken concrete for rock fill shall meet the requirements of Sec. 611.12.

611.22.3 Grout shall consist of one part portland cement and five parts of aggregate by volume. The aggregate shall be a mixture of clean sand and gravel, or of crushed stone and sand, or of chat and sand, all of approved quality. The mixture shall be uniformly graded from coarse to fine and meet the following gradation requirements.

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Percent Passing</th>
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<tbody>
<tr>
<td>19 mm (3/4 in.)</td>
<td>100</td>
</tr>
<tr>
<td>4.75 mm (No. 4)</td>
<td>40 to 60</td>
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611.22.4 Finer aggregate may be used provided the ratio of cement to the material passing the 4.75 mm (No. 4) sieve is not greater than one to three by volume.

611.23 Construction Requirements.

611.23.1 The rock and grout shall be placed in a manner resulting in a securely bound solid mass with the interstices completely filled. The grout shall have a consistency permitting it to flow readily into the voids. After the interstices have been completely filled with grout, the surface shall be swept clean of all surplus grout with a stiff broom and cured by any one of the methods specified for concrete pavement in Sec. 502.12, except that transparent membrane shall be used in lieu of pigmented membrane.

611.23.2 During cold weather, the limitations and the protection requirements of Sec. 502.4 and 502.4.1 shall apply to the grouting.

611.24 Method of Measurement. Measurement of fully grouted rock fill will be made to the nearest 0.5 m$^3$ (nearest 1/2 cu. yd.) complete in place.

611.25 Basis of Payment. The accepted quantity of fully grouted rock fill will be paid for at the contract unit bid price. No direct payment will be made for furnishing or placing the rock fill.

SECTION 611.30 ROCK BLANKET.

611.31 Description. This work shall consist of constructing a protecting blanket of rock or broken concrete on slopes or stream banks.

611.32 Materials. The material for rock blanket shall be durable stone or broken concrete containing a combined total of not more than 10 percent of earth, sand, shale, and non-durable rock. It is preferable that the material contains a large percentage of pieces as large as the
thickness of the blanket will permit, with enough smaller pieces of various sizes to fill the larger voids. For Type 1 Rock Blanket, at least 40 percent of the mass shall be of pieces having a volume of 0.03 m³ (1 cu. ft.) or more. For Type 2 Rock Blanket, at least 60 percent of the mass shall be of pieces having a volume of 0.03 m³ (1 cu. ft.) or more. Acceptance of quality and size of material will be made by visual inspection at the job site. Rock blanket shall be underlain with an approved geotextile fabric unless otherwise directed by the Engineer.

611.33 Method of Measurement. Measurement will be made to the nearest cubic meter (nearest cubic yard) of material in place in the completed blanket.

611.34 Basis of Payment.

611.34.1 Payment for furnishing and placing rock blanket will be made at the contract unit bid price per cubic meter (per cubic yard). No direct payment will be made for excavating the trench nor for backfilling the toe wall and cutoff walls, when required as specified in Sec. 611.53.2.

SECTION 611.40 GROUTED ROCK SURFACE.

611.41 Description. This work shall consist of surface grouting rock fill or rock blanket as shown on the plans or as directed by the engineer.

611.42 Materials. Grout shall meet the requirements of Sec. 611.22.3 and have a consistency thin enough to permit thorough penetration of the grout into the joints and voids between the stones.

611.43 Construction Requirements.

611.43.1 After completion of the rock fill or rock blanket in accordance with Sec. 611.10 or Sec. 611.30, whichever is applicable, the surface shall be grouted at the rate which will fill all voids and secure stone in a stable mass. The surface shall be swept clean of surplus grout with a stiff broom, using the major portion of the grout to fill the voids between stones. The grout shall be cured by any of the methods specified for concrete pavement in Sec. 502.12, except that transparent membrane shall be used in lieu of pigmented membrane.

611.43.2 During cold weather, the limitations and protection requirements of Sec. 502.4 and 502.4.1 shall apply to the grouting.

611.44 Method of Measurement. Measurement will be made to the nearest square meter (nearest sq. yd.) of grouted surface completed.

611.45 Basis of Payment. The accepted quantity of grouted rock surface will be paid for at the contract unit bid price.
SECTION 611.50 REVETMENT.

611.51 Description. This work shall consist of slope or bank protection and drainage ditches constructed at locations shown on the plans or as directed by the engineer, and shall be of the type or types included in the contract.

611.52 Materials. Acceptance of quality and size of material will be made by visual inspection at the job site.

611.52.1 Stone for light stone revetment shall be sound, durable, and free from cracks and other structural defects that would cause it to deteriorate. It shall not contain any soapstone, shale, or other material easily disintegrated. The stone shall be in blocks at least 175 mm (7 in.) in thickness perpendicular to the slope and have approximately rectangular faces 175 mm (7 in.) or more in width. All blocks shall weigh not less than 11 kg (25 lb.), and at least 75 percent shall weigh not less than 23 kg (50 lb.).

611.52.2 The stone for heavy stone revetment shall conform to the requirements of Sec. 611.52.1, except that the blocks shall be at least 300 mm (12 in.) in thickness perpendicular to the slope and all blocks shall weigh not less than 23 kg (50 lb.) and at least 60 percent shall weigh not less than 46 kg (100 lb.).

611.52.3 Broken Concrete. When other work included in the contract requires quantities of broken concrete, the contractors may use such material as blocks for revetment, provided minimum size and weight requirements for stone are maintained.

611.52.4 Grout. Grout for grouted revetment shall be composed of one part portland cement and three parts approved clean sand, by volume, and shall have a consistency which will permit it to flow readily into the joints. Grout shall be used within 60 minutes after the water has been added.

611.53 Construction Requirements.

611.53.1 Unless otherwise approved, the slopes upon which revetment is to be placed shall conform to the section shown on the plans. The slopes shall be compacted to a uniform density as required for adjacent material and lined with an approved geotextile fabric. The revetment shall be started in a trench below the toe of the slope shown on the plans and shall progress upward. Each stone or broken concrete block shall be laid perpendicular to the slope, shall be firmly bedded against the slope and against adjoining stones or broken concrete, and shall be laid with well broken joints. After revetment has been placed, the voids shall be filled with spalls or small stone in such a manner that all revetment stones or broken concrete are tightly wedged. The finished surface shall present a uniform appearance true to line, grade, and section.

611.53.2 When designated in the contract, revetment shall be surface grouted. Grout shall be applied in such a manner as to insure filling all joints and crevices and shall be cured by any of the methods specified for concrete pavement, except that transparent membrane shall be used in lieu of pigmented membrane. Cut-off wall required around revetment: regardless of the details
shown on plans, a 0.6 m (2 ft.) deep cut-off wall, measured from the bottom of the revetment, will be required around the entire perimeter of the revetment blanket except where it abuts headwalls, flared end sections, or inlet sills. No direct payment will be made for construction of the cut-off wall.

611.53.3 During cold weather, the limitations and protection requirements of Sec. 502.4 and 502.4.1 shall apply to the grout and concrete.

611.54 Method of Measurement. Measurement will be made to the nearest square meter (nearest sq. yd.).

611.55 Basis of Payment. The accepted quantity of revetment will be paid for at the unit bid price for each of the pay items included in the contract. No direct payment will be made for excavating the trench nor for any backfilling required.

SECTION 611.60 CONCRETE SLOPE PROTECTION.

611.61 Description. This work shall consist of constructing a concrete slope protection by depositing concrete on the finished earth slope, in conformity with the lines and grades shown on the plans.

611.62 Materials. Slope protection shall be of Class B concrete with materials, proportioning, mixing, slump, and transporting of concrete conforming to Sec. 501. Concrete shall be placed, finished, and cured in accordance with the applicable provisions of Sec. 703.

611.63 Construction Requirements.

611.63.1 Concrete slope protection shall be 200 mm (8 in.) in thickness and reinforced with No. 15 (No. 4) reinforcing steel on 300 mm (12 in.) centers each direction unless specified otherwise in the contract. The concrete shall be placed on a prepared compacted subgrade of uniform density, and shall be consolidated and struck off to the required thickness. Joints shall be the full depth of the concrete and shall consist of 13 mm (1/2 in.) material conforming to Sec. 1057.1.5. Joint spacing will be in accordance with Standard Drawings.

611.63.2 The surface of the paved slope shall have a broom or burlap drag finish and shall be cured in the same manner as required for concrete pavement, except that transparent membrane shall be used in lieu of pigmented membrane.

611.63.3 During cold weather, the limitations and protection requirements of Sec. 502.4 and 502.4.1 shall apply to this work.

611.64 Method of Measurement. Measurement will be made to the nearest 0.10 m² (nearest 1/10 sq. yd.). Final measurement of the completed slope protection will not be made except for authorized changes during construction or when appreciable errors are found in contract quantity. The revision or correction will be computed and added to or deducted from the contract quantity.
611.65 **Basis of Payment.** The accepted quantity of concrete slope protection will be paid for at the contract unit bid price. No direct payment will be made for any excavating or for other work necessary in preparing the subgrade or for any backfilling required.

**SECTION 611.70 GABIONS.**

611.71 **Description.** This work shall consist of furnishing, filling with stones, and placing on a constructed base, open mesh wire mattresses in accordance with the lines, grades, and dimensions shown on the plans or as established by the engineer during construction.

611.72 **Materials.** The gabion baskets shall be constructed of hexagonal triple twist mesh with heavily galvanized steel wire.

611.72.1 Steel wire used in gabion construction shall be heavily galvanized with a zinc coating exceeding federal specification requirements (QQ-W-461g, Class 3). The mesh wire diameter for the galvanized gabions shall not be less than 3 mm (0.1181 in.), approximately U.S. Gage No. 11. The mesh edge wire and selvedge wire shall not be less than 3.9 mm (0.1535 in.), approximately U.S. Gage No. 9. The lacing steel wire for binding gabion units together shall not be less than 2.2 mm (0.0866 in.), approximately U.S. Gage No. 13 1/2.

611.72.2 The mesh steel wire diameter for PVC coated gabions shall not be less than 2.7 mm (0.1063 in.), approximately U.S. Gage No. 12. The mesh edge wire and selvedge wire shall not be less than 3.4 mm (0.1338 in.) approximately U.S. Gage No. 10. The lacing wire shall not be less than 2.2 mm (0.0866 in.), approximately U.S. Gage No. 13 1/2. The PVC coating shall not be less than 0.4 mm (0.015 in.). Care shall be exercised during installation to avoid damage to the PVC coating.

611.72.3 Where the length of the gabion exceeds 1.25 m (4 ft.) the gabion shall be divided by diaphragms, of the same length mesh and gage as the body of the gabions, into cells of equal length and width. The gabion shall be furnished with the necessary diaphragms secured in proper position on the base in such a manner that no additional tying at this juncture will be necessary.

611.72.4 Concrete for the construction of the base pad, if required, shall consist of Class B concrete or concrete of a commercial mixture meeting the requirements of Sec. 501. Clean stone for base construction as required shall be hard and durable of the same size required in the gabion baskets.

611.72.5 Filter fabric shall be a woven polypropylene material meeting the following strength requirements:

- a) Minimum Burst Strength.......................... 3380 kPa (490 psi)
- b) Minimum Trapezoidal Tear Strength............. 440 N x 240 N (100# x 55#)
- c) Minimum Puncture Strength......................... 575 N (130#)
611.72.6 Gabion rock shall be 250 mm (10 in.) maximum size (95% to 100%) passing a 250 mm (10 in.) screen), and a 100 mm (4 in.) minimum size.

611.73 Mesh Dimensions. The maximum linear dimension of the mesh opening shall not exceed 115 mm (4 1/2 in.) and the area of the mesh opening shall not exceed 5200 mm$^2$ (8 sq. in.). Gabions shall be supplied, as specified, in various lengths and heights. The nominal lengths shall be 1.8 m (6 ft.), 2.7 m (9 ft.), or 3.6 m (12 ft.) as required. The horizontal width shall be 900 mm (36 in.).

Dimensions for heights, lengths, and widths are subject to a tolerance limit of plus or minus 3 percent of manufacturer’s stated sizes.

611.74 Certificate of Compliance with Specifications. Each shipment of gabions to a job site shall be accompanied by a certification that states that the material conforms to the requirements of these specifications. A shipment shall consist of all material arriving at the job site at substantially the same time. The certification shall be on company letterhead and shall be signed by an officer of the company having legal authority to bind the company.

611.75 Construction Requirements. Prior to the placement of gabion baskets, the ground surface shall be smoothed and leveled to the line shown on the plans by the construction of a base pad of portland cement concrete or compacted clean stone, or by a combination of these materials. The engineer will select the method or methods to be used on each installation based on the character and soundness of the subsurface material exposed by the excavation. Generally, gabions to be placed on uneven solid rock surfaces will require a Class B concrete pad not less than 50 mm (2 in.) nor more than 100 mm (4 in.) thick. Gabions to be constructed on surfaces other than solid rock will normally be placed on a 300 mm (12 in.) thick base constructed of clean, hard, durable stone of the same type and size required in the gabion baskets. The engineer reserves the right to select the type of base construction considered most advantageous and desirable from the standpoint of structural adequacy and economy. The thickness of the base may be varied considerably, or the base may be stepped to take advantage of continuous formations of solid rock exposed by excavation.

611.75.1 The gabions are supplied folded flat, tied in pairs, and packed in bundles.

The gabions are identified by color stripes and by labels indicating their code size and dimensions. The lacing wire is supplied in coils. All gabions on the channel bottom and lowest one meter (3 ft.) in height on the walls shall be PVC coated.

611.75.2 For assembly, remove a single gabion from the bundle and proceed to unfold it on a hard, flat surface. Stretch the gabion and stamp out all kinks. Fold the front and back panels to a right angle by stepping on the base along the crease. Fold up the end panels and fasten them to the front and back panels using the heavy gage wire projecting from the upper corners of each panel. Assure all baskets are properly squared with the top of all panels even. Securely lace all vertical edges of ends and diaphragms.

611.75.3 The baskets shall be securely laced along all the perimeter of all contact
surfaces with other baskets. Cut a length of lacing wire approximately one and one half times the
distance to be laced but not exceeding 1.5 m (5 ft.). Secure the wire terminal at the corner by
looping and twisting, then proceed lacing with alternating single and double loops at
approximately 125 mm (5 in.) intervals. Securely fasten the other lacing wire terminal. Baskets
should be placed so the vertical joints are staggered.

611.75.4 Set assembled gabion baskets in their proper location and lace the perimeters of
all contact surfaces. The base of empty gabions placed on top of a completed row must also be
tightly wired to the latter. Anchor the first gabion basket by completely filling it to no more than
50 mm (2 in.) above the top. The gabion rock shall be hand placed along and immediately next to
exposed faces. When a 1 m (3 ft.) high gabion is used, it shall be filled in three equal lifts. Two
connecting wires are to be placed between each lift in each cell of all exposed faces from front to
back. The wires shall be looped around two meshes and tensioned.

After anchoring the first gabion, apply tension to the other end of baskets with a come-
along or other approved means in order to help achieve proper alignment. While the gabions are
being stretched, inspect all corners for open “V’s” which will result if corners were not properly
secured. Replace any openings that occur. Keep gabions under tension while being filled. Leave
last gabion temporarily empty to allow for each lacing of the subsequent assembly. Protect the
vertical panels from being bent during the filling operation by temporarily placing and lacing
reinforcing bars along the upper edges of the ends and diaphragms, or by other approved means.

After the hand placement of exposed front faces with rock, the remainder of gabion rock
fill may be placed mechanically throughout, provided care is taken to insure that it is tightly
packed with a minimum of voids. Insure tension wires are placed each 0.3 m (1 ft.) in height.
When the gabions are slightly overfilled to allow for settlement, the lids shall be folded down
into position so that the lid and the gabion edges meet closely without gaps. Secure the lids at the
corner with the wire projecting from the lid. Securely lace the lid shut starting with the front face
and the ends. Adjacent lids may be wired to vertical panels in one operation. Lacing procedure
should be as previously described, every 125 mm (5 in.) Gabions shall be built with an offset or
batter as shown on the project plans.

611.75.5 In general, the gabions may be cut to form curves or to allow pipe connections.
When this is done, cut or bent edges of the mesh shall be fastened securely to another part of the
gabion structure by lacing with wire.

611.75.6 The filter fabric shall be placed between the gabions or clean aggregate, if
installed, and earth on all the unexposed sides. The material shall extend completely beneath the
base row of gabions and up the sides of the bottom mat. All unexposed sections of counter forts
shall be wrapped with filter material. The seams between adjoining rolls of filter material shall
be made with a 300 mm (12 in.) overlap and the seams secured to the baskets every 450 mm (18
in.) to ensure tightness prior to backfilling. The filter fabric shall be cut even with the top of the
wall. Fill or sod shall not extend over the top basket of the wall.

611.75.7 Areas beyond the paylines established on the plans for the excavation item shall
be backfilled with approved earth, or a mixture of clean sand and gravel if such is available from
the creek bed.

611.76 Method of Measurement. The excavation limits and wall details shown on the cross-sections and the included sketch are based on the construction of the wall foundation to the elevations shown on the plans. However, as noted before, it is not intended to excavate sound, unweathered rock and replace it with gabions. It is therefore anticipated that the base of the new wall will be stepped or otherwise varied by the engineer during construction depending on the location and character of the rock encountered in the excavation.

A subsurface report when included in the plans is for the contractor’s information only. Unless an attempt has been made to separate or classify excavation quantities for this project, all excavation will be considered unclassified.

Final excavation quantities for payment will be determined by the engineer after the wall has been completed.

Gabions shall be measured in their final positions to the nearest cubic meter (cu. yd.). Quantities for the gabion aggregate and Class B concrete used in the construction of the wall base, as directed, will be determined by the engineer.

No measurement will be made for filter fabric or material used for backfilling areas around the completed wall.

611.77 Basis of Payment. Payment will be made at the contract unit bid price for each of the pay items included in the contract. Payment for Class B concrete will be made at the contract unit price regardless of the quantity used. No direct payment will be made for filter fabric nor for backfill material.
SECTION 612
TRAFFIC CONTROL DEVICES

612.1 Description. This work will consist of furnishing, constructing, and maintaining traffic control and safety devices at locations shown on the plans or as directed by the engineer. Construction details shall be in accordance with the plans.

612.2 Materials. All materials shall conform to Division 1000, Materials Details, and specifically as follows:

<table>
<thead>
<tr>
<th>Item</th>
<th>Section</th>
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<tbody>
<tr>
<td>Construction Signs</td>
<td>1041</td>
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</table>

612.3 Construction Requirements

612.3.1 Barricades (Moveable, Temporary, and Permanent). Lumber for barricades shall be well seasoned, straight, and free from serious defects that will materially impair the strength. Posts may be either square or round, except as designated on the plans. If round, they shall be free from bark and shall present a good bearing surface for the rails or boards they support. Paint for barricades shall be good quality, commercially available products. Reflective sheeting shall be a commercially available product, with a reflective intensity of Type 1 Level A, enclosed lens sheeting as designated in Federal Specification FP-74 that consists of glass spheres embedded beneath a flexible, transparent plastic forming a smooth outer surface as exposed to use. The contractor shall provide and maintain barricades in good condition throughout the duration of the contract. At a minimum, the number and location of traffic control and safety devices will meet the standard requirements of the Manual on Uniform Traffic Control Devices, where applicable.

612.3.2 Painting and Striping. The surfaces of all barricades shall be given a prime coat and a finish coat of white paint. The surfaces of horizontal boards for all types of barricades that face the traffic and extend across the roadbed shall be striped in accordance with the plans. The striping of all barricades shall be provided by the use of reflectorized white stripes separated by reflectorized orange stripes. Reflectorizing shall be accomplished by applying reflective sheeting to the barricade boards by means of an adhesive.

612.4 Plans and Quantities. The plans will show the type and location of traffic control devices necessary to complete the work. The contractor is herewith advised that St. Charles County will furnish and maintain all advance warning and detour signing.

Any device that becomes damaged or rendered unserviceable shall be promptly repaired or replaced by the contractor as directed by the engineer.

No direct payment will be made for repair or replacement of traffic control facilities as a
result of compliance with this provision.

612.5 All traffic control devices furnished and maintained by the contractor shall remain the property of the contractor. All other advance and detouring signs and devices will remain the property of St. Charles County.

612.6 Flasher Signs. Flasher signs shall be provided at locations shown on the plans or as designated by the engineer. The sign shall be constructed of 19 mm or 16 mm (3/4 in. or 5/8 in.) 5-ply, high density type overlaid Douglas Fir plywood. The sign shall be given a prime coat and a finish coat of white paint. The striping shall be provided by the use of white and reflectorized orange stripes. The arrow shall be painted black on a background of orange reflective sheething. Unless otherwise specified in the contract, flasher signs shall become the property of the contractor after their use is no longer required on the project. Flasher signs that are to become the property of the County shall be left in good condition with respect to repair and paint.

612.7 Basis of Payment

612.7.1 The accepted quantity of temporary, moveable, permanent, and flasher sign barricades will be paid at the unit price bid for each item included in the contract.

612.30 Standard Traffic Control Devices.

612.30.1 Description. This work will consist of furnishing, placing, and maintaining flags, channelizers, cones, and furnishing flagmen in accordance with the contract and as directed by the engineer. This specification also covers the design and responsibility for signs normally required to be employed on construction projects only during construction operations and which are not to remain for any substantial length of time. These signs include such warning and regulatory measures necessary to warn the traveling public and to protect the contractor’s personnel and equipment during specific and limited phases of the work. These signs must comply with the current Manual on Uniform Traffic Control Devices with respect to size, color, and mounting detail. No direct payment will be made for furnishing, placing, relocating, maintaining, or removing signs. Since these signs impose legal obligations or restrictions on traffic, prior approval for their use must be obtained from the engineer and they will be placed at locations designated by the engineer.

612.30.2 Flaggers. As directed by County personnel, the contractor shall furnish flaggers to be used when the roadway is partially or wholly blocked by men or equipment. To increase the visibility of the flaggers, yellow or yellow-orange safety vests, caps, and gloves must be worn. Flaggers shall be located far enough from the work site so the vehicles have sufficient distance to slow down or stop before entering the work area. Under no circumstances will the contractor’s flaggers be allowed to direct traffic unless adequately protected by proper advanced warning signs. Flaggers shall be properly attired to perform their duties, shall be courteous, and shall use an approved “stop and slow” sign to control traffic.

612.30.3 The requirements of this specification shall not relieve the contractor of his
responsibilities for protecting both the public and the workers.

612.30.4 Flexible Non-Metallic Drum-Like Channelizers.

612.30.4.1 Description. This work shall consist of furnishing and placing reflectorized, flexible, non-metallic drum-like channelizers used for traffic control as specified in the contract or as directed by the engineer.

612.30.4.2 Materials. Channelizers shall be manufactured from a plastic polymer, plastic copolymer, rubber elastomer, or any other non-metallic material that can be compounded to meet the requirements of this specification. Channelizers shall be pigmented and molded of a Highway Orange color throughout and stabilized against fading by ultra-violet or other light rays by the incorporation of adequate inhibitors. Channelizers shall be a minimum of 900 mm (36 in.) high and a minimum of 450 mm (18 in.) in diameter, if circular in shape. If other than circular, the minimum side to side dimension at the narrowest point shall be 450 mm (18 in.). Reflective markings shall be horizontal, circumferential, alternating orange and white stripes 100 mm to 200 mm (4 in. to 8 in.) wide. If there are non-reflectorized stripes between the horizontal orange and white stripes, they shall be no more than 50 mm (2 in.) wide. The reflectorized stripes shall be Type 2 reflective sheeting meeting the requirements of Sec. 1041 unless otherwise noted on the plans. There shall be at least two orange and two white stripes on each channelizer laid out in accordance with Sec. 6C-6 of the Manual on Uniform Traffic Control Devices as shown on the plans. The channelizer shall be a two-piece closed-top breakaway design and shall be capable of being securely fastened together in such a manner as to prevent accidental separation from air turbulence created by such things as passing trucks or normal winds, but be capable of separating if struck by a vehicle. The base shall contain a self-draining storage compartment for ballast. The ballast, consisting of loosely filled sand bags or loosely shoveled sand, shall be stored in the base in such a manner that it will not become a projectile upon impact. The base shall be low enough to allow a vehicle to pass over it without making contact with the undercarriage. Channelizers shall exhibit good workmanship and shall be free of objectionable marks or defects that affect appearance or serviceability. Channelizer seams shall be equal in strength to the rest of the channelizer. The top surface of the channelizer, including any recessed areas, shall be designed to drain and shall have a mounting bracket for attaching a Type III object marker. The marker shall be secured to the channelizer by use of a clear polycarbonate connector as shown on the plans.

612.30.4.3 Prequalification. Prior to starting work at any site requiring channelizers for controlling traffic, the contractor shall submit or cause to be submitted to the engineer certified documented evidence from the manufacturer which shows that two randomly selected channelizers representative of those to be used on the project withstood three direct impacts by a vehicle bumper at 90 kph (55 mph) with the following results:

(a) Only negligible damage to the impacted vehicle and no injury to the occupants;

(b) No separation of the Type III object marker;

(c) No permanent deformation or damage to the channelizer that impairs its function or
physical appearance, which renders it unusable;

(d) No significant loss of effectiveness of the reflective material;

(e) A non-hazardous separation of the channelizer from its snap-on base with ballast;

(f) The channelizer design did not allow the ballast or any part of the unit to be trapped under the vehicle.

A new certification will be required upon any modification of the design of the channelizer or any change in the formulation of the plastics used in its manufacture. If directed by the engineer, the contractor shall demonstrate that the channelizer can meet the impact requirements specified above. If the engineer determines that the channelizer constitutes a potential hazard to traffic because of rupture, excessive damage to the impacting vehicle, or other hazardous behavior, the channelizers represented by the test shall not be used for traffic control.

612.30.4.4 Basis of Acceptance. Materials furnished under this specification will be accepted for use upon receipt and approval of a certification indicating the channelizers being supplied are the same model and design as previously approved. The certification shall include the manufacturer and model number of the channelizer and the type, grade and manufacturer of the reflective sheeting.

612.30.4.5 Basis of Payment. Payment for flexible non-metallic drum-like channelizers and Type III object markers will be in accordance with Sec. 616.

612.30.5 Object Markers. Object markers are defined as panels, 150 mm to 200 mm (6 in. to 8 in.) in width and 600 mm (24 in.) in height striped and reflectorized in the same manner as barricades and mounted with the top a minimum of 900 mm (36 in.) above the roadway on a single lightweight post. These devices shall be used for traffic separation or shoulder barricading where space is at a minimum.

612.30.6 All open trench within ten feet of the travel way or low shoulder adjacent to the travel way, shall be marked by the use of reflectorized object markers spaced at intervals of not more than 15 m (50 ft.). Object markers shall be placed as soon as those conditions exist and shall remain in place until all trench has been filled to the level of the travel way and the adjacent shoulder has been leveled sufficiently to be used safely by traffic. During actual operations object markers may be removed through areas where work is actually in progress. They shall be reset as soon as operations have moved ahead if hazards requiring their use remain. Object markers shall be striped on both sides. No direct payment will be made for furnishing, placing, relocating, or maintenance of object markers.

612.31 Method of Measurement. No direct measurement will be made for the use of channelizers, cones, object markers, “Flagmen Ahead” signs, or the furnishing of flagmen.

612.32 Basis of Payment. The furnishing, placing, and maintaining of reflectorized object markers, signs, channelizers, cones, and the furnishing of flagmen as required will be paid
for at the contract lump sum bid price for Standard Traffic Control Devices.

612.40 Detour Lighting

612.40.1 Description. This work shall consist of furnishing and installing detour lighting equipment and materials as shown on the plans and as directed by the engineer.

612.40.2 Materials. Wood poles shall be Class II conforming to details of Sec. 1050, Materials Details. Poles shall be 12.0 m (40 ft.) in length, set 1.0 m (3 ft.) below grade in order to provide a mounting height of 9.7 m (32 ft.) for luminaries. Luminaries shall be 400 watt high pressure sodium vapor as specified in Division 900. Each luminary shall be fitted with a photoelectric device in order to provide “dusk to dawn” lighting capabilities. Photoelectric controls will operate on 240 volts, 60 cycle current.

612.40.2.1 The contractor shall be responsible for contacting the utility companies and making arrangements with regard to power source and metering.

Bracket arms shall be 1.8 m (6 ft.) in length and arranged for 50 mm (2 in.) slipfitter luminary mounting.

Bracket arms shall be fitted to poles by an approved design.

612.40.2.2 Service poles shall consist of wood poles and crossarms, insulators, necessary pole line hardware, conduit, ground rods, guy wires and anchors, and all other accessories and appurtenances mounted on the pole except those furnished by the utility company, or set out separately in the contract. The assembly shall meet the safety requirements and approval of the utility company or municipality furnishing power for operation.

612.40.2.3 Electrical conduit shall be cross linked Polyethylene, 90°C (194°F), type RHH-RHW, #10,2 Conductors, 7 strand twisted, 600 volt, soft drawn copper, color coded black and white.

612.40.2.4 When detour lighting is no longer required on the project, the contractor shall carefully disassemble all components and store all poles, brackets, and luminaries on the right-of-way for the contractor or County Forces to remove.

612.40.3 Method of Measurement and Basis of Payment. No direct measurement will be made for this work. Payment for detour lighting will be based on the unit price bid for each of the pay items included in the contract. No direct payment will be made for any incidental items necessary to complete the work unless specifically provided as a pay item in the contract.

SECTION 612.50 PROJECT INFORMATION SIGNS.

612.51 Description. This work shall consist of the furnishing and installing of project information signs at the time physical construction work begins on the contract.
**612.52 Construction Requirements.**

**612.52.1** Signs shall be constructed and erected in accordance with the details shown and materials specified on the plans. They shall be placed within the right-of-way at locations indicated in the contract or as directed by the engineer. The required number of signs and the locations will be shown on the title sheet of the plans for each affected project. They shall face approaching traffic and be located so as not to obscure or detract from the effectiveness of other official highway signs and markers. Signs shall be kept clean and in good repair, and shall become the property of the contractor after their use is no longer required on the project, unless otherwise specified.

**612.52.2** For Federal-Aid Projects, project signing will be prohibited. For other projects, the Engineer will furnish the contractor all information pertinent to the erection of project information signs.

**612.53** No direct payment will be made for project information signs.

**SECTION 612.60 TEMPORARY EXCAVATION FENCING.**

**612.61 Description.** This item will consist of enclosing an open cut excavation or vertical drop to provide protection to pedestrians on the project with a polyethylene fence fabric on a temporary basis. The location of such temporary excavation fencing will be shown on the plans or designated by the engineer.

**612.62 Construction Requirements.**

**612.62.1** Polyethylene fencing of a good commercially available quality, 1.5 m (5 ft.) in height, fluorescent orange in color, capable of withstanding exposure to the sun and elements will be required to completely enclose open cut trenches or excavations, or vertical drop-offs produced during construction. Temporary posts may be of any kind which will adequately support the attached fence fabric free of distortion, sagging, gaping and open areas at the bottom of the fence. Temporary posts must be driven in place and the subsequent hole backfilled upon removal. Additional fence post installation may be required by the engineer when deemed necessary. Fencing shall be so placed as to completely enclose all designated areas.

**612.62.2** All open cut excavation areas within 3.0 m (10 ft.) of the back of curb or edge of pavement and over 1.0 m (3 ft.) in depth must be fenced in accordance with the provisions of this section. Areas where vertical cuts exist and are accessible to pedestrians with a depth greater than 1.0 m (3 ft.) must be fenced along the top of the cut. These requirements are in addition to other standard safety practices required by the contract and shall not in any manner be construed to relieve the contractor of any liability incumbent on his part. A minimum compliance with the requirements of these sections and the Manual on Uniform Traffic Control Devices will always be required.

**612.63 Method of Measurement.** Temporary excavation fencing, complete in place, will be measured on a lump sum basis and will consist of fencing, posts, mounting hardware, backfilling postholes and associated items necessary to safely enclose open cut excavations or
trenches or vertical drop-offs to the satisfaction of the engineer.

612.64 Basis of Payment. Temporary excavation fencing will be paid at the contract unit bid price.

SECTION 612.70 ADVANCED WARNING ARROW PANEL.

612.71 Description. The advanced warning arrow panel shall be of a moveable design, generally trailer mounted, and shall be capable of operation from a fixed power source or from a self-contained power source. The arrow panel shall be located as shown on the plans or as designated by the engineer.

612.72 The arrow panel shall be at a minimum 1200 mm x 2400 mm (48 in. x 96 in.) with a minimum of 15 replaceable panel lamps which produce a yellow light and are an integral part of a non-reflective black background. An indicator lamp will be incorporated in the black face of the arrow panel to indicate operation. Provision will be made to place the arrow panel, while in operation, at a minimum height of 2.1 m (7 ft.) above the pavement to the bottom of the arrow panel. The arrow panel should produce a minimum legibility distance of 1.6 km (one mile). The arrow panel will be equipped with the capability of the following mode selections:

(1) Left or right flashing or sequential arrows;

(2) Left or right sequential chevrons;

(3) Double flashing arrows;

(4) Caution

The caution mode consists of four or more lamps arranged in a pattern that will not indicate direction.

612.73 Arrow panels will be of Type A or Type B designation. Type A arrow panels will be operated from a fixed power source supplied by a utility company. Arrangement for power supply will be the contractor’s responsibility as will acquisition of necessary permits and payment of connection fees.

Type B arrow panels will be supplied with electrical power from a self-contained system of batteries and generator powered by a diesel engine. The engine will be silenced with baffles and mufflers so as not to produce a disturbance when in operation. A fuel storage tank having a capacity for not less than 48 hours of uninterrupted engine service must be provided.

612.74 The contractor will be responsible for the maintenance of his equipment and must have a backup system available in case of failure of the primary system. At no time will mechanical failure of the arrow panel be an acceptable reason for discontinuing its use as a safety or traffic control device. If repairs or a backup system cannot be effected in a two hour period, work may be suspended or other measures may be required by the engineer. These other
measures may include, but not be limited to, requirements for flaggers, guide cars, or arrow panels provided from companies offering such services.

612.75 Method of Measurement. The quantity of Type A or Type B arrow panel will be measured on a lump sum per each unit basis. No separate compensation for fuel, lubricants, repair parts or manhours or cost involved in securing a backup system will be considered.

612.76 Basis of Payment. The accepted quantity of Type A or Type B arrow panel will be paid at the contract unit bid price.
SECTION 613
PAVEMENT REPAIR

613.1 Description. Full depth pavement repair shall consist of removing specified areas of existing variable thickness portland cement concrete pavement and replacement with either nonreinforced or reinforced portland cement concrete as shown on the plans.

613.1.1 Partial depth pavement repair shall consist of removal of areas of unsound concrete, not to exceed 100 mm (4 in.) deep, and replacing with portland cement concrete or a bituminous mixture as specified in the contract.

613.2 Construction Requirements.

613.2.1 Approximate locations and area of pavement sections to be removed will be shown on the plans. Specific locations and areas shall be as specified by the engineer. All pavement repair subsequent to sawing of pavement shall be accomplished in the same day.

613.2.2 Specified areas of full depth pavement repair shall be removed in accordance with the applicable requirements of Sec. 202.20, except that the saw cut shall be full depth. A diamond saw shall be used for perimeter cuts, and a rock saw may be used to make a cut through the middle portion of the area to be removed for stress relief. The full depth of the pavement shall be removed without mechanically breaking in place and with a minimum of disturbance of sound base. Any aggregate base disturbed by the contractor shall be recompacted or removed and backfilled with portland cement concrete as an integral part of the repair. Unstable aggregate base shall be removed and replaced in accordance with Sec. 304, as directed by the engineer. Subgrade compaction in accordance with Sec. 210 shall be performed if directed by the engineer in areas of unstable subgrade, or the subgrade may be removed and replaced with aggregate base material in accordance with Sec. 304 at the contractor’s option. If subgrade compaction is performed, the aggregate base shall be replaced. Compaction shall be to the satisfaction of the engineer and inspection shall be made visually.

613.2.2.1 For subdivision pavement repairs and utility cuts, a joint sawed to minimum depth of 3/4 the pavement width with a true line and vertical face will be sufficient.

613.2.3 Areas of full depth repair shall be filled with reinforced portland cement concrete as specified in the plans. Dowels and dowel holes shall be as shown on the plans. The dowel holes shall be drilled 35 mm (1 3/8 in.) in diameter maximum, to the depth shown on the plans. The holes shall be blown clean and allowed to dry. The holes shall be injected with an epoxy or polyester bonding agent meeting the requirements of Sec. 1039 to fill the void around the dowel. If the bonding agent is either in bulk or cartridge form, it shall be thoroughly mixed in the proper ratio by an automatic mixing unit prior to injection into the dowel holes. The automatic mixing unit shall be an integral part of the injection device. The bonding agent shall be injected into the dowel hole by inserting the injection device to the back of the hole and slowly withdrawing the
device while dispensing sufficient material to completely fill the void around the dowel when the dowel is inserted. Dowel bars should be 32 mm x 450 mm (1 1/4 in. x 18 in.) and epoxy coated. Prior to inserting the dowel into the hole, a thin plastic disk, manufactured to slip tightly over the dowel, shall be placed over the dowel at approximately midpoint to prevent the bonding agent from flowing from the hole during placement of dowel and to create an effective face at the entrance of the dowel hole. The dowel shall be inserted into the hole with a twisting motion so that the material in the back of the hole is forced up and around the dowel. The dowel shall be placed parallel to the surface and the center line of the travel way and shall not vary more than 6 mm (1/4 in.) in alignment. Dowels shall be firmly seated prior to placing concrete. Welded wire fabric shall be used and placed 75 mm (3 in.) plus or minus 13 mm (1/2 in.) below the surface of the concrete patch.

613.2.4 Repairs shall be made to only one lane at a time. The removed concrete and any excavated subgrade material shall be disposed of at a location furnished by the contractor or at locations on the right-of-way approved by the engineer. If the material is disposed of outside the right-of-way, an acceptable written agreement with the property owner on whose property the material is placed shall be submitted by the contractor.

613.2.5 If the repaired area is not to be resurfaced, the overcut from the sawing operation shall be filled with an expansive mortar, epoxy, polyester, or joint material as directed by the engineer.

613.2.6 All materials, proportioning, air-entraining, mixing, slump, and transporting of concrete shall be in accordance with Sec. 501 as applicable to pavement concrete, except the minimum cement requirement shall be 475 kg/m$^3$ (800 lb./cu. yd.), and the maximum slump shall be 88 mm (3 1/2 in.). All repaired areas shall be finished to provide a smooth ride and to the satisfaction of the engineer. Repaired areas shall be checked by stringline if required by engineer. When stringlined, the surface of the repaired area shall not vary more than 5 mm/3 m (3/16 in./10 ft.) for repairs that are not to be resurfaced nor more than 3 mm/3 m (1/8 in./10 ft.) for repairs that are to be resurfaced, from a straight line between the surface of the existing pavement on each side of the repaired area. Immediately after finishing and as soon as marring of the concrete will not occur, the entire surface of the newly placed concrete shall be cured in accordance with one of the following methods: If the existing pavement has been or is to be resurfaced, an asphalt emulsion shall be applied at a rate of 0.5 L/m$^2$ (0.1 gal./sq. yd.), or as directed by engineer. If the existing pavement surface is concrete and is not to be resurfaced, the curing shall be in accordance with Sec. 502. The area shall not be opened to traffic until the concrete has attained a minimum compressive strength of 24 150 kPa (3500 psi) as determined by tests made in accordance with ASTM methods.

613.2.6.1 When the repair is to be made and opened to traffic the same day, the concrete shall contain Type III cement and an approved accelerator. The aggregates or water or both shall be heated during the season when the ambient temperature may drop below 15$^0$ C (60$^0$ F). Aggregates shall not be heated higher than 65$^0$ C (150$^0$ F). The temperature of the water and aggregates combined shall not be higher than 45$^0$ C (110$^0$ F) when the cement is added. The temperature of the concrete at time of placement shall not be lower than 25$^0$ C (80$^0$ F). Insulating curing mats, approved by the engineer, shall be used throughout the curing period. A minimum
of 4 hours curing time and no minimum compressive strength will be required.

613.2.6.2 If the pavement has been resurfaced, the repaired area shall be filled to the surface of the existing asphalt with portland cement concrete.

613.2.7 Both transverse ends of all new portland cement concrete repairs shall be sawed 50 mm (2 in.) deep and 9 mm (3/8 in.) wide, and sealed in accordance with Sec. 1057.

613.2.8 Weather limitations shall be in accordance with Sec. 502.4.

613.3 Method of Measurement.

613.3.1 Measurement for full or partial depth sawing shall be made to the nearest 0.5 m (nearest linear ft.) of perimeter diamond saw cut.

613.3.2 Measurement for drilling dowel holes and furnishing and installing dowels will be made per dowel.

613.3.3 Measurement for furnishing and placing portland cement concrete and wire fabric, if applicable, or bituminous mixture, if applicable, will be made to the nearest 0.10 m² (nearest 1/10 sq. yd.).

613.4 Basis of Payment. The accepted quantity of pavement repair will be paid for at the unit price for each of the pay items included in the contract. In addition, subgrade compaction and aggregate base shall be paid for as follows.

613.4.1 Subgrade compaction will be paid for in accordance with Sec. 210 except measurement will be made to the nearest square meter (nearest sq. yd.).

613.4.2 Aggregate base will be paid for in accordance with Sec. 304. However, no direct payment will be made for aggregate base material used to replace unstable subgrade.
SECTION 616
TRAFFIC CONTROL PLAN

616.1 Description. This work shall consist of furnishing and installing traffic control devices in accordance with the contract and as directed by the engineer.

616.2 Materials. All construction sign and reflective material shall conform to Sec. 1041.

616.2.1 Flashing Electric Light. This unit shall be a 200 mm (8 in.) conventional traffic signal section meeting the requirements of Division 900. Each unit shall contain a yellow lens. The contractor shall furnish lamps for the flashing electric lights. Each unit shall contain a minimum 200 mm (8 in.) tunnel visor and be equipped for single section mounting. The flasher unit may be the synchronous motor or NEMA solid state type operated on 120 volts AC. Flashing electric lights which will become property of the County shall be controlled by NEMA solid state flasher units and be connected to a permanent power supply. Two-circuit flasher units shall be used to provide alternate flashing of the lights when mounted on barricades or bridges. Indications shall be flashed at not less than 50 nor more than 60 flashes per minute, with an approximate 50 percent on-off ratio. The contractor shall, at his expense, provide all necessary connections to an electrical power source for operation of flashing electric lights.

616.3 Construction Requirements.

616.3.1 The contractor shall furnish, install, maintain, clean, and relocate all signs, drums, cones, barricades, object markers, flashing arrow panels, channelizing devices, lights, and other traffic control devices shown on the plans, or as directed by the engineer. All signs and traffic control devices shall meet the requirements of the Manual on Uniform Traffic Control Devices (MUTCD) and shall be kept legible, in alignment, and in good repair. All signs, except the project terminal signs, shall be covered, set aside, turned, removed, or relocated as work progresses or is completed and their necessity ceases to exist. All traffic control devices shall be removed after completion of construction and shall remain the property of the contractor unless specified otherwise.

616.3.2 The contract will indicate the minimum requirements for traffic control. The contractor may, at his expense, add to the traffic control plan any standard signs or traffic control devices he considers necessary to adequately protect the public and the work.

616.3.2.1 Signs and sign quantities for blasting areas are not included in the contract traffic control plan. It shall be the contractor’s responsibility and expense to furnish, install, maintain, and remove blasting zone signing in accordance with the MUTCD. Placement of blasting area signing shall be subject to the engineer’s approval.

616.3.2.2 Some projects require establishment of stage construction, and the traffic control plans are developed accordingly. Work in any of the specified construction stages or
other unrelated items of work may be accomplished concurrently with another specified stage provided that no interference with the prescribed handling of traffic procedures will occur. The contractor shall submit traffic control plan revisions to the engineer should he choose to deviate from the stages shown in the contract. All changes to the traffic control plan are subject to the engineer’s approval and shall be verified in writing prior to implementation. Sign and device quantities shall be adjusted accordingly.

616.3.2.3 If the engineer determines the need for additional signs or other traffic control devices not included in the traffic control plan, the contractor will be notified in writing to provide the additional signs or devices. Reimbursement for authorized changes to the traffic control plan will be made in accordance with contract unit prices or as agreed upon by the County Engineer.

616.3.3 Flaggers will be required when equipment is crossing a road that is open to vehicular traffic. Hand signaling devices, flagger attire, flagging procedures, and flagger stations shall be in accordance with MUTCD. On resurfacing projects requiring handling two-way vehicular traffic over a single lane, each flagger involved in controlling traffic through and along the work area shall be equipped with a portable transceiver radio and a stop-slow hand signaling device.

616.3.4 The length of time that the contractor may maintain lane closures or one-way traffic operations shall be kept to a minimum and shall be subject to the engineer’s approval. The contractor shall furnish the engineer a traffic control plan indicating the proposed method to achieve temporary stoppage of all traffic lanes if construction operations require such. The plan shall indicate any advance warning or regulatory signs, if used, and their locations; flagmen, if used, and their locations; and all other traffic control devices and their locations which may be used to temporarily stop all traffic. A one time payment for traffic control devices used to temporarily stop all traffic will be made at the unit price for those like items contained in the contract. No direct payment will be made for removing or reusing these particular signs as an indeterminate number of occasions for their use may occur. Traffic control devices used by the contractor which do not have a specific pay item in the contract shall be supplied, installed, maintained, and removed by contractor at his expense.

616.3.5 The contractor will not be allowed to park vehicles or equipment nor store materials on pavements or shoulders being utilized by traffic except in cases of emergency. If the contract specifies time periods that the contractor will not be permitted to perform work, no vehicles or equipment utilized in the construction of the project shall enter or leave the construction area via the pavements handling traffic nor be operated on the pavements handling traffic within the construction area.

616.3.6 The requirements of this specification shall not relieve the contractor of his responsibility for protecting both the public and the work. Should the contractor fail to clean, repair, replace, or otherwise maintain the traffic control devices when directed to do so by the engineer, one or more of the following actions will be taken:

(a) The engineer may employ another agency to correct deficiencies in signing or
warning devices and deduct the cost from the contractor’s pay estimate.

(b) Suspension of all pay estimates until deficiencies are corrected.

616.4 Basis of Payment. Signs and other traffic control devices specified in the traffic control plan or authorized by the engineer will be paid for at the unit price for each of the pay items included in the contract. No direct payment will be made for any incidental items necessary to complete the work unless specifically provided as a pay item in the contract. No direct payment will be made for cleaning, repair, or replacement of traffic control devices.
SECTION 617
CONCRETE MEDIAN BARRIER

617.1 Description. This work shall consist of constructing a concrete median barrier in conformity with the lines, dimensions, and typical sections indicated on the plans. The concrete median barrier may be either cast-in-place, extruded, or precast as shown on the plans.

617.2 Materials. All materials shall conform to Division 1000, Materials Details, and specifically as follows:

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Specification

Prestressing Strands.......................................ASTM A 416
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Concrete median barriers shall be constructed of Class B or B-1 concrete. Materials, proportioning, air-entrainment, mixing, slump, and transporting shall be in accordance with Sec. 501. Concrete shall be placed and finished in accordance with the applicable provisions of Sec. 703.

617.3 Construction Requirements.

617.3.1 Concrete median barriers shall conform to Standard Drawings nos. C617.00, .01, .02 and to the dimensions shown on the plans. Forms shall be of either metal or wood, of sufficient strength to resist springing.

617.3.2 Concrete barriers may be constructed by using an extrusion machine or other equipment specifically designed for constructing cast-in-place reinforced concrete barriers, provided that the finished barrier is true to line and grade and the exposed surfaces conform to the requirements of Sec. 617.3.6

617.3.3 Concrete barriers may be a combination of prestressed concrete sections and reinforced cast-in-place concrete sections, except that this option shall not be used on curves exceeding 5 degrees. Prestressing tendons shall not be stressed until the concrete in the barrier section has attained a compressive strength of at least 20700 kPa (3,000 psi). Prestressing tendons shall be encased in plastic ducts or sheaths that will eliminate bonding between the concrete and prestressing tendon. Prestressing strands shall be liberally coated with an approved corrosion-inhibiting material. End plates for prestressed concrete barrier sections shall be
fabricated of steel meeting the requirements of ASTM A 36 and in accordance with details shown on the plans. End plates shall be hot-dipped galvanized after fabrication in accordance with ASTM A 123 or painted with the prime coat of System C in accordance with Sec. 712.12. Prestressing strands extending into cast-in-place concrete sections of the barrier shall be cleaned and tied in accordance with details shown on the plans.

617.3.4 Precast units shall not be removed from forms and casting beds less than 12 hours after casting and until a compressive strength of not less than 10 000 kPa (1400 psi) is attained. Compressive strength will be determined by tests made in accordance with ASTM C 39. Concrete shall be cured for not less than 7 days in accordance with Sec. 703.3.17, except membrane curing will not be permitted.

617.3.5 Cast-in-place units shall be cured in accordance with the applicable provisions of Sec. 703.3.17, except membrane curing will not be permitted.

617.3.6 The surface shall be of a smooth and even texture, true to line and grade. Median barrier will be straight edged along the top surface and shall not show a variance greater than 13 mm/3 m (1/2 in./10 ft.) on all exposed faces. Failure to comply with this provision will require complete removal and replacement of the affected area. No area less than 3 m (10 ft.) in length will remain in place.

617.3.7 When cast-in-place or extruded construction is used, contraction joints shall be constructed as shown on the plans. Insertion of joint filler will not be required.

617.4 Method of Measurement.

617.4.1 For the purpose of measurement and payment, Type A Concrete Median Barrier will be considered that which is cast or formed with two traffic faces regardless of the width of the barrier. Type B Concrete Median Barrier will be considered that which is cast or formed with one traffic face.

617.4.2 Measurement of concrete median barrier will be made to the nearest 0.1 m (nearest 1/2 linear ft.) for each continuous length and totaled to the nearest 0.5 m (nearest linear foot) for the sum of the lengths. The length will be measured separately for each type. Final measurement will not be made except for authorized changes during construction, or where appreciable errors are found in the contract quantity. The revision or correction will be computed and added to or deducted from the contract quantity.

617.5 Basis of Payment. The accepted quantities of concrete median barrier, complete in place, will be paid for at the unit bid price for each of the pay items included in the contract.
SECTION 618
MOBILIZATION

618.1 Description. This item shall consist of preparatory work and operations including, but not limited to, those necessary for the movement of personnel, equipment, supplies, and incidentals to the project site; for the establishment of all offices, buildings, and other facilities necessary for work on the project except as provided in the contract as separate pay items; and for all other work and operations which must be performed, or costs incurred, prior to beginning work on the various items on the project site.

618.2 Basis of Payment.

618.2.1 Payment for the actual cost of the contract bond and railroad liability insurance will be authorized upon presentation of invoices at least four days prior to the estimate date. Receipted invoices for payments previously allowed on the estimate shall be submitted to the engineer within 27 days of the date of the estimate on which payment was made, or such payment will be deducted from future estimates. The amount paid, but not more than the price bid for mobilization, will be deducted from the contract lump sum price for mobilization and the remainder will be used as the basis for partial payments which will be allowed on the next estimate as follows:

(a) When 5 percent or more of the original contract amount is earned, 25 percent.

(b) When 10 percent or more of the original contract amount is earned, an additional 25 percent.

(c) When 25 percent or more of the original contract amount is earned an additional 25 percent.

(d) When 50 percent or more of the original contract amount is earned, the final percent.

618.2.2 Nothing herein shall be construed to limit or preclude partial payments otherwise provided by the contract.
SECTION 619
PAVEMENT EDGE TREATMENT

619.1 Description. This work shall consist of the elimination of pavement edge differential.

619.2 Material.
619.2.1 Temporary concrete traffic barrier shall comply with Section 617.

619.2.2 Wedge slope shall be constructed of an approved fill material, a commercially available aggregate base material, a commercially available bituminous mix or an approved preformed unit. Acceptance of wedge slope material will be based on visual examination.

619.3 Construction Requirements. At the contractor's option, elimination of pavement edge differential may be accomplished by either conducting operations in such a manner that traffic is exposed to no more than a 50 mm (2 in.) differential, by constructing a wedge shaped slope adjacent to the pavement edge or by furnishing and installing temporary concrete traffic barrier.

619.3.1 Wedge slope shall be as shown on the plans or a directed by the engineer. Slope material, other than preformed units, shall be compacted by a roller, mechanical tamper or other methods approved by the engineer, until there is no visible evidence of further consolidation.

619.3.2 Wedge slope material shall be removed and the pavement edge returned to a vertical face prior to placement of adjacent shoulder or pavement material. Material used to construct wedge slope shall be disposed of as approved by the engineer.

619.3.3 Temporary concrete traffic barrier shall be constructed as shown on the plans or as directed by the engineer.

619.4 Method Measurement.
619.4.1 Measurement will be made to the nearest 0.5 linear meter (linear ft.) along each edge of pavement for all locations actually treated. No location will be measured more than once, regardless of the number of applications.

619.4.2 Final measurement will not be made except for authorized changes during construction or when appreciable errors are found in the contract quantities.

619.5 Basis of Payment. The accepted quantity of edge treatment will be paid for at the contract unit bid price for the units constructed or the units shown in the contract, whichever is greater. Payment shall include all material and labor necessary to eliminate the need for or to
construct, maintain, replace, relocate, remove and dispose of edge treatment. No direct payment will be made for more than one application at any location.
SECTION 620
INLAID PAVEMENT MARKERS

620.1 Description. This work shall consist of furnishing materials for and installation of inlaid, prefabricated, thermoplastic markers into an asphalt surface.

620.2 Materials.

620.2.1 The marker shall be supplied with a precoated factory-applied adhesive backed with protective release paper to make possible immediate application to asphalt pavement without the use of heat, solvent, or other type adhesive operations. The thermoplastic and adhesive shall be of a type that water will not be harmful to successful application.

620.2.2 The nominal thickness of the marker shall be 1.5 mm (60 mils) including the adhesive with nominal widths of 100 mm (4 in.), 300 mm (12 in.), and 600 mm (24 in.). The edges shall not be tapered. The length, width, and shape will be specified on the plans.

620.2.3 Thermoplastic marker material applied at 3.0 mm (120 mils) thickness shall consist of a minimum, by weight, of 20 percent plastics, 30 percent pigments, and 48 percent graded glass spheres. Titanium dioxide shall be at least 20 percent by weight of the total pigment in white markers. Yellow markers shall have a minimum of 18 percent by weight of the total pigment as chrome yellow. Graded glass spheres shall be colorless, clean, and transparent. When tested by ASTM D 1214, at least 85 percent of the glass spheres shall be retained on a 106 μm (140-mesh U.S. Standard) sieve. Glass spheres shall be uniformly distributed throughout the entire cross section of the marker.

620.2.4 Flexibility of the thermoplastic material shall be such that it can be applied without cracking or breaking.

620.3 Construction Requirements.

620.3.1 Markers shall be installed in accordance with the plans, or as directed by the engineer. The width of placement of the asphaltic concrete shall be adjusted so that inlaid markers will not fall on longitudinal joints.

620.3.2 Lines shall be of either white or yellow, continuous or intermittent, and of the widths and configurations required.

620.3.3 Arrows, words, and legends shall be white and may be formed from one piece, multiple pieces, or strips of the marker material.

620.3.4 Markers shall be imbedded in the asphalt surface by the final roller.
620.4 Acceptance. The contractor shall furnish manufacturer’s certification that the thermoplastic pavement marker material meets or exceeds the requirements of this specification.

620.5 Method of Measurement.

620.5.1 Measurement of lines will be made to the nearest meter (nearest 10 linear ft.) of marker material used.

620.5.2 Measurement of arrows and stop lines will be made per each.

620.6 Basis of Payment. Accepted thermoplastic pavement markers will be paid for at the unit bid price for each of the pay items included in the contract.
SECTION 621
PAVEMENT STRIPING AND REMOVAL

621.1 Description. This work shall consist of pavement striping, either by painting or by lane marking tape, to delineate traffic lanes on bypasses, temporary connections, existing pavements, and new pavements used for handling traffic during construction. On new pavements and existing pavements that are to remain in place, lane marking tape shall be used. This work shall also include all necessary operations for removal of existing pavement markings that might mislead traffic and the removal of temporary pavement striping when no longer required.

621.1.1 If in the judgment of the engineer, the weather or pavement condition is unsuitable for the proper adhesion of lane marking tape, the contractor may use painted lane lines.

621.2 Materials. Painted lines and lane marking tape shall be reflectorized, be of good commercial quality, and shall be approved for use by the engineer. Lane marking tape shall be removable by hand and shall leave no objectionable or misleading image after removal.

621.3 Construction Requirements.

621.3.1 Temporary pavement striping for edge lines, center lines, and lane lines shall be as shown on the plans or as directed by the engineer.

621.3.2 All temporary pavement striping within the project limits shall be maintained by the contractor at his expense in a manner approved by the engineer.

621.3.3 Removal of temporary pavement striping and other pavement marking within the project limits will be shown on the plans. Tape shall be removed by hand methods. Paint shall be removed from portland cement concrete pavement by a high pressure water blast method, or a low pressure water and sand blast method, or a steel shot blast method. Paint shall be removed from bituminous pavement by either a low pressure water and sand blast method or by a steel shot blast method. Paint shall be removed without damaging the surface or texture and without leaving an image that might mislead traffic. High pressure water blast methods shall not exceed 69000 kPa (10,000 psi). Low pressure water and sand blast method shall not exceed 20700 kPa (3000 psi). Paint shall be removed from portland cement concrete pavement by a high pressure water blast method, or a low pressure water and sand blast method, or a steel shot blast method. Paint shall be removed without damaging the surface or texture and without leaving an image that might mislead traffic. High pressure water blast methods shall not exceed 69000 kPa (10,000 psi). Low pressure water and sand blast method shall not exceed 20700 kPa (3000 psi).

621.4 Approval.

621.4.1 Prior to approval and use of lane marking tape, the manufacturer shall submit material and application specifications and samples of the lane marking tape for testing and evaluation. The quantity, types, and widths of tape submitted shall be at the discretion of the engineer. Following the testing and evaluation, satisfactory types will be placed on the approved list.
621.4.2 Removable lane marking tape appearing on the approved list may be accepted for use on the basis of the brand name, color, and width as shown on the approved list, so long as satisfactory performance is obtained in the field.

621.5 Method of Measurement

621.5.1 Measurement of temporary pavement striping will be made to the nearest meter (nearest 10 ft.) as measured along the center line of the pavement from point of beginning to point of ending for each line and totaled to the nearest 25 m (nearest 100 ft.). Where intermittent lines are specified or existing, no deduction will be made for the gaps in the striping. Measurement will not be made for removal of pavement markings.

621.5.2 Final measurement will not be made except for authorized changes during construction or where appreciable errors are found in the contract quantity. The revision or correction will be computed and added to or deducted from the contract quantity.

621.5.3 No direct measurement will be made for painted or taped stop bars, arrows, or other lane control markings, which were existing prior to construction or which are shown on the plans.

621.6 Basis of Payment. The accepted quantity of temporary pavement striping will be paid for at the unit price for each of the pay items included in the contract. No direct payment will be made for the removal of pavement markings or for the installation of lane control markings.
SECTION 622
TEMPORARY PAVEMENT MARKING

622.1 Description. This work shall consist of installing and maintaining reflective temporary pavement marking tape on resurfacing projects.

622.2 Materials.

622.2.1 Color. The tape shall be white or yellow as required for the specified application. If requested by the engineer, the contractor shall furnish without charge a test sample of the tape not less than 3 m (10 ft.) long.

622.2.2 Reflectivity. The tape shall be readily visible when exposed to automobile headlights at night and shall show the following minimum reflective values at 0.2 degree and 0.5 degree divergence measured in accordance with MoDOT Test Method T8. The reflective values shall be expressed as average candelas per lux, per square meter (candle power per foot-candle, per square foot) of material, measured at 45 degrees angle of incidence on a 0.3 m x 0.6 m (1 ft. x 2 ft.) panel covered with strips of the tape in a longitudinal orientation.

<table>
<thead>
<tr>
<th>Divergence Angle</th>
<th>White</th>
<th>Yellow</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.2 degree</td>
<td>1.5</td>
<td>1.0</td>
</tr>
<tr>
<td>0.5 degree</td>
<td>1.0</td>
<td>0.5</td>
</tr>
</tbody>
</table>

The reflected color shall be white or yellow as required for the specified application.

622.2.3 Adhesive. The marking tape shall have a precoated pressure sensitive adhesive that requires no activation procedures. The adhesive shall be resistant to oil, chemicals, acids, solvents, and water, and shall be clear in color.

622.2.4 Thickness and Width. The tape shall have an average thickness of not less than 0.4 mm (15 mils) when tested in accordance with ASTM D 2103 and shall have a nominal width of 100 mm (4 in.). Following application, the tape shall remain conformed to the texture of the pavement.

622.2.5 Durability. The tape shall be weather resistant and show no appreciable fading, lifting, or shrinkage during its useful life. Samples of the tape applied to standard specimen plates and tested in accordance with Federal Test Method Standard No. 141, Method 6192, using a CS-17 wheel 1000-gram load shall show no significant change of color after 2000 cycles.

622.2.6 Appearance. The tape as applied shall be in good condition, free of cracks, and with edges straight and unbroken.
622.2.7 Acceptance. The contractor shall furnish a manufacturer’s certification in triplicate certifying that the material supplied conforms to all of the requirements specified. The acceptance of the reflective temporary pavement marking tape will be based upon the manufacturer’s certification and upon the results of such tests as the engineer may make.

622.2.8 At the option of the contractor, machine applied traffic paint and glass beads may be used in lieu of reflective tape provided satisfactory reflectivity is obtained.

622.3 Construction Requirements.

622.3.1 When the contractor’s work has obliterated the existing traffic striping on resurfacing projects open to through traffic, the contractor shall provide and maintain temporary pavement marking. The center line and lane lines of all lanes subjected to traffic during construction shall be marked. The lane marking shall be in place at the end of each day’s work between all lanes open to traffic.

622.3.2 The center line marking shall be yellow for a two-lane road with opposing traffic and shall be white for a two-lane road with one way traffic. Reflective tape shall be applied in increments 1200 mm (48 in.) long parallel to the direction of traffic flow at approximately 12 m (40 ft.) intervals.

622.3.3 The center line marking for pavement of sufficient width to accommodate four or more undivided lanes carrying opposing traffic shall be marked with two parallel 1200 mm (48 in.) increments of yellow tape separated by a 100 mm (4 in.) space at approximately 12 m (40 ft.) intervals. Lane lines for these pavements shall be marked with white tape applied in increments 1200 mm (48 in.) long at approximately 12 m (40 ft.) intervals.

622.4 Method of Measurement. Measurement of temporary pavement marking will be made to the nearest 0.1 km (nearest 1/10 mile) as measured along the center line of the pavement, or each pavement of a divided highway, regardless of the number of applications. Final measurement will not be made except for authorized changes during construction or where appreciable errors are found in the contract quantity. The revision or correction will be computed and added to or deducted from the contract quantity.

622.5 Basis of Payment. The accepted quantity of temporary pavement marking will be paid for at the contract unit price.
SECTION 623
CONCRETE BONDING AND EPOXY MORTAR

SECTION 623.10 CONCRETE BONDING COMPOUND.

623.11 Description. This work shall consist of surface preparation, and application of concrete bonding compound to be used to bond plastic concrete or mortar to hardened concrete as shown on the plans.

623.12 Materials. All mortar shall conform to Division 1000, Materials Details, and specifically as follows:

<table>
<thead>
<tr>
<th>Item</th>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>Epoxy Resin Materials</td>
<td>1036.1</td>
</tr>
</tbody>
</table>

623.13 Construction Requirements.

623.13.1 Surface Preparation. The surface of the hardened concrete to which the plastic concrete or mortar is to be bonded shall be thoroughly cleaned by sand blasting, wire brushes, hammers, or other methods so that all loose and unsound concrete is removed and only sound concrete remains. The areas to be bonded shall be surface dry and all dust and loose particles removed by air jets prior to application of the bonding agent.

623.13.2 Application. The bonding agent shall not be applied when either the air or surface temperature is 15°C (60°F) or below.

623.13.2.1 The two components shall be thoroughly mixed in the ratio and in accordance with the instructions shown on the containers. The two components may be warmed with indirect heat to a temperature of 32°C to 38°C (90°F to 100°F) to reduce the viscosity. Under no circumstances shall any solvent be added to the compound.

623.13.2.2 The mixed bonding agent shall be applied with a moderately stiff bristle brush, and thoroughly worked into the hardened concrete surface. The thickness of application shall be an average of 0.5 to 0.6 mm (20 to 25 mils). If the concrete absorbs the bonding agent, another coat shall be applied.

623.14 Basis of Payment. No direct payment will be made for the furnishing of material, surface preparation, or application.

SECTION 623.20 EPOXY MORTAR.
623.21 **Description.** This work shall consist of surface preparation and the furnishing and application of epoxy mortar as shown on the plans.

623.22 **Materials.** All materials shall conform to Division 1000, Materials Details, and specifically as follows:

<table>
<thead>
<tr>
<th>Item</th>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low Viscosity Epoxy</td>
<td>1036.1</td>
</tr>
</tbody>
</table>

623.22.1 Sand for mortar shall be an approved silica aggregate such as quartzite sand (Ottawa sand or equivalent). The sand shall be clean, dust free, dry (2 percent maximum moisture), bagged, and shall conform to the following requirements:

(a) Chemical Analysis (Average Quarry Run):

- Silicon Dioxide, percent, min .......................... 98.80
- Aluminum Oxide + Titanium Dioxide, 0.85 percent, max ................................................. 0.85
- Iron or Ferric Oxide, percent, max ..................... 0.10
- Sodium Oxide, percent, max ............................. 0.10
- Potassium Oxide, percent, max ......................... 0.20

(b) Physical Properties:

- Specific Gravity ........................................ 2.60-2.70
- Loss on ignition at 1000°C ............................ 0.08-0.16
- Melting Point, degree C ................................. 1676-1871
- Weight per cubic meter (loose), kg .................... 1200 - 1525
- Hardness-Mohs’ Scale, min .............................. 7
- Voids (loose), percent................................. 30 - 50

(c) Gradation:

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Percent Passing</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.18 mm (No. 16)</td>
<td>100</td>
</tr>
<tr>
<td>600 μm (No. 30)</td>
<td>97-100</td>
</tr>
<tr>
<td>300 μm (No. 50)</td>
<td>5-35</td>
</tr>
<tr>
<td>150 μm (No. 100)</td>
<td>0-2</td>
</tr>
<tr>
<td>75 μm (No. 200)</td>
<td>0-0.4</td>
</tr>
</tbody>
</table>

The contractor shall furnish a certification in triplicate to the engineer certifying that the sand supplied conforms to all requirements specified. The certification shall include or have attached typical test results for all specified properties.
623.2.3 Construction Requirements.

623.2.3.1 Surface Preparation. The surfaces to which the epoxy mortar is to be applied shall be free of oil, solvents, grease, dust, bitumen, dampness, loose particles, and foreign matter. A large size commercial vacuum cleaner, or an air jet or both shall be used to remove dust and other particles just prior to placing the mortar. If an air jet is used, care shall be taken to avoid deposit of oil by the air pump.

623.2.3.2 Application. The epoxy mortar shall be prepared and placed when the weather is dry and the air temperature is above 21\(^\circ\) C (70\(^\circ\) F) but not higher than 34\(^\circ\) C (93\(^\circ\) F). The engineer may permit placement when the mix temperature and the surface temperature are above 15\(^\circ\) C (60\(^\circ\) F) and the air temperature is steady or rising.

623.2.3.1 The mortar shall be 3.25 parts sand to one part low viscosity epoxy, by volume.

623.2.3.2 The contractor shall estimate the time required to complete an area to be patched or leveled and the volume of material needed, and he shall mix only the number of containers of material that can be placed in 20 to 40 minutes depending on the temperature.

623.2.3.3 The two components of the low viscosity epoxy shall be thoroughly mixed in the ratio and in accordance with the instructions shown on the containers. Mixing shall be done with a special paddle designed for the purpose and driven by a low speed electric drill (500 to 600 rpm) or other approved mixing device. The mixing shall continue for 2 to 3 minutes or as required to obtain uniformity.

623.2.3.4 When the low viscosity epoxy material has been thoroughly mixed, sand shall be added gradually while mixing continues, and after the proper quantity of sand has been added, mixing shall continue for 1 to 2 minutes until the mixture is uniform.

623.2.3.5 The areas to be patched or leveled shall be thoroughly primed with an application of neat low viscosity epoxy. After the area is primed, the mortar shall be placed and struck off to grade. The surface shall have a rough finish equivalent to that of a portland cement concrete deck.

623.2.3.6 The patched or leveled area shall be protected during the curing period to prevent damage. The length of time required for curing will vary with temperature. The contractor shall acquaint himself with information from the epoxy resin manufacturer relative to the normal curing periods that can be expected at various ambient temperatures. Under no circumstances shall curing be hastened by direct flame application, but approved types of radiant heating systems may be used.

623.2.4 Safety Precautions. Epoxy resin compounds are toxic and the solvents are flammable. The contractor shall take due precaution to protect workmen from the hazards of handling these materials.

623.2.5 Basis of Payment. No direct payment will be made for the furnishing of material,
surface preparation, or application.
SECTION 624
GEOTEXTILE CONSTRUCTION

624.1 Description. This work consists of installation of geotextile for use in subsurface drainage, in erosion control, as a permeable separator or as otherwise specified.

624.2 Material. All material shall conform to Division 1000, Materials Details, and specifically as follows:

<table>
<thead>
<tr>
<th>Item</th>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>Geotextile</td>
<td>1074</td>
</tr>
</tbody>
</table>

624.3 Construction Requirements.

624.3.1 Areas on which geotextile is to be placed shall be reasonably smooth and free from mounds, windrows, debris or projections. Geotextile shall be placed in a manner to minimize wrinkles or creases in the material. When used for erosion control or to separate soil and granular material, geotextile shall be placed loose to the contour of the ground so as to be free to adjust to minor indentations and protrusions as rock or fill is placed against or over the material but secured sufficiently to preclude sliding or displacement during fill placement and under traffic. Geotextile shall be secured in place as necessary to perform the work with steel pins or by other suitable means.

624.3.2 Lengths and widths of geotextile shall be chosen to minimize the required number of overlaps or seams. Adjacent rolls or strips of geotextiles shall either be sewn in accordance with recommendations of the manufacturer to meet seam strength requirements of AASHTO M 288, or overlapped.

624.3.2.1 Overlaps shall be sufficient to prevent openings in the geotextile coverage as a consequence of subsequent filling operations and shall meet the following minimum requirements: 450 mm (18 in.) overlap on slopes 1:3 (3:1) or flatter; 600 mm (24 in.) on slopes steeper than 1:3 (3:1); 900 mm (36 in.) if placed underwater or on soft, yielding ground which, in the opinion of the engineer, ruts excessively under construction traffic; 300 mm (12 in.) when used to cover structural joints or drain pipes; and equal to the trench width, when used to line drainage trenches unless otherwise shown on the plans.

624.3.2.2 Strips installed horizontally on slopes shall be overlapped upslope over downslope. Strips placed transverse to channel slopes shall be overlapped in the direction of flow. If a preformed "sock" is not used to cover pipe embedded in sand, the pipe shall be wrapped one and one-half times, tied or otherwise secured at intervals as required to maintain the integrity of the overlap and laid in the trench with the exposed lap end oriented toward the bottom of the trench.
624.3.2.3 Fill placement and spreading on geotextile shall not be performed against the direction of geotextile overlap.

624.3.3 Traffic shall not operate directly on uncovered geotextile. Sudden stops, starts and turning motions shall be kept to a minimum unless at least two lifts of overfill are in place. Unless otherwise specified, the initial lift of overfill shall not be less than 200 mm (8 in.), loose measurement, in thickness or twice the maximum particle size, whichever is greater.

624.3.4 Damaged or punctured geotextile shall be replaced or patched to the satisfaction of the engineer. Patches may be sewn or overlapped. Unsewn patch overlaps beyond the area of damage shall exceed roll overlap requirements of this section by at least 300 mm (12 in.).

624.3.5 Type 3 (Erosion Control) geotextile shall be protected from damage due to the placement of large rock by limiting the height of drop of the material to no greater than 900 mm (3 ft.). In addition, if a Class B geotextile is used, either a cushioning layer of sand shall be placed on top of the geotextile or a zero drop height shall be utilized to place the rock. Regardless of the required placement technique, the contractor shall demonstrate that the placement technique will prevent damage to the geotextile. Placement of material shall begin at the toe and proceed up the slope.

624.3.6 When placed behind wall panels or facing elements, geotextile shall be installed and secured in a manner proposed by the contractor and approved by the engineer such that migration of fines is controlled while allowing free drainage.

624.3.7 Drainage trenches to be lined with Type 1 (Subsurface Drainage) geotextile shall be prepared with smooth sides and bottoms. The geotextile shall be placed to conform loosely to the shape of the trench and laid back on either side of the trench to allow for placement of aggregate backfill and pipe and for backfill compaction which shall be done in a manner to prevent damage to the geotextile. After compaction, the geotextile shall be lapped over the completed installation trench width or as shown on the plans.

624.3.8 The U. S. Standard sieve number corresponding to the apparent opening size (AOS) shall not exceed 150 µm (100) for geotextile used in contact with any soil with more than 50 percent passing the 75 µm (No. 200) sieve, nor shall it exceed 70 when used between any two dissimilar granular material, less than 50 percent passing the 75 µm (No. 200) sieve, or to control movement of fines from a granular backfill through structural joints or into a drain pipe.

624.3.9 During shipment and storage, geotextiles shall be protected from direct sunlight, ultra-violet rays, temperatures greater than 60°C (140°F), mud, dust and debris.

624.4 Method of Measurement. Geotextile used for lining drain trenches, wrapping drain pipe or for control of piping through structural joints and facing panels will not be separately measured and paid for, but will be considered as incidental and included in the unit price for the drain or structure. Geotextiles used for other purposes will be measured to the nearest square meter (square yard) of surface area covered without regard to any overlap.
624.5 Basis of Payment. The accepted quantity of geotextile will be paid for at the unit price included in the contract for the specific item. No direct payment will be made for securing pins or other incidental items.
SECTION 625
FLOWABLE BACKFILL

625.1 Description. This work shall consist of furnishing flowable backfill as specified on the plans or otherwise allowed for compacted backfill and other cavity filling uses.

625.2 Material.

625.2.1 All material shall conform to Division 1000, Materials Details, and specifically as follows:

<table>
<thead>
<tr>
<th>Item</th>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fly Ash</td>
<td>1018</td>
</tr>
<tr>
<td>Cement</td>
<td>1019</td>
</tr>
<tr>
<td>Admixtures</td>
<td>1054</td>
</tr>
<tr>
<td>Water</td>
<td>1070</td>
</tr>
</tbody>
</table>

Fine aggregate shall meet the quality requirements of Sec 1005.2, except for the percent passing the 75 µm (No. 200) sieve. It shall be fine enough to stay in suspension in the mortar to the extent required for proper flow and shall conform to the following gradation:

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Percent Passing</th>
</tr>
</thead>
<tbody>
<tr>
<td>19.0 mm (3/4 in.)</td>
<td>100</td>
</tr>
<tr>
<td>75 µm (No. 200)</td>
<td>0-10</td>
</tr>
</tbody>
</table>

625.2.2 Mixture. The contractor shall submit to the engineer a mix design including the proportions and source of material, admixtures, dry cubic meter (cubic yard) batch masses (weights) and actual 28 day compressive test results which shall exceed 345 kPa (50 psi).

625.2.2.1 Mix Design. Unless otherwise specified, the mix shall contain a minimum of 60 kg (100 lbs.) of cement and 148 kg (250 lbs.) of fly ash per cubic meter (cubic yard), with the remainder of the volume composed of sand, water and any approved admixtures.

625.2.2.2 Consistency. Consistency of the fresh mixture shall be that of batter, not thin and watery. It shall be tested by filling an open-ended 75 mm (3 in.) diameter, 150 mm (6 in.) high cylinder to the top with the mixture and immediately pulling the cylinder straight up. The correct consistency of the mixture will produce an approximate 200 mm (8 in.) diameter circular-type spread with no segregation. Adjustments of the proportions of fine aggregate or water may be made to achieve proper solid suspension and optimum flowability with the approval of the engineer, however the theoretical yield shall be maintained at one 1 cubic meter (cubic yard) for the given batch masses (weights).
625.2.3 Approved commercial brand mixtures intended specifically for use as flowable backfill may be used provided the specified strengths are obtained. If approved for use, the material shall be placed in accordance with the manufacturer's recommendations which shall be furnished to the engineer. All commercial mixtures shall use 60 kg (100 lbs.) or more of cement per cubic meter (cubic yard) of fill in place.

625.2.3.1 To obtain approval of a commercial brand mixture, the manufacturer shall submit a request along with appropriate documents to the County Engineer for testing and evaluation. Upon approval of the material, the brand name will be placed on a list of prequalified commercial brand flowable backfill material.

625.3 Construction Requirements. The open ends of the area to be backfilled shall be plugged and the void area filled without the use of a vibrator.

625.3.1 Care shall be taken to prevent the movement of any structure from its designed location or intrusion of flowable backfill into undesirable locations. If such movement or intrusion occurs, affected structures may be required by the engineer to be excavated and replaced to the proper grade at the contractor's expense.

625.3.2 If flowable backfill is placed in more than one layer, the base layer shall be thoroughly roughened and all loose and foreign material removed before placing the next layer.

625.3.3 No flowable backfill shall be covered or accepted until a minimum compressive strength of 205 kPa (30 psi) has been attained, as demonstrated by failure to deform or crush underfoot when a pressure of approximately 205 kPa (30 psi) is applied. Note that the material may scuff in this condition. If the backfill does not harden to support the required load, it shall be removed and replaced with an acceptable material.

625.4 Method of Measurement. If flowable backfill is specified, measurement will be made by the computed volume to the nearest 0.1 cubic meter (1/10 cubic yard) of the voids to be filled, as determined from the dimensional area of the open area. Final measurement will not be made except for authorized changes during construction or where appreciable errors are found in the contract quantity.

625.4.1 If flowable backfill is used as an alternate to compacted backfill specified in the contract or as shown on the plans, measurement will be made as required for the item specified.

625.5 Basis of Payment. If flowable backfill is specified, the accepted quantity will be paid for at the contract unit price for "Flowable Backfill", cubic meters (cubic yards).

625.5.1 No additional payment will be made if flowable backfill is used as an alternate to compacted backfill. The accepted quantity will be paid for at the contract unit price for the item specified.
SECTION 626
PAVEMENT SURFACE TEXTURING AND REMOVAL

626.1 Description. This specification covers removing the surface of, or texturing, existing pavements and bridge decks. Traffic control shall be as specified herein or as shown in the plans.

626.10 Coldmilling Existing Pavement For Removal of Surface.

626.10.1 Description. This work consists of improving the profile and cross slope of the existing surface on roadways or bridge decks to the depths indicated on the plans, and removal of the milled material.

626.10.2 Equipment.

626.10.2.1 The equipment for profiling and removing the pavement surface shall be a power operated, self-propelled planing machine or grinder capable of removing a thickness of bituminous or concrete surface to the specified depth and providing a uniform profile and cross slope.

626.10.2.2 The equipment shall be self-propelled with sufficient power, traction and stability (rigid suspension, non-pneumatic tire) to maintain accurate depth of cut and slope. The equipment shall be capable of accurately and automatically establishing profile grades within ± 3 mm (±1/8 in.) each edge of the machine by referencing from the existing pavement by means of a ski or matching shoe or from an independent grade control. The equipment shall be controlled by an automatic system for controlling grade elevation and cross slope at a given rate.

626.10.2.3 The machine shall be equipped with water spray to control dust and other particulate matter created by the cutting action. It shall also have an effective means of removing cuttings from the pavement and discharging them into a hauling unit, all in one operation as the pavement is milled.

626.10.3 Construction Methods.

626.10.3.1 When coldmilling is to be followed by resurfacing, milling shall only begin when the contractor is ready to immediately follow-up with the resurfacing operation. The milled surface shall not be exposed to traffic for an extended period of time before being resurfaced. In the event the milled surface begins to ravel under traffic or other problems resulting from the milling occur, restrictions on the amount of time that a milled area may be left open will be determined by the engineer.
626.10.3.2 The pavement surface shall be removed to the depth, width, grade and cross section as shown on the plans or as directed by the engineer.

626.10.3.3 The pavement planing operations except in depth transition areas shall be regulated by an automatically controlled grade leveling and slope control device. The device shall provide control for producing a uniform surface to the established grade and a cross slope conforming to the requirements of the typical section. The device shall also be equipped with the necessary controls to permit the operator to adjust or vary the slope as directed by the engineer.

626.10.3.4 Depth transitions at the beginning and end of a project, side roads, bridge ends or where shown on the plans shall be coldmilled by using a machine and process as approved by the engineer. Any necessary pavement marking in the transition areas shall be as directed by the engineer at no direct pay.

626.10.3.5 The roadway pavement surface shall be removed and planed around and over manholes, utility valves and drainage appurtenances within the limits of the work as directed by the engineer. Any damage to manholes, utility valves or drainage appurtenances by the removal and planing operation shall be the responsibility of the contractor to correct. After removal of existing material around manholes, utility valves and other appurtenances in the driving lanes, the contractor shall place a temporary wedge of bituminous material at a slope no steeper than 20 mm per meter (1 in./ 4 ft.) around the appurtenance. Bituminous wedges shall be removed prior to resurfacing. No direct payment will be made for compliance with this specification.

626.10.3.6 For roadway surfaces, the surface of each layer shall be substantially free from waves or irregularities. The final surface, including pavement repair limits, shall not vary from a 3-meter (10 ft.) straightedge, applied parallel to the centerline, by more than 3 mm (1/8 in.). Spalled areas shall be repaired using an approved plant mix bituminous pavement commercial mix. The texture produced for the finished pavement shall be a grid surface with discontinuous longitudinal striations meeting the approval of the engineer. The milling shall produce a serviceable riding texture with no objectionable noise level.

626.10.3.7 Existing shoulder material shall be removed as necessary to ensure no ponding of water on the driving surface after the milling operation.

626.10.3.8 Care shall be exercised not to damage existing concrete pavement.

626.10.3.9 Loose material on roadway surfaces not picked up by the milling machine shall be swept or broomed and picked up immediately behind the milling operation, except, in areas with earth or stabilized aggregate shoulders, small amounts of loose material not picked up by the milling machine may be swept to the shoulders as approved by the engineer. Loose material on bridge deck surfaces not picked up by the milling machine shall be swept and removed from the bridge deck immediately behind the milling operation.

626.10.3.10 All milled material from the project shall remain the property of the County and shall be stockpiled as designated in the contract.
626.10.3.11 The contractor shall apply pavement marking as required in the plans through the limits of milling of roadway surfaces in accordance with Sec 622.

626.10.4 Method of Measurement. Measurement for removal of the existing pavement surface will be computed to the nearest square meter (square yard). Final measurement will not be made except for authorized changes during construction, or where appreciable errors are found in contract quantity. The correction will be added to or deducted from the contract quantity.

626.10.5 Basis of Payment. The accepted quantity of removal of existing surface will be paid for at the contract unit price. No direct payment will be made for loading, hauling, stockpiling or disposing of milled material, repairing spalled areas, placing and removing temporary bituminous wedges around manholes, utility valves or other appurtenances, applying pavement marking, or other items incidental to completion of the work.

626.20 Coldmilling Pavement For a Driving Surface

626.20.1 Description. This work consists of improving the profile, cross slope or texture of existing pavement surface for the purpose of rut removal or retexturing. The finished profile shall provide a smooth riding surface, free from gouges, and shall have a uniform textured appearance.

626.20.1.1 The operation shall produce a serviceable riding surface texture with no rutting or excessive noise level and a constant drainable cross-section. The contractor shall be knowledgeable of the equipment capabilities and is advised that the texture specified may not be obtainable at high production speeds.

626.20.1.2 The specific location and description of work to be performed shall be as described in the contract. The locations may be field adjusted in length by the engineer, not to exceed 0.5 kilometer (1/4 mile) for any one location and provided the total area for all locations is not changed, without change in payment. All specified locations shall be milled.

626.20.1.3 Contractors shall make their own conclusions concerning the quantity of material to be removed. The actual depths of milling will vary due to rut depths, drainage and profile requirements.

626.20.2 Equipment. Equipment for profiling and removing the pavement surface shall be in accordance with Sec 626.10. In addition, the following requirements shall apply.

626.20.2.1 The milling drum shall have equally spaced teeth with a minimum of 1 per 5 mm (60 per ft.) of drum width, in a minimum of two equally spaced flights. The minimum drum cutting width shall be 3.6 m (12 ft.).

626.20.2.2 The carbide cutting teeth shall be uniform in diameter, with a uniform length of ±0.5 mm (± 0.02 in.). In addition, the tooth holder blocks shall be uniform and not vary the cutting radius of the mandrel by more than ± 0.5 mm (± 0.02 in.).
626.20.2.3 Broken teeth shall be replaced immediately and may be corrected by replacing the individual tooth, provided the replacement tooth is matched to within ± 0.5 mm (± 0.02 in.) of the adjacent teeth length. This procedure is not to be used to avoid changing the set of teeth as a unit, when needed to produce the required surface texture.

626.20.3 Construction Methods.

626.20.3.1 The pavement surface shall be removed to the depth as directed by the engineer and as described in this specification.

626.20.3.1.1 Rut Removal. Removal of material for rut removal shall be to the approximate depth of the bottom of the wheel rut in the lane being milled. The bottom of the rut should be textured, but only minimal material removed. Milling shall be done in an approximate lane width, but may start to the right of the centerline in the approximate left wheelpath, extending into the shoulder to allow drainage, leaving the existing centerline marking in place.

626.20.3.1.2 Texturing. Removal of material for surface texturing shall be done for the full lane width, to the depth needed in order to texture all of the described areas.

626.20.3.2 After the proper combination of mandrel speed and forward speed have been established to produce the required texture, the daily operation is to be uniform and continuous for other than repair or emergency operations. It shall not be halted to load or unload trucks, or take on water.

626.20.3.3 The pavement milling operations shall be regulated by an automatically controlled grade leveling and slope control device. The device shall provide control for producing a uniform surface to the established grade and a cross slope conforming to the requirements of the typical section. The device shall also be equipped with the necessary controls to permit the operator to adjust or vary the slope as directed by the engineer.

626.20.3.4 The entire surface shall be textured, substantially free from waves or irregularities, and shall not vary from a 3-meter (10 ft.) straightedge, applied parallel to the centerline, by more than 3 mm (1/8 inch). There may be occasional exceptions where the bottom of a wheelpath may not be textured, in order to maintain an acceptable profile. Spalled areas shall be repaired using an approved bituminous patching material.

626.20.3.5 The texture produced for the finished pavement shall be a uniform surface with longitudinal striations. There shall be a maximum lateral distance of 5 mm (0.2 in.) between adjacent longitudinal striation mark lines. The longitudinal distance from the center of a strike mark to the center of the next successive strike mark in line shall not exceed 125 mm (5 in.). The longitudinal successive strike marks shall approximate a continuous grooved line. The difference between the high and low of the surface texture shall be approximately 2 mm (1/16 in.).

626.20.3.6 The pavement surface shall be removed and milled around and over appurtenances such as manholes or utility valves or within the limits of the work as directed by
the engineer. Any damage to appurtenances by the milling and removal operation shall be the responsibility of the contractor to correct.

626.20.3.7 Material adjacent to the lane being milled shall be removed as necessary to provide a smooth transition and to ensure no ponding of water on the driving surface after the milling operation. There will be no pay for additional milling width beyond lane width as required for drainage. Removal in the traffic lanes shall be with the same equipment, providing the same texture. Removal of shoulder material may be with other milling equipment, meeting the engineer's approval.

626.20.3.8 Loose material not picked up by the milling machine shall be swept or broomed and picked up immediately behind the milling operation. If required by the engineer, the finished surface shall be wetted just prior to returning to traffic in order to reduce traffic visibility problems due to dust.

626.20.3.9 All milled material from the project shall remain the property of the County and shall be stockpiled as designated in the contract.

626.20.3.10 All milling shall be completed at each location before milling is started at the next location.

626.20.4 Traffic Control and Marking.

626.20.4.1 Handling traffic shall conform to General Provisions, and specifically as follows.

626.20.4.2 The contractor shall not sign work areas for more than a maximum of one-half day's run. Only one work area shall be closed at a time. Signing shall be in accordance with the latest version of Missouri Standard Plans for Highway Construction and specifically as indicated on the traffic control plan.

626.20.4.3 The contractor shall maintain traffic over the existing pavement. At least one lane and the adjacent shoulder shall be open to traffic at all times.

626.20.4.4 Entrance and exit traffic shall be allowed at all times at interchanges, as designated on the traffic control plan, except for short periods of time as approved by the engineer for the purpose of moving equipment across the pavement.

626.20.4.5 At the end of the work day, existing advanced warning signs and cones shall be removed and traffic shall be allowed to drive on the milled surface.

626.20.4.6 A shadow truck shall be positioned properly with respect to the work. This truck shall have an attached truck mounted attenuator (TMA) and flashing arrow panel. The flashing arrow panel mounted on the shadow truck shall operate in a flashing caution mode for work along the main roadway. The flashing caution mode shall consist of simultaneous flashing lights in each corner of the arrow panel and shall not represent in any way, an arrow or chevron.
626.20.4.7 Removed edge striping next to a shoulder is not required to be replaced by the contractor, unless otherwise noted in the plans. Any other pavement marking removed by the milling is to be replaced in accordance with standard specifications or other provisions of the contract.

626.20.4.8 All expenses incurred by the contractor by reason of compliance with the above traffic requirements shall be considered as included in and completely covered by the unit bid price for the various items of work included in the contract. Any additional signs shall be furnished entirely at the contractor's expense. There will be no direct pay for the relocation of any signs.

626.20.5 Method of Measurement. The roadway lane width will be assumed for computing milling quantities. Measurement for removal of the existing pavement surface will be computed to the nearest square meter (square yard). Final measurement will not be made except for authorized changes during construction, or where appreciable errors are found in contract quantity. The corrections will be added to or deducted from the contract quantity.

626.20.6 Basis of Payment. The accepted quantity of removal of existing pavement surface will be paid for at the contract unit price. No direct payment will be made for loading, hauling, stockpiling or disposing of milled material, repairing spalled areas, temporary pavement marking or other items incidental to completion of the work. Traffic control shall be paid for at the accepted unit bid price for the items included in the contract.

626.30 Diamond Grinding Concrete Pavement

626.30.1 Description. This work consists of grinding concrete pavement to provide good riding characteristics, a surface texture and proper drainage. The finished surface shall be in conformity with the lines, grades, thicknesses and typical cross sections shown on the plans or established by the engineer.

626.30.2 Equipment. The grinding equipment shall be a power-driven, self-propelled machine specifically designed to grind and texture concrete pavement using diamond blades. The effective wheel base of the machine shall be long enough to minimize vertical fluctuations. The equipment shall be of a size that will grind a strip at least 1 meter (3 ft.) wide. The equipment shall be capable of grinding the surface without causing spalls at cracks, joints or other locations.

626.30.3 Construction Requirements.

626.30.3.1 The construction operation shall be scheduled and proceed in a manner that produces a uniform finished surface. Auxiliary or ramp lane grinding shall transition from the edge of the mainline as required to provide drainage and an acceptable riding surface. Grinding of bridge decks will not be required unless otherwise specified in the contract.

626.30.3.2 If pavement undersealing is required, it shall be completed prior to any grinding.
626.30.3.3 Grinding shall be accomplished in a manner that eliminates joint or crack faults and provides drainage by maintaining a constant cross-slope between grinding extremities in each lane. A tolerance not to exceed 2 mm (1/16 in.) will be allowed for adjacent sides of joints and cracks, except that under no circumstances shall the grinding depth exceed 20 mm (3/4 in.) from the top of the original surface. When grinding across faulted joints, a minimum of a 6 meters (20 ft.) transition onto the approach side slab shall be used.

626.30.3.4 The transverse slope of the pavement shall conform to the typical section shown on the plans and shall have no depressions or misalignment of slope greater than 2 mm per meter (1/4 in./12 ft.) when measured with a 3.6-meter (12ft.) straightedge placed perpendicular to the centerline. Areas of deviation shall be reground. Straightedge requirements do not apply across longitudinal joints or outside the ground area.

626.30.3.5 As soon as practicable after grinding, the surface will be straightedged longitudinally by the engineer and all variations exceeding 1 mm per meter (1/8 in./ 10 ft.) will be plainly marked. Areas of deviation shall be reground.

626.30.3.6 Substantially all of the pavement surface shall be textured. Extra depth grinding to eliminate minor depressions in order to provide texturing on 100 percent of the pavement surface will not be required.

626.30.3.7 The grinding process shall produce a final pavement surface that is true to grade and uniform in appearance with a longitudinal line type texture. The line type texture shall contain parallel longitudinal corrugations that present a narrow ridge corduroy type appearance. The peaks of the ridges shall be approximately 0.8 mm (1/32 in.) higher than the bottoms of the grooves with approximately 55 evenly spaced grooves per 305 mm (1 ft.), measured perpendicular to the centerline.

626.30.3.8 The contractor shall remove and dispose of all residue from the grinding in a manner and location acceptable to the engineer. Slurry or residue shall be removed from the pavement surface as soon as practicable and shall not be allowed to encroach on open lanes.

626.30.3.9 No overnight lane closures shall be done for grinding operations.

626.30.4 Traffic Control and Marking. Traffic control and marking shall be in accordance with Sec 626.20.

626.30.5 Method of Measurement. Measurement will be made to the nearest square meter (square yard). Final measurement will not be made except for authorized changes during construction or where appreciable errors are found in the contract quantity.

626.30.6 Basis of Payment. The accepted quantity of ground pavement surface will be paid for at the contract unit price per square meter (square yard) for diamond grinding concrete pavement.
Division 700

STRUCTURES
SECTION 701
PEDESTAL PILE

701.1 Description. This work shall consist of constructing a cylindrical reinforced concrete shaft cast in place to serve as a pedestal pile foundation for a structure.

701.2 Materials. All materials shall conform to Division 1000, Materials Details, and specifically as follows:

<table>
<thead>
<tr>
<th>Item</th>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reinforcing Steel for Concrete</td>
<td>1036</td>
</tr>
</tbody>
</table>

Pedestal piles shall be made of Class B concrete, and all materials, proportioning, air-entraining, mixing, slump, and transporting of portland cement concrete shall be in accordance with Sec. 501.

701.3 Equipment. Casing, where used, shall be a metal shell of ample thickness and strength to withstand stress and avoid distortion due to handling, the internal pressure of plastic concrete, and the external pressure of the surrounding earth and water, and shall be watertight. The inside diameter of the casing shall be equal to the diameter of the pile.

701.4 Construction Requirements.

701.4.1 Excavation for a pedestal pile may be made by hand methods or with a power-driven boring machine as an open well, inside or through a casing, or any combination of these methods, and shall include excavating through whatever material is encountered. The elevations of the bottom of pedestal piles shown on the plans are approximate only and may be raised or lowered by the engineer depending upon the conditions encountered. The shaft shall be sunk vertically within a tolerance of 8 mm/m (1 in./10 ft.). The bottom of the excavation shall be cleaned of all loose boulders and loose or scaly shale or rock. The pile shall be keyed or cast into the foundation material as directed by the engineer.

701.4.2 Where soil conditions permit, the shafts for pedestal piles may be excavated without the use of casings. If the excavation reaches a point where caving conditions or ground water seepage is encountered, a construction method shall be employed which will prevent any caving that tends to make the excavation appreciably larger than the size of the pile. The contractor may install casings to facilitate construction of pedestal piles. Withdrawal of casings will not be required unless otherwise provided in the contract. Casings to be left in place shall be installed in such manner that there will be no voids between the earth and the casing. The casing shall not extend more than 300 mm (12 in.) below the top of satisfactory foundation material. No payment will be allowed for any concrete or other material required because of an oversize casing or oversize excavation. If the elevation of the top of pedestal pile is below ground level at the time of concrete placement, an oversize casing from ground elevation to a point below the
top of the pedestal pile will be required to prevent caving of any material into the freshly placed concrete.

701.4.3 After excavating is completed the contractor shall install a temporary casing for the protection of personnel working in or inspecting the shafts and foundation material. Such casing may be removed, at the discretion of the contractor, either before or during the placing of concrete. The shaft shall be dewatered for inspection of the foundation material. The contractor shall provide fresh air ventilation, electric lights, suitable means of ingress and egress, and shall assist the engineer in making the required inspection of the shaft and foundation material. Test holes may be required by the engineer in accordance with Sec. 206.3 and will be paid for in accordance with Sec. 206.6.2.

701.4.4 The reinforcing steel cage for the pedestal pile shall be completely assembled and placed as a unit for the full length of the pile prior to placing any concrete. The cage shall be supported by some positive method to prevent its displacement. Approved spacers shall be provided at intervals along the cage to insure concentric positioning for the entire length. Additional reinforcement may be added to stiffen the cage at the contractor’s option and expense.

701.4.5 Concrete for the pedestal pile shall be placed as soon as practicable after the excavation has been completed and inspected. Concrete shall be placed through a suitably baffled tube to prevent segregation of concrete materials. The tube shall be of such construction that it will permit discharge and raising as the concrete placement progresses. If casings are to be removed, they shall be withdrawn as the concrete placement progresses. A 600 mm (2 ft.) minimum head of concrete shall be maintained in the casing to prevent displacement of the fresh concrete by caving material. The concreting shall be a continuous operation except for the time interval necessary for retracting the casing. If the placing of concrete is delayed more than 45 minutes, or if any upward movement of concrete inside the casing occurs during the retraction, the pulling shall be stopped and that portion of the casing extending into the concrete shall be left in place. Casings to be removed shall be smooth and well oiled.

701.4.6 Where an excavation cannot be practicably dewatered for the placement of concrete, the engineer may authorize a portion of the concrete to be placed under water. Concrete placed under water shall be carried to a height of at least 600 mm (2 ft.) above the bottom of the casing, and to a height sufficient to withstand the hydrostatic pressure. When this concrete has reached sufficient strength to withstand the hydrostatic pressure, the casing shall be dewatered and the remainder of the concrete placed in the dry.

701.4.7 No piling shall be driven or boring performed, either by jackhammer or drilled caisson methods; within a radius of 6 m (20 ft.) of concrete that has taken initial set and has not attained a compressive strength of at least 10 MPa (1500 psi). Compressive strength will be determined by tests made in accordance with St. Charles County methods.

701.5 Method of Measurement.
701.5.1 Measurement will be made to the nearest 0.1 m (linear foot) of each pedestal pile
in place. No direct payment will be made for excavation below the top of the pile, or for casings left in place.

**701.5.2** Reinforcing steel will be measured and paid for in accordance with Sec. 706. Additional longitudinal and horizontal reinforcement required to extend the length of the steel cage will be measured and paid for, but no payment will be allowed for reinforcement incorporated in any part of the work by the contractor for his convenience.

**701.6 Basis of Payment.**

**701.6.1** The accepted quantity of pedestal pile will be paid for at the contract unit bid price per meter (per linear foot) for the diameter of pile specified.

**701.6.1.1** Payment for additional completed pile lengths in excess of the “longest pile” as hereinafter defined, up to a maximum of 2 m (8 ft.), will be made at the contract unit bid price plus 25 percent.

**701.6.1.2** Any work necessary to extend the length of pedestal piles more than 2 m (8 ft.) in excess of the “longest pile” as hereinafter defined will be paid for as extra work.

**701.6.1.3** The “longest pile” for the purpose of additional payment will be the maximum length pile, regardless of diameter, shown on the plans for interior bents of all bridges included in the contract.
SECTION 702
BEARING PILE

702.1 Description. This work shall consist of furnishing and driving concrete, steel, and timber piles to the bearing and penetration required, at the location shown on the plans.

702.2 Materials.
702.2.1 All materials shall conform to Division 1000, Materials Details, and specifically as follows:

<table>
<thead>
<tr>
<th>Item</th>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reinforcing Steel for Concrete</td>
<td>1036</td>
</tr>
<tr>
<td>Round Timber Piles</td>
<td>1050.5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Item</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steel Strand</td>
<td>AASHTO M 203</td>
</tr>
<tr>
<td>Cast In Place Pile Shells (Thick Shell Type)</td>
<td>ASTM A252</td>
</tr>
<tr>
<td>Welded or Seamless Steel Pipe</td>
<td>AASHTO M 183</td>
</tr>
<tr>
<td>Closure Plates</td>
<td>SAE-1010 or SAE-1015</td>
</tr>
<tr>
<td>Fluted Pipe</td>
<td>SAE-1020</td>
</tr>
<tr>
<td>Forged Steel Tips or Noses</td>
<td>AASHTO M 183</td>
</tr>
<tr>
<td>Structural Steel Pile</td>
<td></td>
</tr>
</tbody>
</table>

702.2.2 Precast Concrete Piles. Precast concrete piles shall be manufactured of Class A-1 concrete to the shape and size shown on the plans or to an approved equivalent section. All materials, proportioning, air-entrainment, mixing, slump, and transporting of portland cement concrete shall be in accordance with Sec. 501. Precast piles shall be straight, with a center line variation of not more than 10 mm/6 m (112 in./25 ft.) of length of pile. Precast concrete piles shall be lifted and handled by a suitable bridle attached to the pile at points shown on the plans. Unless the concrete is steam cured in accordance with Sec. 703.3.17, removal of precast concrete from casting beds shall not begin for at least 48 hours after casting and not then until a compressive strength of 10 MPa (1500 psi) has been attained. If the concrete is steam cured, removal shall not begin until a compressive strength of 10 MPa (1500 psi) has been attained. Curing shall be continued for at least 24 hours after a compressive strength of 17 MPa (2400 psi) has been attained. Precast piles shall not be transported or driven until at least 7 days after casting and then only if the compressive strength of 17 MPa (2400 psi) has been attained. Compressive strength of concrete shall be determined by tests of standard cylinders made of concrete from the same batches and cured in the same manner as the piles.

702.2.3 Precast-Prestressed Concrete Piles. Precast-prestressed concrete piles may be furnished in lieu of precast concrete piles. They shall be manufactured in accordance with Sec.
705 using Class A-1 concrete. End anchors shall not be released until the concrete has attained a compressive strength of 28 MPa (4000 psi) as determined by tests of standard cylinders made of concrete from the same batches and cured in the same manner as the piles.

702.2.4 Cast-In-Place Concrete Piles. Cast-in-place concrete piles shall consist of Class B-1 concrete cast in pre-driven metal shells. The metal shells shall conform to the shape, size and minimum shell thickness shown on the plans, or to an approved equivalent section. All materials, proportioning, air-entrainment, mixing, slump, and transporting of portland cement concrete shall be in accordance with Sec. 501. Metal shells driven with or without a core or mandrel shall be of sufficient thickness or shall be reinforced so that they will hold their original form without distortion after being driven. Metal pile shells shall be free from water, soil, and other deleterious matter when concrete is cast in them. The contractor shall maintain on the job at all times prior to and during the filling of the shells, a light suitable for use in their inspection.

702.2.5 Structural Steel Piles. Structural steel piles shall be of the series rolled as H-bearing piles. They shall be of the size, weight, and structural shape designated on the plans. Piles shall not have a camber or sweep in excess of 3 mm (1/8 in.) multiplied by the length of pile in meters (feet) divided by 1.5 (5). Steel piles shall be stored on platforms, skids, or other supports at the site of the work and shall be supported at not more than 4.5 m (15 ft.) intervals.

702.2.6 Timber Piles. Timber piles shall be pointed where required by soil conditions. If specified in the contract or authorized by the engineer, piles shall be shod with metal shoes of approved design. The points of the piles shall be shaped to secure an even uniform bearing on the shoes. Care after treatment of pile shall be in accordance with Sec. 1050.7.

702.2.7 Pile Lengths. The pile lengths shown on the plans are approximate. The contractor shall be fully responsible for the lengths he furnishes for driving to obtain the specified penetration and bearing. Sub-surface investigations made by the County are for design purposes only.

702.2.8 Test Piles. Test piles shall be the same material and size as the permanent piles, except that if treated timber piles are specified for the structure, untreated timber test piles may be used if not driven in a permanent location. Test piles of precast concrete shall, in general, be driven in permanent position. Test piles shall be of such length as to permit driving the tips to an elevation 3 m (10 ft.) below that indicated by plan lengths unless otherwise specified.

702.2.9 Certifications. For structural steel piles and thick shells for cast-in-place piles, the contractor shall furnish two copies of a certification from the pile manufacturer or fabricator setting out the designated specifications with which the material complies. Heat numbers must be clearly shown on each pile at time of installation and must match certifications.

702.3 Equipment.

702.3.1 Concrete Testing Equipment. Equipment for field determination of compressive strength of concrete shall be furnished by the contractor at the location of manufacture of precast and precast-prestressed piles. The contractor shall furnish a sufficient
number of compression test cylinder molds of a type meeting the approval of the engineer. The contractor shall furnish sufficient personnel for cleaning and preparing reusable molds. The testing machine may be of any mechanical or hydraulic type capable of applying and measuring the required load and shall comply with the accuracy tolerances and corrections specified in AASHTO T 67-74, Sec. 17.1 and Sec. 18. Approximately the last one-half of the load shall be applied at a rate of between 8 and 21 MPa (1200 and 3000 psi) per minute.

702.3.2 Driving Equipment. The contractor shall furnish pile driving equipment adequate for handling the length of pile to be placed in the leads and for driving the total length of pile to the tip penetration and bearing required. Piles shall be driven with power-driven hammers, or by a combination of power-driven hammer and water jets. Power-driven hammers are defined as hammers operated by steam, air, or diesel power. For determining the energy per blow of diesel power hammers without a fully enclosed ram, 75 percent of the manufacturer’s energy rating for the hammer will apply. If the contractor desires to check a diesel power hammer against an approved steam hammer on a specified type of pile at a particular site, he may do so at his expense, and the checked rating of the diesel powered hammer will be used in determination of pile bearing values at that site. Diesel hammers which have a fully enclosed ram shall be equipped with a gauge and accompanying charts which evaluate the equivalent manufacturer’s rated energy being produced under any driving condition.

702.3.3 Leads. Pile driver leads shall be constructed in such manner as to afford freedom of movement of the hammer, and they shall be held in position by guys or stiffener braces to insure support to the pile during driving. Inclined leads shall be used for the driving of battered piles.

702.3.4 Followers. Followers may be used in the driving of piles only if approved in writing by the engineer. When a follower is used, one pile of every group of 10 shall be driven without a follower to determine the available bearing value of the group.

702.3.5 Water Jets. Waterjets used to aid in driving piles shall be sufficient in number to deliver a volume and pressure of water at the jet nozzles that will freely erode the material adjacent to the pile. The use of water jets shall be discontinued before the final penetration is reached, and the piles shall be driven to secure a final penetration of not less than 0.5 m (2 ft.) if the nature of the soil permits.

702.3.6 Hammer Energy. The minimum energy of hammer shall not be less than shown in Table 1.
Table 1M-Hammer Energy (Metric)

<table>
<thead>
<tr>
<th>Type of Pile</th>
<th>Energy Required</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N.m (minimum)</td>
</tr>
<tr>
<td>Precast Concrete</td>
<td>3 times the mass in kilograms being</td>
</tr>
<tr>
<td></td>
<td>driven, but not less than 11 000.</td>
</tr>
<tr>
<td>Steel Shells for Cast-in-Place</td>
<td>3 times the mass in kilograms,</td>
</tr>
<tr>
<td></td>
<td>including mandrel if used, being</td>
</tr>
<tr>
<td></td>
<td>driven, but not less than 11,000.</td>
</tr>
<tr>
<td>Structural Steel</td>
<td>The largest of the following:</td>
</tr>
<tr>
<td></td>
<td>(a) 3 times the mass being driven,</td>
</tr>
<tr>
<td></td>
<td>in kilograms.</td>
</tr>
<tr>
<td></td>
<td>(b) 306 times the bearing value, in</td>
</tr>
<tr>
<td></td>
<td>megagrams.</td>
</tr>
<tr>
<td></td>
<td>(c) 9500.</td>
</tr>
<tr>
<td>Timber</td>
<td>11 000</td>
</tr>
</tbody>
</table>

Table 1E-Hammer Energy (English)

<table>
<thead>
<tr>
<th>Type of Pile</th>
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<tbody>
<tr>
<td></td>
<td>Foot Pounds (minimum)</td>
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<tr>
<td>Precast Concrete</td>
<td>Weight being driven, in pounds, but</td>
</tr>
<tr>
<td></td>
<td>not less than 8000.</td>
</tr>
<tr>
<td>Steel Shells for Cast-in-Place</td>
<td>3 times the weight in pounds,</td>
</tr>
<tr>
<td></td>
<td>including mandrel if used, being</td>
</tr>
<tr>
<td></td>
<td>driven, but not less than 8000.</td>
</tr>
<tr>
<td>Structural Steel</td>
<td>The largest of the following:</td>
</tr>
<tr>
<td></td>
<td>(a) 3 times the weight being driven,</td>
</tr>
<tr>
<td></td>
<td>in pounds.</td>
</tr>
<tr>
<td></td>
<td>(b) 225 times the bearing value, in</td>
</tr>
<tr>
<td></td>
<td>tons.</td>
</tr>
<tr>
<td></td>
<td>(c) 7000.</td>
</tr>
<tr>
<td>Timber</td>
<td>8000</td>
</tr>
</tbody>
</table>

702.4 Construction Requirements.

702.4.1 The contractor shall furnish and drive test piles at locations designated. Where required, test piles shall be driven full length, or to refusal, or to a capacity 50 percent greater than that required on the design plans. In all cases the test piles shall be driven to not less than the minimum tip elevation shown on the plans for permanent piles. Test piles shall be driven with the same type of equipment as will be used for driving the permanent piles. Before driving test piles, the excavation shall be completed to an elevation not more than 0.5 m (2 ft.) above the proposed grade at the point where a test pile is to be driven. Test piles not driven in a permanent location shall be cut off, or pulled and backfilled, as approved by the engineer.

702.4.2 Foundation piles shall not be driven until after the excavation for the footing has been substantially completed. The heads of piles shall be protected against damage during driving. The procedure incident to the driving of piles shall not subject them to excessive and undue abuse. Any pile broken or damaged by reason of internal defects or by improper driving, or driven out of its proper location shall be removed and replaced, or a second pile may be driven adjacent thereto if this can be done without detriment to the structure.
702.4.3 Where piles are to be driven through more than 1.5 m (5 ft.) of compacted embankment, whether constructed under this contract or a previous contract, prebored holes will be required entirely through the embankment to the lowest elevation of the natural ground line adjacent to the embankment, or as designated on the plans. The holes shall be of a diameter not less than that of the pile. The space remaining around any type pile after it is driven shall be completely filled with a ready-mix flowable fill (controlled low strength material) having a compressive strength of approximately 8 MPa (1200 psi).

702.4.3.1 Other locations where preboring for piles shall be required will be shown on the plans. At such locations, holes shall be prebored to the elevation specified prior to pile placement. The holes shall have a diameter not less than that of the pile and shall be large enough to avoid damage to the pile being driven through the hole in hard material. The size of the hole shall be approved by the engineer before preboring is started. Pilot holes of lesser diameter than the pile shall not be extended below the pile tip. After the pile is placed in the hole and before driving begins, the space remaining around the pile shall be filled with sand or other approved material before and maintained full during the driving of the pile. The pile shall then be driven in accordance with the requirements of Sec. 702.4.11.

702.4.4 Final position of piles shall be not more than 21 mm/m (1/4 in./ft.) from the vertical or from the batter line shown on the plans. The maximum variation of the head of the pile from the position shown on the plans shall be not more than 50 mm (2 in.), except that piles in footings entirely below the finished ground line may vary not more than 150 mm (6 in.). All piles pushed up by the driving of adjacent piles, or by any other cause, shall be re-driven to required bearing and penetration. Improperly driven, broken, or otherwise defective shells shall be removed and replaced, or otherwise corrected to the satisfaction of the engineer.

702.4.5 Splices. Extending and splicing of piles is not desirable and full length piles shall be driven wherever possible and practicable. The number of splices used shall be held to a minimum. If extensions and splices are permitted or required by the engineer, they shall be made as follows:

702.4.5.1 Steel shells and structural steel piles shall be spliced by a certified welder. Properly dried low-hydrogen electrodes of the E7OXX series shall be used with adequate protection from the elements as set forth in Sec. 712.8. The contractor shall be fully responsible for the adequacy of welds during driving. Steel shells for cast-in-place concrete piles shall be spliced as shown on the plans. Sections used for splicing shall be at least 1.5 m (5 ft.) in length, and not more than two splices per pile shell will normally be permitted. Structural steel piles shall be spliced with a butt-weld as shown on the plans. The contractor will be permitted to furnish lengths of structural steel piles that incorporate not more than one splice per pile for lengths up to and including 12 m (40 ft.). Not more than two splices will be permitted in each pile furnished for lengths exceeding 12 m (40 ft.). In preparation of piles prior to driving the use of individual sections less than 2.5 m (8 ft.) in length will not be permitted. Additional field splices necessary to extend structural steel piles to reach adequate bearing material shall, as far as practicable, be limited to one per pile.
702.4.5.2 Precast and precast-prestressed concrete piles driven below plan elevations shall be extended by build-up construction. The forms for extensions of concrete piles shall remain in place at least 24 hours. The extension shall be cured in accordance with Sec. 703.3.17 and the exposed surfaces shall be finished in accordance with Sec. 703.3.15.

702.4.5.3 Timber piles driven below plan elevations shall be withdrawn and replaced by longer piles or, if approved in writing by the engineer, they may be spliced. If splices are permitted, they shall be of the butt-joint type. The added piece shall conform closely in diameter to that of the main pile at the point of splice. Piles shall be sawed square and the butt joints shall bear evenly over the entire surface. The joint shall be banded with a 1.2 m (4 ft.) length of iron pipe at least 300 mm (12 in.) in diameter centered on the joint and held in position by 16 mm (5/8 in.) lag screws 150 mm (6 in.) long, with three lag screws in the pile and three in the splice. The sawed and trimmed surfaces of treated piling shall be given two heavy brush coats of copper napthenate before the splice is assembled.

702.4.6 Cut-Offs. Tops of all piles shall be cut off square at cut-off elevations. Pile tops, which support timber caps or grillages, shall conform to the plane of the bottom of the superimposed structure. The heads of all treated timber piles shall be covered with a protective cap made by applying a coat of hot roofing pitch and a sheet of 0.610 mm (0.024 in.) galvanized metal. The cap material shall measure at least 150 mm (6 in.) more in diameter than the diameter of the pile, and shall be bent down over the pile, and the edges neatly trimmed and secured with large head galvanized or copper nails. Payment for compliance with this section will be included in the price for pile in place.

702.4.7 Protective Coatings. Before the coatings are applied, the steel shall be thoroughly cleaned. Steel shells and structural steel piles in end bents shall be coated with a heavy coating of an approved bituminous paint applied for a length of 1 m (3 ft.) below the bottom of the concrete cap. All exposed steel piles shall be coated with bituminous paint 1 m (3 ft.) below and 0.3 m (1 ft.) above the finished ground line. All other exposed surfaces of steel shells and structural steel piles, including bracing, shall be painted in accordance with Sec. 712.12 using System C when the superstructure is concrete and the specified system when the superstructure is steel. Protective coatings below the normal low water line will not be required.

702.4.8 Concrete footings shall not be placed on cast-in-place piles until at least 12 hours after the last pile in the footing has been cast. No piling shall be driven within a radius of 6 m (20 ft.) of concrete that has taken initial set and has not attained a compressive strength of at least 10 MPa (1500 psi). Compressive strength will be determined by tests made in accordance with St. Charles County methods.

702.4.9 Static Load Tests. The bearing value of piles shall be determined by actual load tests when called for on the plans or ordered by the engineer. The test shall consist of the application of a load placed upon a suitable platform supported by the pile, with suitable apparatus for accurately measuring the test load and the settlement of the pile under each increment of load. Hydraulic jacks with suitable yokes and pressure gauges may be used in lieu of the loaded platform. The test load shall be applied to exert a uniform pressure over the pile being tested. Prior to the driving of the pile to be loaded, the contractor shall submit to the
engineer plans for applying the test load. Sketches showing arrangement of apparatus for obtaining settlements and recovery measurements of the test shall also be furnished to the engineer. Two gauges shall be used to measure settlement and recovery of the pile loaded, and at least one gauge shall be used on each hold-down pile to measure uplift if the hold-down system of load application is used. All test loads shall be applied concentrically and shall be kept uniform by constant attention to load gauge readings and jacking applications. The driven pile shall not be disturbed for at least 24 hours prior to the application of any portion of the test load. The load shall be applied in 25 percent increments of the total load, allowing rest periods of 6, 12, and 6 hours respectively between the increment of loading. The safe allowable load per pile shall be considered as 50 percent of that load which, after remaining in place for 48 hours, produces a permanent settlement not greater than 5 mm (1/4 in.), measured at the top of the pile. All test loads shall be removed at 30 minute intervals in the same increments specified for placing, and readings for recovery shall be taken just prior to the removal of each increment. If results of the load tests are not satisfactory, the engineer will make arrangements for such corrective changes as deemed necessary which may include redesign of the foundations. No compensation will be allowed for any delay or inconvenience caused by corrective changes or redesign.

702.4.10 Dynamic Bearing Formulae. The following formulae will be used as a guide to determine the safe bearing value of piles when static load tests are not required.

**Metric Units**

\[
P = \frac{2(9.81)WH \times 2W}{1000 (S+3) (W+w)}
\]

* For single acting hammers.

\[
P = \frac{2E \times 2W}{(S+3) (W+w)}
\]

* For double acting hammers and diesel powered hammers with enclosed rams and bounce pressure gauges.

\[
P = \frac{2(0.75E) \times 2W}{(S+3) (W+w)}
\]

* For all other diesel powered hammers unless tested as specified in Sec. 702.3.2

* The Value of \(\frac{2W}{W+w}\) shall be considered unity if it exceeds one.

P = safe allowable bearing value in kilo Newtons.

W = weight of striking part of hammer in Kilograms.

w = weight of pile and mandrel in Kilograms.

H = height of fall in millimeters.

E = manufacturer’s rated energy in Newton Meters per blow at manufacturer’s rated speed, or in the case of a diesel hammer equipped with a bounce pressure gauge the actual energy shown by the gauge chart.

S = average penetration in millimeters per blow for 10 to 20 consecutive blows.
**English Units**

\[
P = \frac{2WH \times 2W}{(S+0.1) (W+w)}
\]

* For single acting hammers.

\[
P = \frac{2E \times 2W}{(S+0.1) (W+w)}
\]

* For double acting hammers and diesel powered hammers with enclosed rams and bounce pressure gauges.

\[
P = \frac{2(0.75E) \times 2W}{(S+0.1) (W+w)}
\]

* For all other diesel powered hammers unless tested as specified in Sec. 702.3.2

The Value of \( \frac{2W}{W+w} \) shall be considered unity if it exceeds one.

\( P \) = safe allowable bearing value in pounds.
\( W \) = weight of striking part of hammer in pounds.
\( w \) = weight of pile and mandrel in pounds.
\( H \) = height of fall in feet.
\( E \) = manufacturer’s rated energy in foot-pounds per blow at manufacturer’s rated speed, or in the case of a diesel hammer equipped with a bounce pressure gauge the actual energy shown by the gauge chart.
\( S \) = Average penetration in inches per blow for 10 to 20 consecutive blows.

**702.4.10.1** The above formulae are applicable only if:

(a) The piles are driven in a vertical position.
(b) The hammer has an unrestricted fall.
(c) The pile head is not broomed, crushed, or splintered.
(d) There is no appreciable bounce of the hammer after striking the pile.
(e) The penetration is at a uniform or uniformly decreasing rate.

**702.4.10.2** For piles driven to a batter, the safe bearing value of the pile shall be taken as follows:

\[
P_B = \frac{0.1 (10-m)}{(1+m^2)} P
\]

( Applies for both English and Metric units)

\( P_B \) = safe allowable bearing value in kilo Newtons (pounds) for batter pile.
\( m \) = the tangent of the angle of batter.
\( P \) = safe allowable bearing value in kilo Newtons (pounds) for vertical pile.

**702.4.11** Piles shall be driven to the minimum penetration indicated on the plans. If no minimum penetration is shown on the plans, piles shall have a tip elevation of at least 3 m (10 ft.) below the bottom of the supported footing or 3 m (10 ft.) below the natural ground line,
whichever is lower, unless specifically authorized otherwise by the engineer. Piles other than structural steel piles shall be driven to attain a bearing value not less than that shown on the plans, determined in accordance with Sec. 702.4.10. Structural steel piles shall, in general, be driven to practical refusal that is defined as a pile bearing value of 1.9 times the design bearing value. In general, timber piles shall not be driven to a bearing value in excess of 90 kN (5 tons), nor concrete piles to a bearing value in excess of 45 kN (10 tons), over the design bearing value.

702.5 Method of Measurement.

702.5.1 Piles in place shall be the actual length of all piles, except test piles, measured to the nearest 0.5 m (nearest linear foot) for that portion of each pile that remains permanently in the structure. Test piles will be measured to the nearest 0.5 m (nearest linear foot) of pile authorized and driven. Precast and precast-prestressed concrete piles with built-up extensions will be considered single piles for measurement. No measurement will be made for the length of pile destroyed when making the extension.

702.5.2 No direct payment will be made for prebored holes through compacted embankments, ready-mix flowable fill used to fill the prebored holes, nor for that excavation required to apply protective coatings.

702.6 Basis of Payment.

702.6.1 The accepted quantity of bearing pile will be paid for at the unit bid price for each of the pay items included in the contract. No direct payment will be made for incidental items necessary to complete the work unless specifically provided as a pay item in the contract. No direct payment will be made for painting exposed surfaces of steel shells, structural steel piles, and bracing. Test piles will be paid for at the contract unit bid price. Test piles when driven and used as permanent piles in place will be paid for as test piles and not as piles in place.

702.6.2 No direct payment will be made for any splices or cut-offs. No direct payment will be made for pile tip reinforcement when shown on the plans or required by specification.

702.6.3 Metal shoes, where specified, will be considered incidental to the work, and no direct payment will be made for metal shoes.

702.6.4 Handling of structural steel piles will include the cutting off or splicing of structural steel piles as necessary and the removal from the project of materials resulting from cut-offs or left-over piles. No direct payment will be made for this item.
SECTION 703
CONCRETE MASONRY CONSTRUCTION

703.1 Description. This work shall consist of constructing culverts, bridges, retaining walls, and other structures of portland cement concrete, and the manufacture, transportation, and erection of precast concrete slab units for bridges.

703.2 Materials.
703.2.1 All materials shall conform to Division 1000, Materials Details, and specifically as follows:

<table>
<thead>
<tr>
<th>Item</th>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bearing Pads</td>
<td>1038</td>
</tr>
<tr>
<td>Joints for Concrete Structures</td>
<td>1057.2</td>
</tr>
<tr>
<td>Joint Sealing Material</td>
<td>1057.2.6</td>
</tr>
<tr>
<td>Precast Concrete Box Culverts and Bridge Sections</td>
<td>1049</td>
</tr>
</tbody>
</table>

All materials, proportioning, air-entraining, mixing, slump, and transporting of portland cement concrete shall be in accordance with Sec. 501 or 704, as applicable.

703.2.2 Changes in sources of cement and aggregates will be permitted only with the written approval of the engineer. Aggregates of essentially the same characteristics, except as noted in Sec. 1005.1.7 and Sec. 1005.2.3, and cements resulting in concrete of the same color, shall be used in any individual unit of the structure. The superstructure is considered an individual unit of the structure unless otherwise shown on the plans.

703.2.3 Concrete for precast slab units may be either Class A-1 or Class X.

703.3 Construction Requirements.
703.3.1 Falsework. Falsework for concrete masonry construction shall be adequate to support and hold the forms true to lines, camber, and grades shown on the plans. The contractor shall submit detailed plans for falsework, but the submission of the plans will not relieve the contractor of the responsibility for obtaining satisfactory results. The falsework shall be constructed in accordance with the submitted plans. The submittal of detailed falsework plans for small structures may be waived by the engineer. Falsework and forms for single and multi-span concrete frames and for continuous concrete slab and girder type bridges shall be provided for the full length of each continuous or monolithic unit and for the full width of the structure before starting concrete placement in that unit. Timber used in falsework shall be sound, in good condition, and free from defects that might impair its strength. Timber falsework piles shall be sound, reasonably straight, free from defects, and long enough to obtain the required bearing without splicing. They shall be accurately cut to the proper grade, and the use of shims or
blocking shall be held to a minimum. Screw jacks shall be placed at approved locations to secure and maintain the required camber. Means shall be provided by the contractor for accurately determining settlement of the falsework while it is being loaded. The contractor shall furnish responsible personnel who shall correct the settlement by adjusting the jacks. These personnel shall be on duty at all times while the falsework is being loaded and until settlement ceases.

703.3.2 Forms. Forms for concrete shall be built true to the lines and grades designated, and be mortar-tight and of sound materials adequate to prevent distortion during the placing and curing of concrete. All concrete shall be formed unless otherwise specified. A concrete pad of approved thickness may be used as a form for the unexposed bottom of end bent beams on piles. No direct payment will be made for the concrete pads. Form work plans, if required by the engineer, shall be submitted by the contractor before form work is started. If during or after placing the concrete, the forms sag or bulge, the concrete affected shall be removed, the forms realigned, and new concrete placed. Construction camber to take care of shrinkage or settlement impairing the strength of the structure by the reduction of depth will not be permitted. The forms shall be designed for a fluid density of 2400 kg/m³ (150 lb./cu. ft.), and in addition, for a live load of 2.5 kPa (50 lb./sq. ft.) on horizontal surfaces and 1.5 kPa (30 lb./sq. ft.) on vertical surfaces for impact and vibration.

703.3.2.1 Face lumber of forms for exposed surfaces of concrete shall present a smooth dressed surface free of loose knots, knot holes, and other defects. The spacing of supports and the thickness of face lumber shall be adequate to prevent distortion due to the pressure of the concrete. Face lumber shall have a minimum nominal thickness of 25 mm (1 in.) for solid lumber or 20 mm (3/4 in.) for plywood. Form material shall be placed with horizontal joints. Triangular moulding, smooth on three sides and having 20 mm (3/4 in.) width on each of the two form sides, shall be used to bevel all exposed edges of the structure, except where special bevels are shown on the plans. A 20 mm (3/4 in.) drip strip will be constructed on the outside edge of all bridge decks.

703.3.2.2 Forms reused shall be in good condition. Form lumber that is unsatisfactory in any respect shall not be used.

703.3.2.3 Design and construction of forms shall permit their removal without damage to the concrete. Cofferdam braces or struts which will extend through any exposed concrete section will not be permitted. Forms under copings and around offsets may be given a draft of not more than 83 mm/m (1 in./ft.) to permit removal without damage to the concrete. For narrow walls where access to the bottoms of the forms is not otherwise obtainable, an opening shall be provided so that chips, dirt, sawdust, or other extraneous material may be removed immediately prior to placing concrete.

703.3.2.4 Interior forms for the top slab of box girder bridges, including their supporting joists and wales, may remain in place unless otherwise shown on plans.

703.3.2.5 Deck Forming Hardware. Material utilized in supporting or securing falsework or forms for bridge decks must be constructed as to be held in place independently of the shear connectors or deck reinforcing steel. Any deck supporting hardware to remain
embedded in the deck or haunch area must be so constructed as to allow for removal to a depth of 25 mm (1 in.) for patching. Also, all hardware that remains in the concrete shall be epoxy coated or galvanized. Where blocking or wedges are required to secure or support forms or brackets, they must form an integral part of the unit and must be securely attached to the form or bracket.

703.3.3 Form lining will be permitted and will be required for exposed curved surfaces. Liners shall be of plywood or of an approved composition board and shall be at least 6 mm (1/4 in.) in thickness.

703.3.4 Fiber tubes for column forms above the ground line shall have a finish free of gaps or overlaps in the inside ply and shall be coated inside with a waterproofing material which will not stick or bond to or discolor the concrete surface of the column. Fiber tubes for column forms from 150 mm (6 in.) below the finished ground line down may show seams, shall be waterproofed, and need not be removed.

703.3.5 Metal forms and combination wood and metal forms may be used when approved by the County Engineer. The forms shall have 9 mm (3/8 in.) plywood fastened to the interior face of the forms to eliminate ridges in the concrete. The minimum size of the plywood shall be 1.2 m x 2.4 m (4 ft. x 8 ft.), with smaller sizes allowed only as the shape of the structure would dictate. The requirement for 9 mm (3/8 in.) plywood to eliminate ridges will not be applicable where the exterior faces of the structure will be covered or for non-exposed areas on box culverts.

703.3.6 Oiling of the inside of all forms will be required except for those having composition linings. The oil used shall be a light, clear paraffin base oil or other approved material that will not discolor or damage the exposed concrete surface. The coating shall be applied before placing reinforcing steel.

703.3.7 Ties and spreaders and all metal appliances used inside of forms to hold them to correct alignment and location shall be so constructed that after removal of forms, the metal may be removed to a depth of at least 25 mm (1 in.) below the surface of the concrete. Metal tie rods used inside the forms where concrete will have an exposed surface shall be a type that will not produce a cavity at the surface of the concrete greater than 40 mm (1 1/2 in.) in diameter. Bolts and rods used as ties shall not be removed by pulling them through the concrete. Wire ties and pipe spreaders will not be permitted, and metal or wood spreaders that are separate from form ties shall be removed as concrete is being placed. A bolt-through method of supporting forms for massive substructure units may be used with the approval of the engineer. Epoxy coated or galvanized coil ties and threaded rods may be permitted to stabilize barrier curb formwork.

703.3.8 Cavities produced by the removal of metal tie rods shall be carefully filled at the time of form removal with mortar composed of approximately one part cement to two parts sand. White cement shall be added to the mortar if necessary to obtain the required color. In order to reduce the shrinkage, no mortar shall be placed in the cavities until 45 minutes after the initial mixing. In lieu of the above, any approved non-shrinking, non-staining type of mortar may be used. After the cavities are filled, the surface shall be left smooth, even, and uniform in color and
256

texture. Tie rod cavities in surfaces against which backfill is to be placed shall be filled with mortar or an approved plastic compound meeting the requirements of Sec. 1057.3. Patching of tie rod cavities in the interior surfaces of box girders will not be required.

703.3.8.1 At the time the wall forms are removed, in addition to filling the tie holes, all fins and irregular projections are to be removed, all surface voids filled, the exposed faces rubbed to a surface which is smooth, even, and uniform in color and texture, and immediately thereafter cured as directed.

703.3.9.1 Fiber tubes shall be properly designed for the use indicated and fabricated of spun-wound or laminated paper. The outside surface shall be waterproof. Tubes shall be stored under cover and kept off damp ground until ready for use. Distortion of the tubes shall be prevented during storage. The ends shall be covered with suitably designed caps that shall be mortar tight. If material used for capping tubes expands when moist, a preformed joint filler 6 mm (1/4 in.) in thickness shall be used around the perimeter of the caps.

703.3.9.2 Steel tubes shall have a minimum thickness of 0.610 mm (0.024 in.) and shall be designed for the use indicated and fabricated to insure against damage or excessive distortion in handling, storage, and placing. The diameter of the tube shall be as specified on the plans with a tolerance of plus zero and minus 20 mm (3/4 in.). The ends of tubes shall be covered with suitably designed metal end caps that are mortar tight. Excessive rusting of tubes will be reason for rejection.

703.3.9.3 Tubes for producing voids in concrete slab superstructures shall be accurately located in positions indicated on the plans and shall be positively anchored to the joists carrying the floor forms. Anchors and ties shall be designed to leave a minimum of supporting material exposed in the bottom of the finished slab of the completed structure. Supporting material shall be epoxy coated or be equipped with plastic coated feet. Details of proposed anchorage and ties for the tubes shall be submitted for approval before work is started on the bridge superstructure. One 20 mm (3/4 in.) weephole shall be provided near each end of each tube. Weepholes shall be placed in straight lines parallel to bents. They shall extend through the forms and be kept open at all times. Tubes shall be protected from moisture and heat until concrete is placed. Distortion of tubes after placing of concrete shall not increase their vertical axis by more than 15 mm (1/2 in.).

703.3.10 Falsework and form removal from under any structural concrete unit shall not be started until the concrete has attained at least the compressive strength shown in Table I. The falsework support of all concrete spans of a continuous or monolithic series shall be first released from the center of all spans, and release shall then proceed simultaneously from all span centers each way toward adjacent bents. Release shall be in such manner as to permit the concrete to gradually and uniformly take stresses due to its own weight.
TABLE I

<table>
<thead>
<tr>
<th>Class of Concrete</th>
<th>Compressive Strength psi, min</th>
<th>Mpa, min</th>
</tr>
</thead>
<tbody>
<tr>
<td>B-I, B-II</td>
<td>3000</td>
<td>21</td>
</tr>
<tr>
<td>B</td>
<td>2750</td>
<td>19</td>
</tr>
<tr>
<td>X</td>
<td>3000</td>
<td>21</td>
</tr>
</tbody>
</table>

Compressive strength will be determined by tests made in accordance with St. Charles County methods.

703.3.10.1 Except as provided in Sec. 703.3.17, forms for vertical surfaces of bridge superstructure shall be removed as soon as the concrete is self-supporting, generally within 24 hours after placement, to permit prompt patching of tie holes.

703.3.11 The forms for precast slab units shall be placed on a rigid, level, smooth base and shall be sufficiently rigid in themselves that there will be no movement of the forms during the placing and the setting of the concrete. Unless the concrete is steam cured in accordance with Sec. 703.3.17, removal of non-prestressed precast slab units from casting beds shall not begin for at least 48 hours after the casting. In addition, whether cured by steam or other means, removal shall not begin for at least 48 hours after the casting. In addition, whether cured by steam or other means, removal shall not begin until a compressive strength of 10 MPa (1500 psi) for Class A concrete, and 8 MPa (1200 psi) for Class X concrete has been attained. Curing shall be continued for at least 24 hours after a compressive strength of 16 MPa (2400 psi) for Class A concrete, and 14 MPa (2000 psi) for Class X concrete has been attained. Precast units shall not be transported or erected until at least 7 days after casting and then only if the stipulated strength for curing has been attained.

703.3.11.1 Concrete Testing Equipment. Equipment for field determination of compressive strength of concrete shall be furnished by the contractor at the location of manufacture of precast slab units. The testing machine may be of any mechanical or hydraulic type capable of applying and measuring the required load and shall comply with the accuracy tolerances and corrections specified in AASHTO T67, Section 17.1 and Section 18. Approximately the last one-half of the load shall be applied at a rate of between 8 and 21 MPa (1200 and 3000 psi) per minute. The contractor shall furnish a sufficient number of compression test cylinder molds of a type meeting the approval of the engineer. The contractor shall furnish sufficient personnel for cleaning and preparing reusable molds.

703.3.12 Placing concrete in any unit of a structure shall not begin until preparations for placing and finishing are satisfactory to the engineer. Concrete shall be placed in the forms in layers as near final position as practicable with minimum handling. Each placement shall be completed in a continuous operation with no interruption in excess of 45 minutes between the placing of contiguous portions of concrete. Where a finishing machine is to be used, it shall be moved over the area to be finished, immediately prior to placing concrete in any bridge deck.
pour, to facilitate checking reinforcement cover and slab thickness. This checking shall be made in the presence of the engineer and with the screeds in the finishing position. Placing of concrete for bridge decks shall proceed uniformly for the full width of the placement. Once begun, placing of concrete in the superstructure of a continuous or monolithic series of spans shall proceed as rapidly as good construction practice will permit until all the concrete in that series is placed. Vibrators having a minimum frequency of 4500 impulses per minute shall be used to thoroughly consolidate the concrete in the forms and around the reinforcing steel. Sufficient vibrators shall be on hand to insures continuous placement of the concrete without delay. They shall not be used for moving concrete from place to place nor shall they penetrate or disturb previously placed layers of concrete which have taken initial set. Vibration shall not be prolonged so as to cause segregation of the materials. Reinforcing steel protruding through transverse or longitudinal headers shall not be disturbed until the concrete is at least 24 hours old.

703.3.12.1 Where placing operations involve dropping the concrete more than 1.5 m (5 ft.), the concrete shall be deposited through vertical sheet metal or other approved pipes. These pipes shall be made in sections not to exceed 1.2 m (4 ft.) in length. In chutes, the velocity of the concrete shall be retarded by the use of baffles or chokers, or by the use of a series of short chutes to reverse the direction. Open troughs and chutes shall be either metal or metal-lined. Where concrete is placed in the interior of pneumatic caissons, it may be deposited through air locks or other approved devices, and the requirement of dropping the mix not more than 1.5 m (5 ft.) will be waived.

703.3.12.2 Concrete shall be worked under and around the reinforcing steel without displacing the steel. Forms and reinforcing steel above concrete being placed and placing equipment shall be kept clean and free from coatings of hardened concrete. Water used for flushing the equipment shall be discharged clear of the concrete and forms.

703.3.12.3 Concrete shall be placed around the tubes forming voids in slab spans using methods to prevent the displacement of the tubes. For tubes having an inside diameter greater than 355 mm (14 in.), the concrete shall be placed in three layers. The first layer shall extend from the floor forms up to a plane 1/4 tube diameter above the bottom of the tubes and the second layer to 3/4 tube diameter. For tubes 355 mm (14 in.) or smaller, the concrete shall be placed in two layers, with the lower layer extending to the middle of the tube. Each layer, after placing, shall be vibrated and allowed to settle before the next succeeding layer is placed, which layer shall be deposited while the concrete in the layer below is still plastic enough to permit intermixing the two layers by use of a vibrator.

703.3.12.4 The sequence of placement of concrete for roadway slabs on a continuous series of spans will be shown on the plans together with the minimum rates of placement required for the basic sequence and for any permissible combinations thereof. The contractor shall observe the basic sequence of placement. If the contractor wishes to request to alter the placing sequence or to combine units, he shall submit a request in writing for approval. Requests to combine parallel units by eliminating longitudinal construction joints shown on the plans, thus increasing finishing widths, will not normally be approved.
703.3.12.5 Concrete for substructure units shall be placed in the dry unless otherwise authorized by the engineer. If the supporting material at plan elevation of the bottom of a pile footing is not sufficiently stable to support the concrete it shall be stabilized, or the bottom of the footing shall be formed to adequately support the concrete. No direct payment will be made for the stabilizing of material or forming under pile footings.

703.3.12.6 Depositing concrete under water will be permitted when provided for in the contract or upon written permission of the engineer. The concrete shall be placed by means of a tremie or a bottom dump bucket. The tremie shall consist of a tube having a diameter of not less than 250 mm (10 in.) and shall be equipped with a hopper of suitable capacity. The bottom dump bucket shall have a capacity of not less than 0.25 m$^3$ (1/3 cu. yd.). The concrete shall be placed in its final position in still water and shall not be vibrated or disturbed after being deposited. Concrete placed under water and for seal courses shall be seal concrete in accordance with Sec. 501. No additional compensation for seal concrete will be given unless previously stipulated in the contract.

703.3.12.7 Equipment provided for conveying and placing concrete by mechanically applied pressure shall have adequate capacity and be suitable for the intended work. Pumping equipment shall be placed so as to prevent transmission of vibration to freshly placed concrete. It shall be so operated as to produce a continuous stream of uniform concrete. The system through which the concrete is pumped shall be manufactured so that no aluminum parts will come into contact with the concrete. An approved backup system will be required for all deck pours.

703.3.12.7.1 At the completion of concrete placement the last concrete used from the pipeline shall be ejected in a manner that will prevent contamination or segregation of the concrete.

703.3.12.8 Concrete used for filling cavities or crevices or low areas as authorized by the engineer and as required in Sec. 206.4.2 shall be Class B concrete. This concrete shall be unformed mass concrete placed separately from and prior to the placing of footing concrete.

703.3.13 Construction and expansion joints in concrete masonry shall be located where provided on the plans except that in case of an unforeseen contingency, an emergency construction joint may be permitted. Surfaces of construction joints shall be roughened or scored unless shear keys are shown on the plans. Shear keys shall be placed in construction joints as shown on the plans or as directed by the engineer. No direct payment will be made for additional shear keys required by the engineer, but not shown on the plans. The face edges of all joints shall be carefully finished, and feather edges shall be avoided. When the placing of concrete is temporarily discontinued, the concrete after becoming firm enough to retain its form shall be cleaned of laitance and other objectionable material, and shall be thoroughly wetted before placing new concrete. Contraction joints in floor slabs of truss bridges may be sawed. Waterstops and flashings as required on the plans shall be continuous if practicable. If splices are shown on the plans or permitted by the engineer, they shall be watertight.

703.3.13.1 Gray sponge rubber compound expansion joint material shall be of the dimensions shown on the plans. Splices shall be held to a practicable minimum and shall be
made by lacing with copper wire or soft-drawn galvanized steel wire. All joint material shall be securely stitched to one face of the concrete with 2.588 mm (No. 10 gage) copper wire or 2.692 mm (No. 12 gage) soft-drawn galvanized steel wire. Unless Joint sealing is specified, the gray sponge rubber material shall be left exposed for its full length with clean and true edges.

703.3.14 Riding surfaces shall be finished true to the alignment, grade, cross section, and camber shown on the plans. These surfaces shall be finished by use of an approved mechanical finishing machine. On skewed structures, the finishing machine shall be adjusted to finish the surface approximately parallel to the skew if the angle of skew exceeds 45 degrees or if the angle of the skew exceeds 30 degrees and the ratio of placement width divided by span length equals or exceeds 0.8. Use of vibratory screeds will not be approved whether or not they are a part of the proposed finishing machine.

703.3.14.1 Machine finishing shall be with an approved self-propelled mechanical finishing machine. The engineer may waive its use on isolated irregular shaped areas of the bridge surface. The finishing machine shall travel on adjustable rails or guides set to proper grade and supported outside the limits of the finished riding surface. Where a longitudinal joint is shown on the plans, the finishing machine rails or guides shall be placed as close as practicable to the longitudinal joint. The rails shall be supported to limit the full operating load deflection between supports to 3 mm (1/8 in.) or less. They shall in general be placed parallel with the centerline of roadway or the longitudinal axis of the area to be finished. Where supports are so located that fresh concrete must be placed around them, the rails or guides shall be furnished in sections of 3 m (10 ft.) or less and placed above the concrete surface. The sections and supports shall be removed and the holes filled with concrete immediately after the final straightedging. The finishing machine shall make sufficient passes to obtain the specified cross section and surface finish. The final pass of the machine shall be of maximum practicable length and shall be coordinated with the rate of placement. Finishing machine loads will not be permitted on concrete less than 48 hours old.

703.3.14.2 Where hand finishing of riding surfaces is permitted, the surface shall be struck off to the design section by a rigid metal shod template. The template shall be supported on rails or guides that can be adjusted to produce the design section and slab thickness. The rails or guides shall be supported above or outside the concrete surface. The surface behind the template shall be finished with a longitudinal float. The longitudinal float shall have a rigid metal shod smoothing surface which is a true plane not less than 3 m (10 ft.) long and 200 mm (8 in.) wide. The float shall be operated from movable bridges with a combined longitudinal and transverse motion. Each transverse pass shall overlap the previously floated area by approximately one-half the length of the float.

703.3.14.3 Sufficient work bridges shall be provided to complete the work in an orderly and continuous manner. Work bridges shall be supported outside the limits of concrete placement.

703.3.14.4 Straightedging. The riding surface shall be checked with a 3 m (10 ft.) straightedge immediately after the final finishing operation. The straightedge shall be pulled lightly across the surface from one edge of the finished area to the other without interruption.
Reaching from outer edges to the center of the finished area will not be permitted. Each transverse pass shall overlap the previously straightedged portion by approximately one-half the length of the straightedge. The straightedge or float shall not be used to cut or move concrete from its finished position. Any irregularities, bumps, or improperly finished areas shall be refinished and the surface again checked by repeating the straightedge operation.

**703.3.14.5 Roadway Finish Texture.** The roadway surface, except within 300 mm (12 in.) of the inside face of the curbs, shall be textured as soon as the condition of the concrete will permit. The roadway finishing shall otherwise conform to the applicable portions of Sec. 502.10.5. Hand operated devices producing a satisfactory texture will be permitted.

**703.3.14.6 Surface Test.** As soon as curing has been completed, the riding surface will be thoroughly straightedged by the engineer and all variations exceeding 3 mm in 3 m (1/8 in. in 10 ft.) will be plainly marked. Areas more than 3 mm (1/8 in.) high shall be removed by an approved device consisting of multiple cutting edges leaving a grooved surface finish comparable to that produced by the broom. The use of a bush hammer or other impact device will not be permitted.

**703.3.14.7** Unless an armored joint is shown on the plans, construction and expansion joints in the roadway surface shall be carefully edged and left free of all mortar and concrete. These joints shall be sealed with joint sealing material if required by the plans. Joints shall be dry and shall be cleaned immediately before they are sealed. Required joint sealing shall be done prior to surface sealing the bridge deck.

**703.3.15** Surface finish for concrete masonry units, other than those specified in Sec. 703.3.14, shall begin immediately following removal of the forms. All exposed surfaces shall receive a surface finish that will completely remove all fins and irregular projections. Form tie cavities, holes, honeycomb spots in other than exposed surfaces, and other defects, shall be thoroughly cleaned, saturated with water, and carefully pointed with a mortar in accordance with Sec. 703.3.8. Repaired surfaces shall be satisfactorily cured.

**703.3.16** Bridge seats shall be finished with a wood float to a smooth even surface. Where lead plates or fabric pads are used to seat steel bearing plates, the area under the lead plates or fabric pads shall be finished to within 3 mm (1/8 in.) above plan elevation and shall be dressed to a uniform, level bearing with a carborundum brick or power grinder after the concrete has set sufficiently to fix the larger particles of sand. Where elastomeric bearing pads are used, the finishing of 3 mm (1/8 in.) above plan elevation and grinding of the bridge seat area will not be required. Wells for anchor bolts shall be completely filled with an expansive type mortar meeting the requirements of Sec. 1066 after the steel has been erected and adjusted. In lieu of wells, anchor bolt wells and holes, and other depressions that might collect water and freeze shall be sealed.

**703.3.17 Curing.** Curing of exposed concrete masonry surfaces shall be in accordance with Sec. 502.12 except as follows: Riding surfaces and other surfaces to be surface sealed shall be cured with mats of jute, cotton, or other suitable fibers. Curing mats shall be applied as soon as the concrete has set sufficiently that no marring of the surface or distortion will result. The
mats at the time of placement shall be sufficiently wet to prevent moisture absorption from the finished surface. The mats for curing riding surfaces shall be kept continuously wet by use of a sprinkler, soaker hose, or similar means until the concrete has attained at least the compressive strength shown in Table I, but in no case for less than 5 days. For use as a vapor barrier, covering of the deck with plastic sheeting will only be permitted with prior approval of the engineer and will not relieve the contractor of the requirement to keep the deck continuously wet by use of a sprinkler, soaker hose, or similar means. The mats for curing other surfaces shall be kept continuously wet for 72 hours. The mats shall then remain in place until they are dry or, if not dry, for at least 24 hours after the end of the wet curing period. Surfaces to be dampproofed, and railroad bridge decks to be waterproofed, shall not be cured with membrane. Such surfaces may be cured by the use of the prime coat specified in Sec. 708.3.2. Other exposed surfaces shall be cured by covering with transparent membrane applied in accordance with the requirements of Sec. 502.12.1, or by the use of wet burlap. If permitted by the engineer, footings may be cured by submersion.

703.3.17.1 Steam curing or curing by complete submersion in water will be permitted for precast members. If steam curing is applied, the jets shall not impinge directly on the concrete or on the forms; free circulation around the units shall be maintained; the steam shall be thoroughly saturated at all times; the temperature around the concrete shall not be raised more than 20°C (40°F) per hour and shall not exceed 70°C (160°F) at any time. After the expiration of the steam curing period, the temperature inside the chamber shall be reduced at a rate of not more than 20°C (40°F) per hour until a temperature has been reached about 10°C (20°F) above the temperature of the air to which the concrete will be exposed.

703.3.17.2 Curing concrete for box girder superstructures shall begin as soon as possible after completion of each concrete placement. Wet mats shall be used for curing the top surface of the bottom slab and the exposed top surfaces of girders and diaphragms for at least 72 hours after the concrete has been placed. Immediately after the removal of the wet mats from these units, the riding surface shall be cured with white-pigmented membrane and all other surfaces with transparent membrane, except the surfaces of construction joints in accordance with Sec. 502.12.1, unless these items have attained the applicable strength specified in Table I. The interior surfaces of girders and diaphragms shall be cured by leaving the forms in place for 5 days or by applying membrane. The membrane curing shall be in accordance with the requirements of Sec. 502.12.1 except that the membrane shall be applied with a brush or roller.

703.3.17.3 Structures shall not be opened to any construction or public vehicular traffic nor will heavy or concentrated loading by materials be permitted until the concrete has reached a compressive strength of 22 MPa (3200 psi).

703.3.18 Scale Prevention Treatment. Bridge decks, except those which are to be surfaced later, shall be treated with one application of an approved mixture of equal parts, by volume, of commercially available double-boiled linseed oil and mineral spirits. The material shall be applied to the top surface of roadways, and the top and roadway faces of concrete sidewalks, curbs, parapets, and medians. It shall be applied on a clean, dry surface of concrete that has been allowed to dry a minimum of 48 hours after curing mats have been removed and before the bridge is opened to other than essential construction traffic. Foreign material on the
surface shall be removed and the ambient temperature shall not be below $2^0 \text{C} (35^0 \text{F})$ at the time of application. The application of the mixture shall be at the rate of not less than 0.25 liters per square meter (0.05 gal./sq. yd.). The mixture may be sprayed or flowed on, or applied with an approved distributor, and shall be thoroughly broomed, brushed or mopped on all specified surfaces.

**703.3.19 Hot Weather Concreting.** When the weather forecast predicts temperatures of $32^0 \text{C} (90^0 \text{F})$, or higher, the contractor shall schedule placing and finishing of bridge deck concrete during hours in which the ambient temperature will be lower than $32^0 \text{C} (90^0 \text{F})$. The mixed concrete when placed in the forms shall have a temperature no higher than $32^0 \text{C} (90^0 \text{F})$. The forms and reinforcing steel shall be cooled by acceptable methods such as covering with wet burlap for at least 12 hours prior to the placing of concrete. The concrete shall be protected with wet curing mats as soon as it has hardened sufficiently to allow placement of the mats.

**703.3.20 Cold Weather Concreting.** Concreting shall proceed on all structures, except bridge superstructures, whether or not heating is required, unless it can be definitely established that the over-all progress of the project will not be affected. Placing of concrete in the superstructure of a continuous or monolithic series of spans once begun shall be continued within the provisions of cold weather concreting procedures until all the concrete in that series is placed. Concrete placed in cold weather shall be protected from freezing during the curing period by the use of a heated weatherproof enclosure. Concrete shall not be placed on frozen ground, nor against steel or concrete surfaces with temperatures lower than $2^0 \text{C} (35^0 \text{F})$. No concrete shall be placed where the ambient temperature is below $2^0 \text{C} (35^0 \text{F})$, and concrete in bridge superstructures shall not be placed where the ambient temperature is below $7^0 \text{C} (45^0 \text{F})$. Insulated forms for cold weather protection may be used at approved locations in lieu of enclosures, if the method will keep the temperature of the concrete between $5^0 \text{C}$ and $26^0 \text{C} (40^0 \text{F}$ and $80^0 \text{F})$. The contractor shall secure prior approval of the type of insulation, method of insulation, and the locations at which it is proposed for use.

**703.3.20.1** The aggregates or water or both shall be heated during the season when the atmospheric temperature may drop below $5^0 \text{C} (40^0 \text{F})$. Aggregates shall not be heated higher than $65^0 \text{C} (150^0 \text{F})$. The temperature of the aggregates and water combined shall not be higher than $38^0 \text{C} (100^0 \text{F})$ when the cement is added. Any method of heating during the mixing of concrete may be used, provided the heating apparatus will heat the mass uniformly and avoid hot spots which will burn the materials. The temperature of the concrete at the time of placing in the forms shall not be lower than $7^0 \text{C} (45^0 \text{F})$ for concrete in footings and massive piers and abutments, nor less than $16^0 \text{C} (60^0 \text{F})$ for all other concrete.

**703.3.20.2** Curing of superstructure concrete and substructure units above ground surface, retaining walls, and box culverts of more than 1.5 m$^2$ (15 sq. ft.) shall be within a weatherproof enclosure when the ambient temperature is below $5^0 \text{C} (40^0 \text{F})$. Temperature within the enclosure shall be uniformly maintained between $5^0 \text{C}$ and $27^0 \text{C} (40^0 \text{F} \text{ and } 80^0 \text{F})$ for not less than 7 days nor more than 14 days. Heating may be discontinued after 7 days provided the concrete has attained at least the applicable strength shown in Table I. When dry heat is used, at least 40 percent relative humidity shall be maintained. The contractor shall provide adequate fire protection at all times and shall maintain proper temperature and humidity conditions within the
housing during the curing period. The exposed surfaces of the concrete shall be kept moist either by the application of steam or wet burlap mats. When curing is complete, the temperature within the enclosure shall be lowered gradually at a rate not to exceed 2°C (3°F) per hour, until the outside temperature is reached. Substructure concrete below ground surface may be protected by submersion provided the temperature of the water is maintained between 5°C and 27°C (40°F and 80°F) for 7 days.

703.3.20.3 Concrete headwalls for pipe culverts, drop inlets, and box culverts of 1.5 m² (15 sq. ft.) or less opening, may be placed without air temperature limitations, but the contractor is not relieved of responsibility for proper protection from freezing during placing and curing of the concrete.

703.3.21 Extending and widening of existing concrete structures shall be in accordance with the details shown on the plans. A continuous groove at least 25 mm (1 in.) deep shall be sawed in the faces of the existing concrete as a guide for the line of break to prevent spalling. Surfaces of existing concrete which are to come in contact with new concrete shall be thoroughly cleaned, saturated with water, and painted with a neat cement grout of painting consistency. The new concrete shall be placed immediately after the cement grout has been applied. If new concrete is to be placed against the natural finish of existing concrete work, the surface shall be roughened by bushhammering before being cleaned and treated. Before applying a new concrete riding surface, any existing bituminous surfacing shall be removed and the exposed concrete surface roughened by bushhammering before being cleaned and treated. No direct payment will be made for work incidental to joining new concrete to existing concrete.

703.4 Method of Measurement.

703.4.1 Concrete masonry will be computed from the dimensions shown on the plans, or as revised in writing by the engineer, and will be computed to the nearest 0.10 m³ (1/10 cu. yd.) for each structure. No deduction will be made for the space occupied by reinforcing steel, conduit, or piles. Deductions will be made for the space occupied by the tubes in voided slabs. Any revision or correction will be computed and added to or deducted from the contract quantity.

703.4.2 Measurement of concrete quantities in seal courses will be made for the actual quantity placed, except that this quantity will be limited to that included within vertical planes 450 mm (18 in.) outside the neat lines of the footings proper, and to the maximum depth shown on the plans or as authorized by the engineer.

703.4.3 Measurement of concrete quantities used to fill cavities or crevices will be made for the accepted quantity placed below the authorized elevation of the structure footing.

703.5 Basis of Payment.

703.5.1 The accepted quantity of concrete masonry, complete in place, will be paid for at the unit bid price for each of the pay items included in the contract.

703.5.2 The accepted quantity of concrete used to fill cavities, crevices, or low areas
below the final authorized bottom of footing elevation will be paid for at the unit bid price for concrete included in the contract.

703.5.3 No direct payment will be made for incidental items necessary to complete the work unless specifically provided as a pay item in the contract. No direct payment will be made for concrete required to fill overbreak where footings or walls are cast against vertical faces of rock or shale excavation. No direct payment will be made for concrete required to fill areas of over-excavation where footings or walls are cast against the vertical faces of the neat footing lines in lieu of forms.
SECTION 704
LOW MASS DENSITY CONCRETE
MASSONRY CONSTRUCTION
CLASS X CONCRETE

704.1 Description. This work shall consist of constructing structures of low mass density concrete, designated as Class X Concrete, composed of a mixture of portland cement, fine aggregate, low mass density fine and coarse aggregate, water, and approved additives.

704.2 Materials.

704.2.1 All materials shall conform to Division 1000, Materials Details, and specifically as follows:

<table>
<thead>
<tr>
<th>Item</th>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>Portland Cement ...........................................</td>
<td>1019</td>
</tr>
<tr>
<td>Fine Aggregate ............................................</td>
<td>1005.2</td>
</tr>
<tr>
<td>Low mass density Fine and Coarse Aggregate ...............</td>
<td>1005.3</td>
</tr>
<tr>
<td>Concrete Admixtures .......................................</td>
<td>1054</td>
</tr>
<tr>
<td>Water .......................................................</td>
<td>1070</td>
</tr>
</tbody>
</table>

The low mass density concrete shall be proportioned, mixed, and transported in accordance with the applicable provisions of Sec. 501. Each kind and size of aggregate shall be stored and proportioned separately.

704.2.2 Mix Design. The proportions of cement, fine aggregate, and low mass density fine and coarse aggregates will be designated by the engineer within the limits of these specifications. Unless otherwise approved by the engineer, Grade 5 low mass density coarse aggregate shall be used. Twenty to 40 percent by volume of the fine aggregate shall be material naturally produced by the disintegration of rock of a siliceous nature and shall meet the requirements of Sec. 1005.2 with the gradation requirements of Sec. 1005.2.4.1. Class C or D Sand, as defined in Sec. 501.2.2.3, shall not be used. The weight of freshly mixed Class X Concrete shall not be greater than 1920 kg/m$^3$ (120 lb./cu. ft.) nor less than 1680 kg/m$^3$ (105 lb./cu. ft.). The mixture shall have a slump, when placed, of not more than 50 mm (2 in.). When air-entrained concrete is specified, the entrained air content shall be 7 percent by volume, with an operating tolerance of plus or minus 2 percentage points.

704.2.2.1 The cement requirement will be 415 kg/m$^3$ (696 lb./cu. yd.), plus or minus 10 kg (19 lb.), as determined by using the batch weights and the weight per cubic meter (foot) of the
fresh concrete in accordance with AASHTO T 121. High early strength cement may be used as provided for in Sec. 501.6.

704.2.3 If specified in the contract, an approved retarder shall be provided and incorporated into the concrete. If not specified in the contract, the use of an approved retarder may be permitted upon written request of the contractor. Approval for the continued use of a retarder will be contingent upon satisfactory performance of the work and permission for its use may be withdrawn at any time satisfactory results are not obtained. Retarder shall be added in accordance with Sec. 501.7.3 by means of a dispenser conforming to the requirements of that section. When both retarder and air-entraining agent are used, the sequence and rate of discharge of both materials shall be as directed by the engineer. No direct payment will be made for furnishing the retarder, incorporating it into the mix, or for placing or finishing the concrete involved.

704.2.4 Trial batches, if required, shall be prepared sufficiently in advance of placing concrete in the structure to permit determination of the 7 day compressive strength of the concrete, or for such other tests as may be determined by the engineer. Generally, three trial batches, of not less than 1.5 m³ (2 cu. yd.) each, shall be mixed for testing. The batches shall be mixed in accordance with Sec. 704.3.2 and agitated in such manner to reproduce the time of haul and discharge time.

704.3 Construction Requirements. The following requirements shall be in effect except as may be modified by an approved alternate submitted by the contractor.

704.3.1 Storage of aggregates shall, in general, be in accordance with Sec. 501.5.3. A moisture sensing device in the fine aggregate bins or weight determination hopper will not be required.

704.3.1.1 All low mass density aggregates shall be stockpiled on the job or at a central batching plant for not less than 24 hours prior to use in the batches. Aggregates shall be stored in floored bins adjacent to the proportioning plant. The aggregates shall be pre-wetted and drained to a uniform moisture content meeting the approval of the engineer. Stockpiles shall be protected to prevent excessive evaporation of moisture after wetting. Wetting of stockpiles shall be done not less than 12 hours prior to use.

704.3.2 While the mixer is in motion, it shall be charged with approximately one-half of the water and all the aggregate required for a batch. The aggregate and water shall be mixed at least one minute, after which the cement shall be added gradually. Additional water shall be added as required to produce the desired consistency. The mixing shall be continued for not less than 5 minutes after the entire batch is in the mixer. Some modification of the usual water measuring and dispensing equipment may be necessary to meet the requirements of these specifications. The consistency of the concrete mix shall be kept uniform and the minimum quantity of water shall be used which will produce the desired workability. If central or truck mixed concrete is furnished, all batches shall be mixed 10 additional revolutions at mixing speed immediately prior to discharge from the hauling unit. Central or truck mixed low mass density concrete shall be delivered to the site of the work and discharge completed within one hour after
beginning of mixing operations.

704.3.3 Forming, placing, finishing, and curing shall be in accordance with the applicable portions of Sec. 703. The concrete shall be placed by starting at one corner and along the header, vibrating the placed concrete uniformly and thoroughly, but not to such extent as to segregate the mixture. Additional concrete shall be placed on top of the leading edge of the concrete previously placed, and shall be adequately vibrated to consolidate the mixture under and around the reinforcing steel in such manner that the mixture will flow along the bottom of the form and come up around the reinforcing steel.

704.4 Method of Measurement. Low mass density (Class X) Concrete will be computed from the dimensions shown on the plans, or as revised in writing by the engineer, and will be measured to the nearest 0.10 m$^3$ (1/10 cu. yd.) for each structure. No deduction will be made for the space occupied by reinforcing steel or conduit. Any revision or correction will be computed and added to or deducted from the contract quantity.

704.5 Basis of Payment.

704.5.1 The accepted quantity of low mass density (Class X) concrete masonry will be paid for at the contract unit bid price. No direct payment will be made for surface sealing, furnishing and placing joint materials, water stops or flashing, and other incidental construction attached to or incorporated in the concrete masonry.

704.5.2 Payment for trial batches directed by the engineer in accordance with Sec. 704.2.4 will be made at 50 percent of the contract unit bid price for Class X Concrete.
SECTION 705
PRESTRESSED CONCRETE MEMBERS
FOR BRIDGES

705.1 Description. This work shall consist of the fabrication and installation of prestressed concrete members, complete in place, in the superstructure of bridges. This work covers both pretensioned and post-tensioned members.

705.2 Materials.

705.2.1 All materials shall conform to Division 1000, Materials Details, and specifically as follows:

<table>
<thead>
<tr>
<th>Item</th>
<th>Section</th>
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<tbody>
<tr>
<td>Reinforcing Steel for Concrete Structures</td>
<td>1036.1</td>
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<tr>
<td>Structural Steel</td>
<td>AASHTO M 183</td>
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<tr>
<td>Structural Steel (for anchorage plates)</td>
<td>AASHTO M 223</td>
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<td>Grade 345 MPa (50)</td>
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<tr>
<td>Steel Strand</td>
<td>AASHTO M 203</td>
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<tr>
<td>Parallel-Lay Wire Cables</td>
<td>AASHTO M 204</td>
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<tr>
<td>High-Tensile Strength Alloy Bars,</td>
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<tr>
<td>(stress relieved and cold stretched to 900 MPa [130,000 psi] min)</td>
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</tr>
<tr>
<td>Ultimate tensile strength</td>
<td>1000 MPa (145,000 psi) min</td>
</tr>
<tr>
<td>Yield strength (0.2 percent offset)</td>
<td>900 MPa (130,000 psi) min</td>
</tr>
<tr>
<td>Modulus of elasticity</td>
<td>173 000 MPa (25,000,000 psi)</td>
</tr>
<tr>
<td>Elongation in 20 diameters</td>
<td>4 percent min</td>
</tr>
<tr>
<td>Diameter tolerance</td>
<td>+0.7 mm, -0.2 mm (+0.03 in., -0.01 in.)</td>
</tr>
</tbody>
</table>

705.2.2 Enclosures for post-tensioning tendons shall be mortar tight, semi-rigid metal tubes with an internal diameter at least 6 mm (1/4 in.) larger than the bar, cable, strand, or wire group to be enclosed, and shall be provided with suitable entrance and discharge ports for grouting.

705.2.3 Mortar for grouting tendons in post-tensioned members shall consist of a mixture of cement and fine sand in the approximate proportions of one part cement to 3/4 part sand, by volume, with sufficient water to form a grout having the consistency of heavy paint.
705.2.4 Concrete materials, proportioning, air entrainment, mixing, slump, and transporting of portland cement concrete shall be in accordance with Sec. 501. Concrete for prestressed members shall conform to all requirements of Class A-1 concrete except that the coarse aggregate shall meet the requirements of Section 1005.1 Gradation E of these specifications and the concrete slump shall not exceed 90 mm (3 1/2 in.). The contractor may use Type I or Type III cement.

705.2.5 Certification. All wire, strand, bars and anchorage assemblies shipped to the site shall be assigned a lot number and tagged for identification. The contractor shall furnish three copies of the certified mill test report giving the chemical analysis and results of physical tests on the material furnished, except chemical analysis will not be required for steel strand complying with AASHTO M 203. The contractor shall furnish three certified copies of the stress-strain curve representative of the lot to be used.

705.3 Equipment.

705.3.1 Prestressing. The contractor shall provide all equipment necessary for the construction and the prestressing of concrete members. Prestressing shall be done with approved jacking equipment. If hydraulic jacks are used, they shall be equipped with accurate pressure gauges. All gauges, load cells, dynamometers, and other devices for measuring the stressing load shall have an accuracy within 2 percent. The combination of jack and gauge shall be calibrated by a testing laboratory meeting the approval of the engineer. A certified graph or table showing the calibration shall be furnished to the engineer. The total load as determined from the strand elongation shall check that indicated by the gauge within 5 percent of the total load required. If other types of jacks are used, proving rings or other devices calibrated by a testing laboratory meeting the approval of the engineer shall be furnished so that the jacking forces may be accurately determined. Calibration shall be repeated at intervals not exceeding 1 year and after each overhaul. While work is in progress, if any jack or gauge appears to be giving erratic results, or if gauge pressure and elongations indicate materially different stresses, recalibration may be required. The contractor shall furnish means of accurately measuring the elongation of the tendons to within 2 mm (1/16 in.). Elongation upon completion of stressing operations shall be within 5 percent of that specified. No tensioning of strands shall be done at ambient temperatures below -10 °C (30 °F).

705.3.2 End Anchorages. End anchorages and stressing blocks for pretensioned members shall be adequately designed to withstand the forces incident to prestressing and to maintain the prescribed tension in all prestressed tendons of any member until the concrete has been placed and attained its specified transfer strength.

705.3.3 Concrete Testing Equipment. Equipment for field determination of compressive strength of concrete shall be furnished by the contractor at the location of manufacture of prestressed concrete members. The testing machine may be of any mechanical or hydraulic type capable of applying and measuring the required load and shall comply with the accuracy tolerances and corrections specified in AASHTO T 67 Sec. 17 and 18. Approximately the last one-half of the load shall be applied at a rate of between 8 and 21 MPa (1200 and 3000 psi) per minute. The contractor shall furnish a sufficient number of compression test cylinder
molds of a type meeting the approval of the engineer. The contractor shall furnish sufficient manpower for cleaning and preparing re-useable molds.

705.4 Construction Requirements.

705.4.1 Shop Drawings. Shop drawings for prestressed concrete members will be required, which are to show in detail the type, size, number of units, location of tendons, enclosures, method and sequence of releasing the strands, anchorage details, and details of proposed lifting loops and lifting procedure. The method of prestressing will be optional with the contractor, provided the total prestressing force and the center of gravity of the prestressing tendons, as shown on the plans, are maintained. The shop drawings shall also tabulate the design computations including initial tension and total load and the tensioning schedule. Tack welding will not be permitted in lieu of tying the reinforcing bars. Six (6) sets of shop drawings shall be submitted to the engineer for approval. Material shall not be ordered until the shop drawings have been approved. Four (4) sets of prints will be marked approved or approved subject to the corrections noted. The contractor shall promptly make the necessary corrections and resubmit for final approval. When shop drawings are finally approved, the contractor shall furnish as many additional prints as may be requested. The approval of shop drawings will cover only the general design features, and in no case shall this approval be considered to cover errors or omissions in shop drawings. The contractor shall be responsible for the accuracy of the shop drawings and the fabrication of the members. The contractor shall also bear the cost of all extra work in the erection of the structure caused by errors in shop drawings and for any changes in fabrication necessary for the satisfactory construction of the structure. After shop drawings have been approved, no changes in dimensions or substitution of materials or construction methods shall be made without written approval. Shop drawings shall be revised to show any authorized changes and the required number of prints shall be furnished to the engineer.

705.4.2 Forms and Formwork. Forms and formwork, placing and tying of reinforcing bars, and placing and vibrating of concrete shall conform to the applicable requirements of Sec. 703 and 706, with the following additions:

(a) Clamps, bolts, or other devices connecting the bulk-head to the side forms, inserts, blockouts, etc., shall be capable of being removed or loosened before steam curing is applied.

(b) The casting bed shall have a concrete deck on which the form grillage and soffit plates may be adequately centered, aligned, and leveled to the same plane.

(c) Exterior forms for prestressed members shall be metal other than aluminum, mortar-tight, and of adequate design to produce members within the tolerances specified.

(d) The temperature of the mixed concrete when placed shall not be higher than 32\(^0\) C (90\(^0\) F). The forms and reinforcing steel shall be cooled by acceptable methods to an ambient temperature of 32\(^0\) C (90\(^0\) F) or lower.

(e) Fabricating plants with demonstrated facilities for protection of the concrete during
cold weather may, with the approval of the engineer, cast prestressed units when the ambient temperature is below 8°C (45°F). When the ambient temperature is below 5°C (40°F), the forms or enclosures shall be preheated to attain an ambient temperature of at least 5°C (40°F). No concrete shall be placed when the ambient temperature is below 2°C (35°F).

(f) The concrete for each unit shall be placed in a minimum of two continuous lifts. Not more than 30 minutes shall elapse between the placing of contiguous lifts of concrete. The thickness of the first layer for I-beam sections shall be such that the top of the concrete is slightly above the top of the bottom fillet. The casting procedure shall be modified when the length of girders and placement conditions are such that an initial set of concrete may result if each lift is continued full length before another lift is placed.

(g) All bulkheads for casting of the prestressed member shall be made of metal other than aluminum of sufficient stiffness to prevent deflection during jacking. Holes for the strands shall be accurately punched or drilled. Beams cast with bulkheads constructed from non-metallic materials, bulkheads constructed from aluminum, or bulkheads with improper strand location will not be accepted for incorporation into the project.

(h) The maximum permissible spacing for top form clamps and bottom form ties is 760 mm (30 in.). Beams cast with top form clamp or bottom form tie spacings greater than 760 mm (30 in.) will not be accepted for incorporation into the project.

705.4.3 Prestressing Tendons. Prestressing tendons for pretensioned members, and metal enclosures for post-tensioned members, shall be accurately placed and securely held during the placing and curing of the concrete. All strands shall be free of contaminants such as dirt, oil, paint, wax, corrosion, or other foreign material that may prevent bond between the strands and the concrete. The use of prestressing strands having kinks, bends, nicks, or other defects will not be permitted. A light coating of rust will not be cause for rejection provided that the loose rust is removed and the surface of the strands is not visibly damaged. Tensioned strands shall be protected against excessive temperatures such as those produced by torches, welding equipment, or sparks. Strands from more than one source shall not be used in any one tensioning operation. After strand release, all strands that are indicated to have a bent projection from the beam shall be cold bent, in a manner that will not injure the strand wires.

705.4.4 Strand Splices. One approved splice per strand will be permitted provided the splices are located outside of the prestressed member. For single strand tensioning, the number of strands per bed that may be spliced is not restricted. When multi-strand jacking is used, either all strands shall be spliced or not more than 10 percent of the strands shall be spliced. Spliced strands shall be similar in physical properties, from the same source, and have the same twist or lay. Previously tensioned strands may be reused one time provided they meet all of the requirements of these specifications.

705.4.5 Wire Failures. Wire failures may be accepted provided not more than one wire in any strand is broken and the area of broken wires does not exceed 2 percent of the total area of
705.4.6 **Stressing Requirements.** The contractor shall provide a technician skilled in the use of the system of prestressing to supervise the prestressing operations.

705.4.7 **Elongation.** It is the responsibility of the contractor to compute the required elongation. Two copies of the computations shall be submitted to the engineer. The length of the strand to be used in calculating elongations shall be the actual length of the strand along its trajectory between the fixed anchorage and the reference point at jacking end of the strand. Stress losses due to slippage of strand anchorages and movement of anchorage abutments shall be included in the elongation computations.

705.4.8 **Pretensioned Members.** Prestressing tendons shall be uncoated, seven-wire, low relaxation strands, conforming to AASHTO M 203, Grade 1860 (270). Several pretensioned members may be cast in one continuous line. The time intervening between the casting of the first and last member on a bed shall not exceed 4 days unless otherwise permitted by the engineer. When the temperature at the time of tensioning is such that correction must be made to compensate for change in strand stresses, all members on the bed shall be cast in a continuous pour. The tension in the strand as determined from the elongation at the time of placing concrete shall be within 5 percent of that specified. The stress to be given each strand shall be as shown on the plans. Pretensioning shall be by either the single strand or multi-strand jacking method. Each strand shall be brought to a uniform initial tension as shown in the tensioning schedule on the approved shop drawings. The initial tension of each strand shall be accurately measured by a dynamometer or other approved means. The initial tension shall be within 200 N (50 lb.) or 2 percent of that required, whichever is the larger. The same jack used for single strand tensioning may be used for initial tensioning provided it is equipped with a proper gauging system for measuring the initial tension. Measurement of elongation shall not begin until initial tensioning has been completed. Strands tensioned as a group shall have the same initial tension, be from the same source, and have essentially the same modulus of elasticity.

Coil ties shall be held in place in the forms by setting studs of the same diameter as the coil tie rods projecting through the forms. Studs shall be left in place during casting of the beams, removed, and then replaced prior to shipping the beams. Coil ties shall have a concrete pull-out strength of not less than 40 kN in 21 MPa (9000 lb. in 3000 psi) concrete. The coil ties shall have an ultimate tensile strength of not less than 80 kN (18000 lb.). Beams cast with improperly located or missing coil ties will not be accepted for incorporation into the project. Drilling and epoxy anchoring of coil tie rods will not be permitted.

705.4.9 **Post-Tensioned Members.** Post-tensioned members shall be stressed in such a manner that the tension being applied and the elongation of the tendon may be measured at all times. The contractor shall furnish a certified record of gauge pressures and elongations to the engineer. Friction losses in the enclosures, elastic shortening, and anchorage set shall be included in the computations for the required elongation of the tendon. In cases of discrepancies between gauge readings and the stress indicated by the elongation of the tendon, the elongation method of stress determination shall govern. Loads shall not be applied to the concrete until it has attained the design compressive strength shown on the plans. Tendons shall be stressed in a sequence to
produce the least eccentricity of the load. Post-tensioning elements shall be placed in metal enclosures and after stressing shall be bonded by pressure grouting the space between the enclosure and the tendon. Enclosures shall be thoroughly cleaned of all foreign materials prior to grouting. The discharge ports shall be closed after all air has been forced out of the enclosure, as evidenced by the steady discharge of grout at its proper consistency, and a pump pressure of at least 345 kPa (50 psi) maintained on the grout for a sufficient length of time to insure completely filling all voids in the enclosure. Post-tensioned members shall not be removed from their supports for at least 24 hours after grouting.

705.4.10 Strand Release. Strands shall not be released until the concrete has attained the initial compressive strength, $f_{ci}$, shown on the plans. The compressive strength shall be determined by tests of standard cylinders made of concrete from the same batches and cured in the same manner as the members. The strands or prestressing elements shall be cut or released in a sequence that produces the least eccentricity of the load. If steam curing is used, strand release shall be performed while the members are still warm. Forms, hold down devices, or other appurtenances which may restrict movement of the members shall be removed or loosened prior to strand release. The sequence for releasing the strands shall be in accordance with the approved shop drawings.

705.4.11 Curing. Concrete members shall be kept continuously wet until the conclusion of the curing period. Curing shall be accomplished by covering with burlap or jute mats kept continuously wet, by moist air, by live steam, or any combination of these methods. Other moist curing methods may be used provided the details of the proposed method are submitted to the engineer and approved. As soon as the concrete has set sufficiently that no marring of the surface or distortion will result, wet burlap or jute mats shall be applied in contact with the exposed surface. Curing shall be continued until the concrete has attained the design compressive strength shown on the plans. The concrete shall not be exposed to temperatures below freezing until the curing has been completed.

705.4.11.1 Steam Curing. A preset period of not less than 4 hours shall be allowed before steam cure is applied. When the ambient temperature is below 10°C (50°F), steam shall be applied also during the preset period, but only at a rate sufficient to keep the air surrounding the beam at a temperature between 10°C and 20°C (50°F and 70°F). After the preset period, steam shall be applied at a rate that will not increase the temperature of the air surrounding the members more than 20°C (40°F) per hour. The maximum curing temperature shall not exceed 70°C (160°F) and the difference in temperature adjacent to the concrete at different locations within the enclosure shall not exceed 15°C (30°F) at any time. Fluctuations of the temperature adjacent to the concrete during the curing period at any one location shall not vary more than 15°C (30°F). The contractor shall furnish and have available for the use of the engineer a minimum of two portable recording thermometers, and not less than one for each 45 m (150 ft.) of enclosure, for use in determining the magnitude and degree of uniformity of temperatures within the enclosure. The temperature recording system shall be capable of automatically producing a temperature record during the entire curing period. The temperature record shall show the temperature at each location at intervals of not more than 15 minutes and have a range of approximately -20°C to 95°C (0°F to 200°F.) The temperature recording system shall be accurate within plus or minus 3°C (5°F). Steam shall be applied from pipes with perforations at
suitable intervals laid along each side of the member, or by other approved arrangements. Jets of steam shall not be permitted to impinge directly against the member, forms, or test specimens. Provisions shall be made for effective circulation of the steam around all portions of the members. The steam shall be thoroughly saturated at all times. If dehydration of the concrete or perceptible drying of the wet burlap initially placed on the concrete is noted, soaker hoses placed on top of the members, or other approved methods shall be used to supply sufficient moisture during the steam curing period. Steam curing shall continue until the required strength for transfer of load has developed. Steam or other curing methods shall continue until the concrete has attained the design compressive strength shown on the plans. After the expiration of the steam curing period, the temperature inside the chamber shall be reduced at a rate of not more than 200°C (400°F) per hour until a temperature has been reached approximately 120°C (200°F) above the temperature of the air to which the concrete will be exposed.

705.4.12 Form Removal. Forms shall not be stripped from prestressed concrete members sooner than 12 hours after casting. If forms are removed before the concrete has attained the strength which will permit the units to be moved or stressed, only the minimum area of the curing enclosure that is necessary to remove each individual form section shall be removed at any one time. The open area in the enclosure shall immediately be closed as each form section is removed. When the surrounding air temperature is below –10°C (30°F), no portion of the enclosure shall be removed before the unit has attained the required transfer strength. Forms of test specimens shall be stripped at the same time the forms are removed from the members.

705.4.13 Handling. Handling and storage of prestressed members shall be performed with the members in an upright position and with points of support in approximately the same position as designated for the final position of the members in the structure. Members shall not be transported or erected until the concrete has attained the design compressive strength shown on the plans. In storage, the members shall be fully supported across their width on battens that are not less than 100 mm (4 in.) wide. During transportation, the ends of I-beams shall not extend a distance of more than the depth of the beam beyond the bolsters or other supports on the transporting vehicle. Other beams shall not extend more than 1 1/2 times their depth beyond the supports on the transporting vehicle. During storage, the supports shall maintain the members in essentially a level position without twisting. Stacking of members in storage shall be done only with the approval of the engineer. If such permission is granted, the supports of all members shall be in the same vertical planes and shall be of adequate thickness to prevent damage to the lifting devices.

All members shall be subject to final inspection and checking for dimensional tolerances, with the exception of camber, within 24 hours prior to shipment. Any members found to not conform to the requirements of Sec. 705.4.14 and Sec. 705.5 will not be accepted for incorporation into the project. All members found to be acceptable will be stamped approved by the engineer.

705.4.14 Surface Finish. Surface finish shall be in accordance with the requirements of Sec. 703.3.15, except that no cracks of any kind in post-tensioned members shall be filled before the stressing is completed. The engineer will determine the kind, type, and extent of cracks and surface defects such as honeycomb and chipped edges or corners that will be tolerated. Repairs may be permitted in accordance with Sec. 703.3.8. Commercially available patching materials
are to be used in lieu of mortar, with the type of material to be used to be directed by the engineer. The top surface of I-Girders shall be scored transversely to a depth of approximately 6 mm (1/4 in.) with a wire brush, stiff broom, or other approved method. The top surface of box sections are to be finished smooth with a mag or other approved means. A 75 mm (3 in.) wide strip at each end and at 1/4 points or 1/10 points, depending on the haunch spacing shown on the plans) across the top flange of the I-Girders shall be smooth finished to accurate top flange depth unless other finishing instructions are noted on the plans. No laitance shall remain on surfaces to be embedded in concrete. After removal of hold-down devices, holes shall be plugged. If the method for plugging these holes is not shown on the shop drawings, written approval of the proposed method shall be obtained from the County Engineer. Exposed reinforcing steel shall be thoroughly cleaned of all concrete before delivery of members. The portions of girders to be embedded in the diaphragms at supports shall be roughened by sandblasting or other approved methods to provide suitable bond between girder and diaphragm. The outside surface of exterior girders shall receive a smooth finish at the time of form removal.

705.5 Dimensional Tolerances. The applicable dimensional tolerances shall be as shown in Table I.
<table>
<thead>
<tr>
<th>Dimensional Tolerance</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length of beam</td>
<td>± 1 mm/m (1/8 in./10 ft.) but not more than 18 mm (3/4 in.)</td>
</tr>
<tr>
<td>Width (Flanges, Web and Fillets)</td>
<td>± 9 mm (3/8 in.), - 6 mm (1/4 in.)</td>
</tr>
<tr>
<td>Depth (Flanges, Web and Fillets)</td>
<td>± 6 mm (1/4 in.)</td>
</tr>
<tr>
<td>Depth (Overall)</td>
<td>± 12 mm (1/2 in.), - 6 mm (1/4 in.)</td>
</tr>
<tr>
<td>Horizontal alignment (Deviation from a straight line parallel to centerline of member)</td>
<td>Length: Up to 12 m (40 ft.) 12 m to 18 m (40 to 60 ft.) over 18 m (60 ft.)  Max. Deviation: 12 mm (1/2 in.) 18 mm (3/4 in.) 25 mm (1 in.)</td>
</tr>
<tr>
<td>Camber (Deviation from design camber at time of release)</td>
<td>± 1 mm/m (1/8 in./10 ft.) but not greater than 12 mm (1/2 in.)</td>
</tr>
<tr>
<td>Camber (Differential between adjacent beams)</td>
<td>1 mm/m (1/8 in./10 ft.) of span but not greater than 25 mm (1 in.)</td>
</tr>
<tr>
<td>Stirrup bars (Projection above top of beam)</td>
<td>± 18 mm (3/4 in.)</td>
</tr>
<tr>
<td>Stirrup bars (Longitudinal spacing)</td>
<td>± 25 mm (1 in.)</td>
</tr>
<tr>
<td>Tendon position</td>
<td>± 6 mm (1/4 in.) center of gravity of strand group and individual tendons</td>
</tr>
<tr>
<td>Position of deflection points for deflected strands</td>
<td>± 150 mm (6 in.), longitudinal</td>
</tr>
<tr>
<td>Position of lifting devices</td>
<td>± 150 mm (6 in.), longitudinal</td>
</tr>
<tr>
<td>Side inserts (Centerline to centerline, and centerline to end)</td>
<td>± 12 mm (1/2 in.)</td>
</tr>
<tr>
<td>Exposed or encased beam ends (Deviation from square or designated skew)</td>
<td>Horizontal ± 6 mm (1/4 in.), Vertical ± 10 mm/m (1/8 in./ft.) of beam height.</td>
</tr>
<tr>
<td>Bearing area (Deviation from plane)</td>
<td>± 3 mm (1/8 in.)</td>
</tr>
<tr>
<td>Bearing plates (centerline to centerline)</td>
<td>± 1 mm/m (1/8 in./10 ft.) but not greater than 18 mm (3/4 in.)</td>
</tr>
<tr>
<td>Bearing plates (centerline to end of beam)</td>
<td>± 12 mm (1/2 in.)</td>
</tr>
</tbody>
</table>
**705.6 Marking.** Each precast unit shall be identified with the date, manufacturer, and identification number. Markings may be indented on the unit or painted thereon with waterproof paint, and shall be located as shown on the plans or as designated by the engineer.

**705.7 Method of Measurement.** Measurement will be made by individual units of each type and each length of prestressed members, complete in place, in the finished structure. The concrete, reinforcing bars, prestressing tendons, anchorages and accessories, enclosures, grout, coil ties, and all other incidentals will be construed as comprising an individual unit.

**705.8 Basis of Payment.** Accepted prestressed concrete members will be paid for at the contract unit bid price.
SECTION 706
REINFORCING STEEL
FOR CONCRETE STRUCTURES

706.1 Description. This work shall consist of furnishing and placing reinforcing steel of the shape, size, and grade required.

706.2 Materials.

706.2.1 All materials shall conform to Division 1000, Materials Details, and specifically as follows:

<table>
<thead>
<tr>
<th>Item</th>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reinforcing Steel for Concrete</td>
<td>1036</td>
</tr>
</tbody>
</table>

706.2.2 Reinforcing steel shall be accurately cut and bent to the dimensions and shapes indicated on the plans, preferably at the mill or shop. Cutting and bending tolerances for reinforcing steel shall be in accordance with the Concrete Reinforcing Steel Institute’s manual of standard practice.

706.2.3 From each heat number, one additional 1 m (36 in.) long bar for each alternating size, beginning with the smallest size, shall be included for testing.

706.3 Construction Requirements.

706.3.1 Reinforcing steel shall be protected from damage at all times. When placed in the work, it shall be free from dirt, oil, paint, grease, loose mill scale, thick rust, and other foreign substances. Thin powdery rust need not be removed. All reinforcing steel required for superstructure concrete, such as slabs, girders, beams, etc., and top slabs of concrete box culverts of more than 1.2 m (4 ft.) span, shall be held securely in correct position by means of approved metal bar supports and ties. These supports shall be manufactured and placed in accordance with the typical details shown on the plans for the various types of superstructures. Reinforcing bars shall be positively secured against displacement. For bridge decks and top slabs of culverts, bars in the top mat shall be firmly tied with wire at each cross or lap. At other locations, the bars shall be firmly tied at the alternate crossings, or closer. The steel shall be tied in correct position and inspected, before any concrete is placed. Such inspection will not relieve the contractor of responsibility for constructing the unit in accordance with the plans. Care shall be exercised to maintain proper clearance between the forms and the reinforcement. Measurements to reinforcing steel shall be made to the centerline of bar, except where clear distance from face of concrete is shown on the plans. Before concrete is placed, any dried mortar shall be cleaned from the reinforcing steel.
706.3.2 Bars shall not be spliced except where shown on the plans or as permitted by the engineer. The use of splices shall be avoided at points of maximum stress. Where possible, splices shall be staggered and arranged to develop the full strength of the bar. Splices shall be made only as shown on the plans or as authorized by the engineer.

706.3.3 Reinforcing steel bar supports for concrete structures shall generally be in accordance with the bar support specifications of the Concrete Reinforcing Steel Institute’s manual of standard practice. Additionally, bar supports will be required, as directed by the engineer, in walls and columns to insure the required concrete cover. Reinforcing steel bar supports shall be epoxy or plastic coated for bridge superstructures and have plastic capped feet at all other exposed locations. When concrete is being placed on subgrade, fill-size cement brick shall be used to support the reinforcing steel. Bar supports used to support the upper mat of steel, in multiple mats, shall be full height, providing the proper clearance. Standees resting on the lower mat of bars will not be permitted.

706.4 Method of Measurement. Measurement will be made to the nearest 10 kg (10 lb.) for each structure. The weight paid for shall be the theoretical weight of plain bars, and no allowance will be made for the clips, wire, supports, and spacers, standees or other fastening devices for holding the reinforcement in place. Allowance will not be made for an overrun in scale weights of bars. Final measurement will not be made except for authorized changes during construction, or where appreciable errors are found in the contract quantity. The revision or correction will be computed and added to or deducted from the contract quantity.

706.5 Basis of Payment. The accepted quantity of reinforcing steel, complete in place, will be paid for at the contract unit bid price. No additional payments will be made for test samples required under provisions of the contract. No direct payment will be made for reinforcing steel bar supports, cost to be included in the reinforcing steel contract unit price.
SECTION 707
CONDUIT SYSTEM ON STRUCTURE

707.1 Description. The work shall consist of furnishing and placing all material and equipment and performing all work necessary to make a complete raceway as shown on the plans.

707.2 Materials. All materials shall conform to Division 1000, Materials Details, and specifically as follows:

<table>
<thead>
<tr>
<th>Item</th>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electrical Conduit</td>
<td>1060</td>
</tr>
</tbody>
</table>

The type of conduit will be specified on the plans. Junction boxes used in the conduit system shall be cast aluminum or cast iron with hot-dip galvanized finish inside and out.

707.3 Construction Requirements.

707.3.1 Conduit bends shall be made in a neat, approved manner by skilled workers. No crushed or damaged conduit shall be used. Conduit ends shall be reamed to remove all burrs, and all cuttings resulting from reaming shall be removed from the conduit before installation. The ends of conduit runs shall be protected by bushings and shall be capped temporarily if conductor cable is not installed immediately. Conduit shall be rigidly held in place to prevent misalignment during placement of concrete. Care shall be exercised when placing concrete to prevent damage to the conduit. Concrete shall be thoroughly worked around the conduit so that there will be complete encasement without voids. Reinforcing bars shall not be cut, bent, displaced, or otherwise altered unless authorized by the engineer. Joints in rigid steel conduit shall be made by means of threaded connections treated with good quality commercially available joint compound to make a waterproof joint. Expansion fittings for the conduit shall be as shown on the plans. A 13 mm (1/2 in.) diameter drain hole in all low points of conduits and junction boxes where exposed, and a 13 mm (1/2 in.) rigid steel conduit drop from the low point if the conduit and junction boxes are encased in concrete, shall be provided for drainage of moisture condensation. Exposed ends of such drains shall be covered with 18 x 14 mesh copper insect screen wire held in place with a conduit bushing.

707.3.2 Immediately after placing concrete, the conduit around which the concrete is placed shall be tested by the contractor, in the presence of the engineer, for continuity and freedom from obstruction by pulling a steel ball through the entire length. The steel ball shall have a diameter 13 mm (1/2 in.) smaller than the inside diameter of the conduit being tested. Galvanized pullwires shall be installed in conduits for pulling wiring by others.

707.3.3 Junction box covers shall be waterproofed with cemented rubber gaskets and securely bolted in place. The junction boxes shall be drilled and tapped for all conduit
connections.

**707.4 Method of Measurement.** The work provided herein will not be measured for payment, but will be considered a lump sum unit.

**707.5 Basis of Payment.** The accepted conduit system on structure will be paid for at the contract lump sum bid price.
SECTION 708
DAMPPROOFING

708.1 Description. This work shall consist of the application of dampproofing materials below the ground line on those portions of substructure units or walls designated in the contract. Dampproofing will be classified as Ordinary Dampproofing or as Special Dampproofing.

708.2 Materials. All materials shall conform to Division 1000, Materials Details, and specifically as follows:

<table>
<thead>
<tr>
<th>Item</th>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dampproofing and Waterproofing Materials</td>
<td>1072</td>
</tr>
</tbody>
</table>

708.3 Construction Requirements.

708.3.1 Dampproofing shall not be applied in wet weather nor when the ambient temperature is below 10°C (50°F). Concrete shall be dry and clean before dampproofing is applied. When bituminous material is used for curing, it may also serve as a priming coat, except that additional primer may be necessary before application of the mop coat. The bitumen for dampproof mop coat shall be carefully heated to a temperature within the following limits:

- Asphalt: 150°C to 175°C (300°F to 350°F)
- Coal-Tar Pitch: 90°C to 120°C (200°F to 250°F)

The bitumen shall be heated in kettles equipped with armored thermometers, and stirred frequently.

708.3.2 Ordinary Dampproofing. Ordinary dampproofing shall be applied by coveting the surfaces either with (1) a light priming coat of asphaltic primer and an asphalt mop coat, or (2) with an approved priming coat and a coal-tar pitch mop coat. The application of primer shall be allowed to cure properly before applying the mop coat. The primer shall be applied without heating at the approximate rate of 0.4 L/m² (1 gal/ 100 sq. ft.) of surface with a 3 or 4 knot roofing brush. If asphalt primer is too thick to allow easy brushing, the material may be thinned by the addition of a small quantity of gasoline or naphtha. After the primer has cured, the mop coat shall be applied at the rate of approximately 2.5 kg/m² (50 lb./100 sq. ft.) of surface to obtain a thickness of approximately 2 mm (5/64 in.) for the dampproof coating.

708.3.3 Special Dampproofing. If special dampproofing at joints is required, it shall consist of applying a coat of primer as specified in Sec. 708.3.2. After the primer has cured, a 2.5 kg/m² (50 lb./100 sq. ft.) mop coat shall be applied as for ordinary dampproofing. While this mop coat is still hot, there shall be applied a strip of bituminous treated cotton fabric which shall extend at least 150 mm (6 in.) each side of construction and expansion joints. A second mop coat shall then be applied at the rate of 1.5 kg/m² (30 lb./ 100 sq. ft.) to obtain a thickness of
approximately 1.2 mm (3/64 in.), and while still hot another strip of bituminous treated cotton fabric shall be applied, extending 75 mm (3 in.) beyond the edges of the first layer of fabric. The entire surface of the fabric shall be given a final 2.5 kg/m² (50 lb./100 sq. ft.) mop coat. On surfaces that are vertical or nearly so, the strips of cotton fabric shall be placed vertical or with the slope. On other surfaces, the strips shall be laid shingle fashion, beginning at the lowest part of the area to be dampproofed. All fabric shall be pressed into place in the hot bitumen to eliminate air bubbles and to bring it into close contact with the concrete surface.

708.3.4 Patching of defective dampproofing, where necessary, shall extend at least 300 mm (12 in.) beyond the outermost edge of the defective portion. The second ply of the patch shall extend at least 75 mm (3 in.) beyond the first ply.

708.3.5 Work shall be so regulated that at the end of the day all fabric that has been applied will have received the final coat of bitumen.

708.4 Basis of Payment. No direct payment will be made for dampproofing.
SECTION 709
WATERPROOFING

709.1 Description. This work shall consist of furnishing and applying waterproofing material to concrete railroad bridge decks supporting ballasted track. Waterproofing shall consist of (1) one coat of asphaltic primer, (2) two layers of asphalt treated cotton fabric with three moppings of asphalt, or when so specified, three layers of asphalt treated cotton fabric and four moppings of asphalt, and (3) a protective covering of asphalt plank.

709.2 Materials. All materials shall conform to Division 1000, Materials Details, and specifically as follows:

<table>
<thead>
<tr>
<th>Item</th>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dampproofing and Waterproofing Materials</td>
<td>1072</td>
</tr>
<tr>
<td>Concrete Joint Sealer, Hot-Poured Elastic Type</td>
<td>1057.2.6</td>
</tr>
</tbody>
</table>

709.3 Construction Requirements.

709.3.1 Waterproofing shall not be applied in wet weather, nor when the ambient temperature is below 100 C (500 F). Concrete shall be dry and clean before waterproofing is applied. When bituminous material is used for curing, it may also serve as a priming coat, except that additional primer may be necessary before application of the waterproofing material. Projections that might damage the waterproofing shall be removed. There shall be no depressions or pockets in horizontal surfaces of finished waterproofing except those required for drainage.

709.3.2 Surfaces to be waterproofed shall, except as otherwise specified at joints, be primed in accordance with the requirements of Sec. 708.3.2. Joints shall be sealed with joint sealing material prior to application of waterproofing materials. At deflection and expansion joints primer shall be omitted for a width of 450 mm (18 in.) on each side of the joint and a strip of impervious paper 900 mm (36 in.) wide shall be placed before waterproofing is applied.

709.3.3 Surfaces to be waterproofed shall be mopped in sections. While the first mopping of asphalt is still hot, a strip of cotton fabric shall be laid on the mopping and pressed into place. Each mopping thereafter shall be so applied that it will completely cover and seal the cotton fabric. The asphalt for each application shall be applied at a rate of not less than 1.8 L/m2 (4.5 gal/100 sq. ft.) of surface. Asphalt shall be heated to permit uniform application but shall not be heated above a temperature of 1750 C (3500 F).

709.3.4 Two layers of cotton fabric waterproofing shall be started by mopping a section of the surface 50 mm (2 in.) wider than half the width of the fabric. On this hot mopping, a half width of the fabric shall be laid. The top surface of this fabric and an adjacent section of the surface 50 mm (2 in.) wider than a half width of the fabric shall then be mopped. On this mopping shall be laid a full width of the fabric, completely covering the first strip. Thereafter,
full widths of fabric shall be laid in hot moppings, and in such manner that each strip will lap the second preceding strip by 50 mm (2 in.). End laps shall be not less than 300 mm (12 in.).

709.3.5 Three layers of cotton fabric waterproofing shall be placed as for 2 layers, except that the first strip shall be a 1/3 width of the fabric; the second a 2/3 width; and the third and succeeding strips full widths. The second full strip shall lap the first strip at least 50 mm (2 in.). Each succeeding strip shall lap the third preceding strip at least 50 mm (2 in.).

709.3.6 The waterproofing shall be turned into drainage openings without breaking. Waterproofing shall be made effective along the sides and ends of slab, at gussets, stiffeners, and all other places where waterproofing terminates. Work shall be so regulated that at the end of the day all fabric that has been placed will have received a coat of asphalt. The waterproofing shall be free from punctures, pockets, or folds. Patching of defective waterproofing shall extend at least 300 mm (12 in.) beyond the outermost edge of the defective portion. The second and each succeeding ply of the patch shall extend at least 75 mm (3 in.) beyond the preceding ply.

709.3.7 Asphalt planking used as a protective covering shall be placed as soon as practicable after the waterproofing. The surface of the waterproofing shall be kept free of dirt or other foreign material. Immediately prior to laying the plank, a hot asphalt coating shall be applied at a rate of not less than 2.5 kg/m² (50 lb./100 sq. ft.). The planks shall be laid tight against those previously placed, whose edges and ends shall have been heavily coated with hot asphalt. All joints shall be completely filled with hot asphalt.

709.4 Method of Measurement. Final measurement of waterproofing concrete railroad bridge decks will not be made except for authorized changes during construction or where appreciable errors are found in the contract quantity. The revision or correction will be computed and added to or deducted from the contract quantity. The area will be computed to the nearest square meter (nearest sq. ft.) for the actual surface area over which the waterproofing extends, including the portions of the faces of the curbs and ends of slab.

709.5 Basis of Payment. The accepted quantity of waterproofing of concrete railroad bridge decks will be paid for at the contract unit price.
SECTION 710
EPOXY COATED REINFORCING STEEL

710.1 Description. This work shall consist of furnishing and placing epoxy coated reinforcing steel of the shape, size and grade required in the bridge deck. The steel reinforcing bars shall meet requirements of ASTM A 615 (AASHTO M 31).

710.2 Materials.

710.2.1 All materials shall conform to Division 1000, Materials Details, and specifically as follows:

<table>
<thead>
<tr>
<th>Item</th>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>Epoxy Coated Reinforcing Steel</td>
<td>1036.3</td>
</tr>
<tr>
<td>Epoxy for Coating</td>
<td>According to the requirements of the following manufacturer’s specifications.</td>
</tr>
</tbody>
</table>

2. Scotchkote 213, Minnesota Mining and Manufacturing Company.
5. CORVEL ECA 1558-Red-27000, Polymer Corporation.
8. MOBIOLOX 1004-R-2, Mobil Chemical Company.

710.2.1.1 Epoxy Coating Materials. The epoxy coating chosen by the contractor shall not be changed during the life of the project.

710.3 Construction Requirements.

710.3.1 Shipping and Handling. Coated bars should be prepared for shipment by use of excelsior or equivalent padded metal bands or other methods that will prevent damage during shipment. All personnel responsible for loading or unloading coated bars shall use caution to avoid dragging or dropping the bundles. All systems for handling coated bars shall have padded contact areas.

Extra handling precautions should be offset by elimination or reduction of major repair by the fabricator and/or contractor. If, in the judgment of the engineer, the coating is damaged to the
extent that the coating can no longer provide the intended protection, the material shall be
returned to the coating applicator for either repair or replacement. No separate payment will be
made for patching materials, or any requirement of repair to the coating.

710.3.2 Placement.

710.3.2.1 The epoxy coated bars shall be placed on plastic or plastic coated wire supports
and shall be held in place by use of plastic coated tie wires or molded plastic clips. In placing
epoxy coated bars, care shall be maintained to prevent coated bars from coming into contact with
other steel items such as drains and shear connectors.

710.3.2.2 After the reinforcing bars are secured to bar supports, a final visual inspection
will be made and all uncoated or damaged areas shall be repaired as required by the engineer.

710.3.2.3 The contractor shall exercise caution when placing and vibrating concrete to
prevent any damage to the epoxy coating. The vibrator head shall be equipped with a protective
tip to prevent the vibrator from damaging the coated bars. Material used as the protective tip is
subject to the approval of the engineer. Equipment and protective devices used to consolidate the
concrete shall be as directed by the engineer.

710.3.3 Repairing Bars. If the epoxy coating is damaged, patching will be required. All
damaged areas shall be patched in accordance with Sec. 1036.3.5 and in accordance with the
manufacturer’s instructions. Patching will be required on all sheared or cut ends of bars, end
areas left bare by the coating process, and any areas where the entire coating is removed. All
repairs shall be completed as soon as practicable, and in the case of bare end areas and sheared
ends, before visible oxidation of the surface occurs.

710.3.4 Electrical Test System.

710.3.4.1 Description. The electrical test for continuity will be made under the direction
of the engineer. The continuity test will consist of four transverse bars in each test span with
uncoated exterior longitudinal bars connected by cable clamps as approved by the engineer to
complete the test circuit. This test will enable St. Charles County and other agencies having
jurisdiction to periodically check the circuits for continuity in order to indicate any possible
failures within the epoxy coated materials at bar splices.

710.3.4.2 Equipment. A suitable electrical source will be supplied as directed by the
engineer.

710.3.4.3 The transverse bars designated for electrical lead connections shall be shifted to
the edge of slab in accordance with the details shown on the bridge plans. Four lines of
transverse bars in each bridge span will be selected by the engineer to provide a test system,
unless shown otherwise on the plans. Each of the lines of transverse bars shall be spliced and
clamped to provide electrical continuity when more than one bar is required to reach across the
width of slab. In order to provide electrical continuity, the uncoated exterior longitudinal bars on
each side of the slab shall be clamped to the four selected lines of transverse test bars per span to
produce a metal-to-metal connection.

710.3.4.4 The contact surface at each connection where bars cross shall be cleaned and filed or ground to a bare metal surface 6 x 6 mm (1/4 x 1/4 in.) minimum size and securely clamped with a U-bolt or cable clamp as approved by the engineer. After the U-bolt or cable clamp is installed, the connection then shall be coated with an epoxy material as specified in Section 1036.3.5. The epoxy shall be applied to the clamp and that portion of the longitudinal bars extending 75 mm (3 in.) either side of the clamp.

710.3.4.5 Where test system longitudinal or transverse bars have parallel splices, the contact surfaces of the splices shall be ground or filed to a flat bare metal surface of 6 mm (1/4 in.) width for the length of the splice and clamped with two cable clamps to produce a metal-to-metal connection. The entire splice including the clamp shall be coated with an epoxy material as specified in Sec. 1036.3.5. The coating shall extend for a distance of 75 mm (3 in.) beyond the end of the bars being spliced.

710.3.4.6 Prior to placement of concrete, each bar selected for testing will be visually inspected for damaged coating that shall be repaired.

710.3.4.7 The engineer will make two tests of the system. The first test will be made immediately before the concrete slab is poured. The second test will be made after the slab is poured but prior to constructing the curbs.

710.3.4.8 The contractor shall notify the engineer a minimum of 48 hours prior to the placement of concrete to allow him ample time to complete the first test. The engineer will test the system for electrical continuity that is defined as zero ohms resistance between lead bars and test bars. The contractor shall adjust or repair the contact areas on the test bars or elsewhere to insure electrical continuity throughout the system, if any test bar does not make a continuous electrical circuit.

710.4 Basis of Payment.

710.4.1 Payment for reinforcing steel with epoxy coating, complete in place, will be made under Item 710-99.99, reinforcing steel (epoxy coated), which price shall include furnishing all materials, cleaning, coating, completing the test system, as shown on the plans and for all equipment, tools, labor and any work incidental thereto.
### SECTION 712

**STRUCTURAL STEEL CONSTRUCTION**

#### 712.1 Description.
This work shall consist of the fabrication, inspection, erection, and painting of bridges and structures made of structural steel and miscellaneous metals.

#### 712.2 Materials.

**712.2.1** Except as amended by Sec. 712.2.3, all materials shall conform to, Division 1000, Materials Details and specifically as follows:

<table>
<thead>
<tr>
<th>Item</th>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paint For Structural Steel</td>
<td>1045</td>
</tr>
<tr>
<td>Shear Connectors</td>
<td>1037</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Specification</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Structural Carbon Steel</td>
<td>AASHTO M 183 (ASTM A 36)</td>
</tr>
<tr>
<td>Structural Low Alloy Steel</td>
<td>AASHTO M 223 (ASTM A 572)</td>
</tr>
<tr>
<td></td>
<td>Grades 290 AND 345 MPa (42, 45 and 50)</td>
</tr>
<tr>
<td></td>
<td>AASHTO M 222 (ASTM A 588)</td>
</tr>
<tr>
<td>Quenched and Tempered Alloy Steel</td>
<td>AASHTO M 244 (ASTM A 514)</td>
</tr>
<tr>
<td></td>
<td>ASTM A 517</td>
</tr>
<tr>
<td>Low Carbon Steel Bolts and Nuts</td>
<td>ASTM A 307</td>
</tr>
<tr>
<td>High Strength Bolts, Nuts and Washers</td>
<td>AASHTO M 164 (ASTM A 325)</td>
</tr>
<tr>
<td>Cold Finished Carbon Steel Shafting</td>
<td>AASHTO M 169 (ASTM A 108)</td>
</tr>
<tr>
<td></td>
<td>Grade 1018</td>
</tr>
<tr>
<td>Carbon Steel Forgings</td>
<td>AASHTO M 102 (ASTM A 668)</td>
</tr>
<tr>
<td></td>
<td>Class F</td>
</tr>
<tr>
<td>Alloy Steel Forgings</td>
<td>AASHTO M 102 (ASTM A 668)</td>
</tr>
<tr>
<td></td>
<td>Class G</td>
</tr>
<tr>
<td>Gray Iron Castings</td>
<td>AASHTO M 105 (ASTM A 48)</td>
</tr>
<tr>
<td></td>
<td>Class 50</td>
</tr>
<tr>
<td>Malleable Iron Castings</td>
<td>ASTM A 47</td>
</tr>
<tr>
<td>Carbon Steel Castings</td>
<td>AASHTO M 103 (ASTM A 27)</td>
</tr>
<tr>
<td></td>
<td>Grade (70-40)-(485-275)</td>
</tr>
<tr>
<td>Galvanized Coating</td>
<td>AASHTO M 111 (ASTM A 123)</td>
</tr>
<tr>
<td>Lead for Bearing Pads</td>
<td>ASTM B 29</td>
</tr>
</tbody>
</table>

Bolts, nuts, and washers specified to be galvanized shall be galvanized in accordance with the requirements of AASHTO M 232 (ASTM A 153), or mechanically galvanized with the coating, thickness, adherence, and quality requirements conforming to AASHTO M 232 (ASTM A 153),
Class C. AASHTO M 164 (ASTM A 325) bolts to be hot-dip galvanized shall have a Rockwell hardness of C24 to C32 when tested after heat treatment but prior to hot-dip galvanizing.

712.2.2 Falsework material shall be subject to the engineer’s approval. Timber materials shall be sound, in good condition, and free from defects that will impair their strength. Steel members shall be in good condition and of a shape and strength suitable for the purpose intended. Falsework piling shall be capable of withstanding driving to a depth sufficient to develop adequate bearing.

712.2.3 For structural steel, the contractor shall submit a copy of the certified mill test report giving the chemical analysis and results of physical tests on the material furnished. The mill test report shall also state the location of the mill where the molten metal was produced. Two copies of the mill test report will be required for material used in railroad structures. If the steel is manufactured outside the United States, the contractor shall submit a certified test report from a U.S. laboratory, approved by the County, showing specific results of chemical analysis and physical tests for each heat being furnished and stating that the material meets the specification requirements. Mill tests and laboratory reports shall be submitted for approval before any request is made for shop or field inspection. In addition, the County reserves the right to take samples for chemical analysis and physical tests from the fabricated steel delivered to the project site. Any delay caused from obtaining and analyzing samples from delivered steel shall not be cause for additional compensation nor extension of time for completion of the contract.

712.2.3.1 Structural steel components shown on the plans as requiring notch toughness shall meet the longitudinal Charpy V-notch requirements specified in Table A with sampling and testing procedures in accordance with AASHTO T 243 (ASTM A 673) using the (P) frequency of heat testing for AASHTO M 244 (ASTM A 514) and ASTM A 517 and the (H) frequency of heat testing for all other steels. The mill test reports shall include the results of all Charpy V-notch tests.
### TABLE A

<table>
<thead>
<tr>
<th>Steel Specification</th>
<th>Thickness</th>
<th>Charpy V-Notch Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>AASHTO M 183 (ASTM A 36)</td>
<td>Up to 100 mm (4 in.)</td>
<td>21 J (15 ft-lb) @ 4°C (40°F)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AASHTO M 223 (ASTM A 572)</td>
<td>Up to 100 mm (4 in.)</td>
<td>21 J (15 ft-lb) @ 4°C (40°F)</td>
</tr>
<tr>
<td></td>
<td>Mechanically Fastened</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Up to 50 mm (2 in.)</td>
<td>21 J (15 ft-lb) @ 4°C (40°F)</td>
</tr>
<tr>
<td></td>
<td>Welded</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Over 50 mm (2 in.) to 100 mm (4 in.) Welded</td>
<td>28 J (20 ft-lb) @ 4°C (40°F)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AASHTO M 222 (ASTM A 588)</td>
<td>Up to 100 mm (4 in.)</td>
<td>21 J (15 ft-lb) @ 4°C (40°F)</td>
</tr>
<tr>
<td></td>
<td>Mechanically Fastened</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Up to 50 mm (2 in.)</td>
<td>21 J (15 ft-lb) @ 4°C (40°F)</td>
</tr>
<tr>
<td></td>
<td>Welded</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Over 50 mm (2 in.) to 100 mm (4 in.) Welded</td>
<td>28 J (20 ft-lb) @ 4°C (40°F)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AASHTO M 244 (ASTM A 514 or ASTM A 517)</td>
<td>Up to 100 mm (4 in.)</td>
<td>34 J (25 ft-lb) @ -18°C (0°F)</td>
</tr>
<tr>
<td></td>
<td>Mechanically Fastened</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Up to 60 mm (2 1/2 in.)</td>
<td>34 J (25 ft-lb) @ -18°C (0°F)</td>
</tr>
<tr>
<td></td>
<td>Welded</td>
<td></td>
</tr>
<tr>
<td></td>
<td>60 mm (2 1/2 in.) to 100 mm (4 in.) Welded</td>
<td>48 J (35 ft-lb) @ -18°C (0°F)</td>
</tr>
</tbody>
</table>

**712.2.4** For high strength bolts, the contractor shall furnish a manufacturer’s certification showing results of tests performed in accordance with AASHTO M 164 (ASTM A 325) which shall include the proof load test, and shall maintain identification by container markings which shall match identifying numbers on the certification. For bolts manufactured outside the United
States, the testing requirements of Sec. 712.2.3 shall apply.

712.2.5 For cast steel, the foundry shall furnish a certified copy of foundry reports giving the chemical analysis and results of physical tests on the material from each heat. These reports shall be submitted for approval of material being furnished before any required machine work is done on the castings.

712.2.6 For gray iron castings, the foundry shall furnish one finished tension test specimen in accordance with AASHTO M 105 (ASTM A 48) from each heat. The required machine work shall not proceed until material being furnished has been approved. If cast steel is furnished in lieu of gray iron, the minimum tensile strength shall be 345 MPa (50,000 psi).

712.2.7 Machine finished surfaces shall be coated as soon as practicable after being inspected and accepted and before being removed from the shop or placed in the open, with an application of one of the products qualified under Military Specifications MIL-C-1796 (Corrosion Preventative, Petrolatum, Hot Application). Other approved coatings may be used. In lieu of this coating, surfaces not to be in full contact may be given a shop coat of the primer specified for the paint system to be used.

712.2.8 Identification of Metals. The steel shall be stamped or stenciled and color striped with paint at the mill. Heat numbers shall be steel stamped or stenciled with paint at the mill. Separate markings and color codes shall be in accordance with AASHTO M 160 (ASTM A 6). The characteristic color stripes shall be placed on each part cut from the mill piece. For steels not covered by AASHTO M 160 (ASTM A 6), the fabricator shall furnish the engineer the color coding in writing before beginning fabrication. Heat numbers shall be painted on all principle pieces, and these pieces shall be so noted on the shop drawings. Principal pieces for this requirement shall include all beams, flanges, webs, splice plates, bearings, bearing stiffener plates, load bearing members of end diaphragms, pin plates, hanger plates, and others as may be directed by the engineer. The color code and heat number markings shall be placed on the material so as to be visible throughout the work of fabrication. Loss of identification on pieces or items will be cause for rejection of the pieces or items.

712.2.9 Steel Stamping. Steel stamping of match marks, erection marks, or other identification will be limited to the ends of flange plates and flange splice plates, the middle third of web plates, and the center of web splice plates. Steel stamping on pin plates and hanger plates will not be permitted. Any steel stamping in areas other than those specified herein, or approved by the engineer, will be considered surface imperfections and shall be repaired in accordance with Sec. 712.3.3.7.

712.3 Fabrication and Inspection.

712.3.1 Inspection. Inspection of fabricated material will ordinarily be made in the shop for fabricating shops within the 48 contiguous States, and for shops outside the U.S. but within 1600 km (1000 miles) of St. Charles County. However, in some cases shop inspection may be waived and inspection made when the fabricated material is delivered to the project site. If steel is fabricated at locations beyond the above limits, nondestructive testing and shop inspection of
the fabricated material will be waived and inspection and nondestructive testing performed at the project site. Under these conditions, the contractor may request shop inspection of the fabricated material and, when the engineer considers this to be in the best interest of the County, inspection will be made in the shop. Regardless of where the fabricated material is inspected, some shop inspection prior to fabrication will be required to qualify welders and welding processes and procedures. The engineer shall be notified not less than one month in advance of the need for inspection. Should failing tests result, all transportation costs and expenses of inspectors incurred to provide shop inspection solely for the retest of welders and welding processes and procedures shall be borne by the contractor. All costs of shop inspection at plants outside the 48 contiguous States, which are beyond 1600 km (1000 miles) from St. Charles County, shall be borne by the contractor. In such cases, the contractor will be charged with transportation costs and expenses of inspectors for trips made from St. Charles County to points to which they must travel for shop inspection work. These transportation costs and expenses of inspectors will be deducted by the County from moneys due the contractor.

712.3.1.1 The engineer shall be notified in advance of the beginning of the shop work and be given adequate opportunity to be present if he or she so desires. Requests for shop inspection shall be made a minimum of 4 days in advance of the need for inspection. The engineer shall have full access to all parts of the shop or project site where material is being fabricated or assembled for inspection, and shall be provided with every reasonable facility for determining the character of material, the quality of work, and the weight of the pieces. All trusses, plate girders, and continuous I-beams shall be assembled for inspection, and they shall be in a position that will permit the inspection of all parts. If inspection of the fabricated material is made at the project site, the contractor shall be responsible for assembly for inspection prior to erection. The additional work of handling and assembly for inspection at the project site, any delay or additional costs caused by the inspection, required repairs or refabrication, securing samples for chemical analysis and physical tests, repair of areas where samples were removed, or nondestructive testing of all repairs shall not be cause for additional compensation nor extension of time for completing the work.

712.3.1.2 It is understood, regardless of where the inspection is made, that work and materials that do not conform to the specifications and to recognized good practice may be rejected at any time prior to final acceptance of the project.

712.3.2 Shop Drawings. Shop drawings for structural steel, and miscellaneous metals will be required, and shall be prepared in strict accordance with the design details shown on the plans. If details are lacking, they shall be supplied and shall conform to the design plans and specifications. All drawings shall be clear and complete, and shall be thoroughly checked before submittal. Four sets of prints of the shop drawings for railroad structures, and two sets for other structures shall be submitted for approval. The prints submitted shall be legible and have distinct details of sufficient contrast to be suitable for microfilming. Prints that do not have the desired clarity and contrast will be returned for corrective action. One set of these prints will be returned marked approved, or approved subject to the corrections noted. The contractor shall promptly make the necessary corrections and resubmit for final approval. When shop drawings are finally approved, the contractor shall furnish as many additional prints as may be requested. Reproductions on cloth or film of the original shop drawings will be required for railroad
structures and shall be delivered to the engineer prior to completion of the work. The approval of shop drawings will cover only the general design features, and in no case shall this approval be considered to cover errors or omissions in shop details. The contractor shall be responsible for the accuracy of the shop drawings, the fabrication of material, and the fit of all connections. The contractor shall also bear the cost of all extra work in erection caused by errors in shop drawings and for any changes in fabrication necessary for satisfactory erection. After shop drawings have been approved, no changes in dimensions or substitutions of sections shall be made without written approval. Shop drawings shall be revised to show any authorized changes and the required number of prints shall be furnished the engineer.

712.3.2.1 Shop drawings for fabricators located outside the 48 contiguous states whether marked approved or approved subject to the corrections noted, will be returned to the contractor, and it shall be the contractor’s responsibility to transmit them to the fabricator for further handling. Should such fabricator also be the contractor, all prints will be returned to the office located on the project.

712.3.3 Fabrication. Fabrication of all parts of the structure shall be carefully done in strict accordance with the approved shop drawings.

712.3.3.1 Straightening of any deformed structural material shall be performed by non-injurious methods prior to being laid off, punched, or otherwise worked in the shop. Sharp kinks and bends will be cause for rejection.

712.3.3.2 Holes for connections of main members shall be subpunched or subdrilled, and reamed while assembled in the shop, or may be drilled from the solid with main members, and each splice plate fully assembled in their final erection positions. Holes for floor beams and framed stringer connections shall be drilled or reamed to a steel template of sufficient thickness to center the drill accurately, and all members to be secured through the same group of holes shall be drilled or reamed from the same template. Holes may be punched full size in secondary members such as lateral, longitudinal, and sway bracing, lacing bars, stay plates, and diaphragms.

712.3.3.3 Subpunched holes for bolts having diameters greater than 19 mm (3/4 in.) shall be punched 5 mm (3/16 in.) smaller than the nominal diameter of the bolt. For bolts having diameters of 19 mm (3/4 in.), the holes shall be punched 18 mm (11/16 in.) in diameter. For bolts having diameters of 16 mm (5/8 in.) or less, the holes shall be punched full size and spear reamed. The punch and die shall have the same relative sizes as specified in Sec. 712.3.3.6 for full size punched holes. After assembling, subpunched or subdrilled holes shall be reamed with tapered reamers to a diameter not more than 2 mm (1/16 in.) larger than the nominal diameter of the bolt for M16 to M24 (5/8 to 15/16 in.) bolts, and not more than 3 mm (3/32 in.) larger than the nominal diameter of the bolts for M27 (1 1/16 in.) and larger bolts.

712.3.3.4 Holes drilled full size from the solid shall be 2 mm (1/16 in.) larger than the nominal diameter of the bolt for M16 to M24 (5/8 to 15/16 in.) bolts, and 3 mm (3/32 in.) larger than the nominal diameter of the bolt for M27 (1 1/16 in.) and larger bolts.
712.3.3.5 Reaming or drilling full size from the solid shall be done while the truss, girder, or continuous I-beam is assembled, either in an upright position or on its side, properly adjusted for camber and sweep and after the connecting parts have been firmly bolted together. A minimum of one full span, from bearing to bearing, shall be fully assembled before reaming and drilling full size shall begin. Connecting parts assembled in the shop for the purpose of reaming holes in field connections shall not be interchanged or reversed and shall be matchmarked. A diagram showing such marks shall be detailed on the shop drawings. Burrs resulting from reaming or drilling shall be removed. Reamed or drilled holes shall be cylindrical and perpendicular to the member. Eighty-five percent of the holes in any group shall not show an offset greater than 1 mm (1/32 in.) between adjacent thickness of metal after reaming or drilling. The remainder of the holes shall be so reamed or drilled and aligned that a bolt of nominal diameter will enter the hole and the head and nut shall seat on the metal.

712.3.3.6 Punching full size holes for bolts in carbon steel may be done if the thickness of the metal does not exceed the nominal diameter of the bolt. For carbon steel thicker than the nominal diameter of the bolt, the holes shall be subpunched and reamed, or drilled from the solid. Punching full size holes in alloy and low alloy steels may be done in material 16 mm (5/8 in.) thick or less. Holes in alloy and low alloy steels over 16 mm (5/8 in.) shall be subpunched and reamed or drilled from the solid. Except for special cases, the diameter of the punch for full size holes shall not be more than 2 mm (1/16 in.) greater than the diameter of the bolt, and the diameter of the die shall not be more than 2 mm (1/16 in.) greater than the diameter of the punch. Punching shall be done accurately and there shall be no drifting to enlarge unmatched holes.

712.3.3.7 All welding, oxygen cutting, shearing and clipping, and dimensional tolerances shall be in accordance with the requirements set forth in the American Welding Society Structural Welding Code AWS Dl. 1-80, and no later revisions thereof, as amended by AASHTO 1981 Standard Specifications for Welding of Structural Steel Highway Bridges-Third Edition, and no later revisions thereof, except as further amended by the following:

(Apparign numbers refer to AWS D1.1-80 (WAS) and AASHTO Standard Specifications for Welding of Structural Steel Highway Bridges, 1981-Third Edition (AASHTO) as noted).

AWS Sec. 1.1 Paragraph 1.1.3 -- A new paragraph 1.1.3 shall be added as follows:

All reference to the contractor herein shall include any fabricators, erectors, welding services, testing services, or other individuals or organizations representing the contractor in the fabrication and nondestructive testing of any materials covered by these specifications.

AWS Sec. 1.3 Paragraph 1.3.1 -- Paragraph 1.3.1 shall be replaced with the following:

Manual shielded metal-arc, flux cored arc, and submerged arc welding procedures for steels other than quenched and tempered steels which conform with the provisions of Sec. 2, 3, 4, and 9 will be deemed as prequalified and will be approved for use without performing procedure qualification tests. Use of the gas metal-arc welding process will require qualification of a groove weld in accordance with Sec. 5, Figure 5.10.1.3D(2), plus a Charpy V-Notch impact
strength of 27 J (20 ft.-lb.) at a temperature of -18°C (0°F) or below. Once the process is so qualified, all gas metal-arc welding procedures which conform with the provisions of Sec. 2, 3, 4, and 9 will be deemed as prequalified and will be approved for use without performing procedure qualification tests. Prequalification is applicable only to steels with a minimum specified yield thickness of 415 MPa (60,000 psi) or less and for weld throat thicknesses of 80 mm (3 in.) or less.

AWS Sec. 1.3 Paragraph 1.3.2 -- Paragraph 1.3.2 shall be replaced with the following:

No electroslag or electrogas welding shall be used.

AWS Sec. 1.3 Paragraph 1.3.3 -- Paragraph 1.3.3 shall be replaced with the following:

Stud welding shall be in accordance with Missouri Standard Specifications Sec. 712.3.4.

AWS Sec. 1.3 Paragraph 1.3.5 -- A new paragraph 1.3.5 shall be added as follows:

If a quenched and tempered steel is to be welded, the welding procedure shall be qualified in accordance with Sec. 5 before starting production welding.

AWS Sec. 1.3 Paragraph 1.3.6 -- A new paragraph 1.3.6 shall be added as follows:

All primary shop welds shall be made by approved automatic welding processes. An automatic welding process is one in which the wire or electrode feed, speed of travel, and guidance are all mechanically controlled. Noncompliance with this requirement will be cause for rejection of the welded material unless prior approval is granted by the engineer for welding the specified joints by the use of other processes. The automatic welding process requirement for primary shop welds shall be shown on the shop drawing for each joint. Primary shop welds are defined as flange and web butt welded splices in I-beams, box members, and plate girders; plate girder or box flange to web fillet welds; and cover plate to flange fillet welds.

AWS Sec. 2.7 Paragraph 2.7.1.1 --Paragraph 2.7.1.1 shall be replaced with the following:

The minimum fillet weld size, except for fillet welds used to reinforce groove welds, shall be as shown in the following table:

<table>
<thead>
<tr>
<th>Material Thickness of Thicker Part Joined</th>
<th>Minimum Size of Fillet Weld *</th>
</tr>
</thead>
<tbody>
<tr>
<td>To 13 mm (1/2 in.), inclusive</td>
<td>5 mm (3/16 in.) Single</td>
</tr>
<tr>
<td>Over 13 mm to 19 mm (1/2 to 3/4 in.)</td>
<td>6 mm (1/4 in.) pass</td>
</tr>
<tr>
<td>Over 19 mm to 38 mm (3/4 to 1 1/2 in.)</td>
<td>8 mm (5/16 in.) welds</td>
</tr>
<tr>
<td>Over 38 mm to 57 mm (1 1/2 to 2 1/4 in.)</td>
<td>10 mm (3/8 in.) must</td>
</tr>
<tr>
<td>Over 57 mm to 150 mm (2 1/4 to 6 in.)</td>
<td>13 mm (1/2 in.) be</td>
</tr>
<tr>
<td>Over 150 mm (6 in.)</td>
<td>16 mm (5/8 in.) used</td>
</tr>
</tbody>
</table>
* Except that the weld size need not exceed the thickness of the thinner part joined.

**AWS Sec. 2.8 Paragraph 2.8.5** -- Paragraph 2.8.5 shall be replaced with the following:

Plug and slot welds are not permitted in quenched and tempered steels. Plug and slot welds for repair purposes are not permitted in any steel without the approval of the engineer.

**AASHTO Sec. 3.1 Paragraph 3.1.5.1** -- Paragraph 3.1.5.1 shall be deleted.

**AWS Sec. 3.2 Paragraph 3.2.1** -- Paragraph 3.2.1 shall be replaced with the following:

Surfaces and edges to be welded shall be smooth, uniform and free from fins, tears, cracks, or other defects that would adversely affect the quality or strength of the weld. Surfaces to be welded and surfaces adjacent to a weld shall also be free of loose or thick scale, slag, rust, moisture, grease, or other foreign material that will prevent proper welding or produce objectionable fumes. Mill scale that withstands vigorous wire brushing, a thin rust inhibitive coating, or anti-spatter compound may remain, except that for girders all mill scale shall be removed from the surface on which flange-to-web welds are to be made.

**AASHTO Sec. 3.2 Paragraph 3.2.2B** -- A new paragraph 3.2.2B shall be added as follows:

Oxygen or plasma cut edges of quenched and tempered steel plates forming stress carrying members, other than webs of girders, shall be removed to a depth of at least 3 mm (1/8 in.) by machining or grinding. It shall be the contractor’s responsibility to obtain quenched and tempered plates within size tolerance that will permit edge removal when required.

**AASHTO Sec. 3.2 Paragraph 3.2.3** -- Paragraph 3.2.3 shall be replaced with the following:

Visual Inspection and Repair of Plate Edges. The following provisions shall apply to all plate edges whether mill or cut and whether welded or free.

**AASHTO Sec. 3.2 Paragraph 3.2.3.4** shall be replaced with the following:

The corrective process described in Table 3.2.3 shall not apply to discontinuities in rolled plate surfaces. Imperfections in top and bottom surfaces of alloy and low alloy flange and truss member plates may be repaired in accordance with AASHTO M 160 (ASTM A 6) except that repair by welding will be permitted only when approved by the engineer. Approval will be limited to areas where there will be less than the maximum design stress in the finished structure. When surface imperfections in alloy, low alloy, and carbon steel plates are repaired by grinding, they shall have edges faired to the plate surface with a slope not exceeding 1 in 10.

**AASHTO Sec. 3.2 Paragraph 3.2.8** -- Paragraph 3.2.8 shall be replaced with the following:
All corner of main stress-carrying members, and all corners to be painted shall be routed to a 1.6 mm (1/16 in.) radius.

AWS Sec. 3.3 Paragraph 3.3.6 -- Paragraph 3.3.6 shall be replaced with the following:

Members to be welded shall be brought into correct alignment according to shop drawing joint details, and as matchmarked and punchmarked in the shop for field welded joints, and shall be held in a fixed position by bolts, clamps, wedges, guy lines, struts, and other approved devices or by tack (partial joint) welding until welding has been completed. In aligning splices of beams and girders, the center line of webs shall be made to align vertically and horizontally. The use of jigs and presses and non-attached fixtures is recommended for shop assemblies. The use of falsework is recommended for field assemblies. Suitable allowances shall be made for warpage and shrinkage.

AWS Sec. 3.4 Paragraph 3.4.6 -- Paragraph 3.4.6 shall be replaced with the following:

All shop splices in each component part of a coverplated beam or built-up member shall be made and all required non-destructive testing completed and approved before such component part is welded to other component parts of the member. Shop welded web splices are permitted where detailed on the shop drawings and approved by the engineer. No additional payment will be made for optional shop welded web splices.

AWS Sec. 3.5 Paragraph 3.5.1.4 -- Paragraph 3.5.1.4 shall be replaced with the following:

Permissible variation in specified sweep from horizontally curved welded beams or girders shall not exceed 0.01 m x No. of meters from nearest end x 0.10 (1/8 in. x No. of feet from nearest end x 0.10), but not to exceed 13 mm (1/2 in.).

AWS Sec. 3.5 Paragraph 3.5.1.8.1 -- A new paragraph 3.5.1.8.1 shall be added as follows:

The maximum permissible variation from specified width for rolled or burned flange plates shall be -3 mm (1/8 in.) to +9.5 mm (3/8 in.).

AWS Sec. 3.5 Paragraph 3.5.1.9 -- Paragraph 3.5.1.9 shall be replaced with the following:

Bearing at Points Loading. The bearing ends of bearing stiffeners shall be flush and square with the web and shall have at least 75 percent of this area in contact with the inner surface of the flanges. The remaining 25 percent of the area of the bearing stiffener shall be within 0.25 mm (0.010 in.) of the inner surface of the flanges. The outer surface of the flanges when bearing against a steel base or seat shall fit within 0.25 mm (0.010 in.) for 75 percent of the projected area and not more than 0.794 mm (1/32 in.) for the remaining 25 percent of the projected area. Girders without stiffeners shall bear on the projected area of the web on the outer flange within 0.25 mm (0.010 in.) and the included angle between web and flange shall not exceed 90 degrees in the bearing length. The top surface of a flange or shelf plate supporting a
bearing rocker, shall be considered a flat surface with a tolerance of 0.003 mm/mm (0.003 in/in) in any direction over the projected area of the rocker.

**AASHTO Sec. 3.5 Paragraph 3.5.1.16** -- A new paragraph 3.5.1.16 shall be added as follows:

Permissible variation in length of assembled beams or girders between the center line of bearing devices shall not exceed ± 6 mm (± 1/4 in.) for any one span or ± 9.5 mm (± 3/8 in.) for any two or more spans within the assembled unit. The actual center line of any bearing device shall be within the thickness of the bearing stiffener.

**AASHTO Sec. 3.5.1.17** -- A new paragraph 3.5.1.17 shall be added as follows:

When the contract involves fabrication of a bridge with a bearing to bearing span of 30 m (100 ft.) or more, certifications and identifying numbers of calibrated tapes or numbered tapes matched to a calibrated master shall be submitted. Certification of the tape to be used or certification of the master from which the tape was matched, shall be by the U.S. National Bureau of Standards. Certification shall be renewed at least every 2 years. Tapes are to be calibrated in both the supported and unsupported positions. Unsupported lengths shall be calibrated in segments to insure a calibrated pull at a length not to exceed the desired measurement by more than 15 m (50 ft.).

**AWS Sec. 3.7 Paragraph 3.7.2.5** -- A new paragraph 3.7.2.5 shall be added as follows:

If, after two repairs to the same area of a weld requiring radiographic quality, there is any part of the original defect remaining, or there is a new rejectable indication, the total joint shall be cut apart, all deposited weld metal removed, joint preparation made, and the total joint rewelded. For welded joints requiring less than 100 percent radiographic quality, a third weld repair to an area may be made only with the approval of the engineer.

**AWS Sec. 3.7 Paragraph 3.7.2.6** -- A new paragraph 3.7.2.6 shall be added as follows:

The gas metal arc welding process shall not be used for the repair of welds except when repairing welds made by the GMAW process.

**AWS Sec. 3.11 Paragraph 3.11.3** -- A new paragraph 3.11.3 shall be added as follows:

Welds to be galvanized shall be blast cleaned to remove every particle of slag.

**AWS Sec. 3.13 Paragraph 3.13.4** -- Paragraph 3.13.4 shall be replaced with the following:

If backing for welds that are subject to computed stress is left in place to become a part of the structure, the strip shall be a single length insofar as possible. If more than a single length is needed, such lengths shall be jointed by complete joint penetration butt welds. These welds shall have no cracks, incomplete fusion, or inadequate joint penetration, and porosity and slag
inclusions shall not exceed the limits permitted by Sec. 9.25. These welds shall be examined by radiographic testing prior to their use in the final welds. Defects shall be repaired and the repaired welds re-examined by the same method of testing. The surface of this butt weld shall be ground flush as necessary to obtain proper fit-up in the weld joint with which the backing is to be used.

**AWS Sec. 4.1 Paragraph 4.1.2** -- Paragraph 4.1.2 shall be deleted.

**AASHTO 4.2 Table 4.2** -- Table 4.2 shall be replaced with the following:

**Table 4.2** -- Minimum Preheat and Interpass Temperature *

(Metric Units)

<table>
<thead>
<tr>
<th>Welding Process</th>
<th>Base Metal</th>
<th>to 13 mm</th>
<th>over 13 mm to 38 mm</th>
<th>over 38 mm to 65 mm</th>
<th>over 65 mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>SMAW</td>
<td>ASTM A 36</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SAW</td>
<td>ASTM A 572</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GMAW</td>
<td>ASTM A 588</td>
<td>10°C</td>
<td>50°C</td>
<td>80°C</td>
<td>110°C</td>
</tr>
<tr>
<td>FCAW</td>
<td>ASTM A 514</td>
<td>ASTM A 517</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(English Units)

<table>
<thead>
<tr>
<th>Welding Process</th>
<th>Base Metal</th>
<th>to 1/2”</th>
<th>over 1/2”</th>
<th>over 1 1/2”</th>
<th>over 2 1/2”</th>
</tr>
</thead>
<tbody>
<tr>
<td>SMAW</td>
<td>ASTM A 36</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SAW</td>
<td>ASTM A 572</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GMAW</td>
<td>ASTM A 588</td>
<td>50°F</td>
<td>125°F</td>
<td>175°F</td>
<td>225°F</td>
</tr>
<tr>
<td>FCAW</td>
<td>ASTM A 514</td>
<td>ASTM A 517</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* For ASTM A 514/A 517 steel, the maximum preheat and interpass temperature shall not exceed 205°C (400°F) for thicknesses up to 38 mm (1 1/2 in.) inclusive, and 230°C (450°F) for greater thicknesses. Heat input when welding ASTM A 514/A 517 steel shall not exceed the steel producer’s recommendation. Welding shall be carried continuously to completion or to a point
that will insure freedom from cracking before the joint is allowed to cool below the minimum specified preheat and interpass temperature.

**AWS Sec. 4.9 Paragraph 4.9.5** -- A new paragraph 4.9.5 shall be added as follows:

If required by the engineer, a sample joint, having the same cross section as the joint to be used in construction and a length of at least 300 mm (1 ft.), shall be welded with the electrode, flux, current, arc voltage, and speed of travel that are proposed to be used; a macroetched cross section of the welded joint shall be prepared as a demonstration that the requirements of Paragraph 4.7.7 and 4.9.4 will be met. When welding current, arc voltage, and speed of travel are established by a test made in accordance with the requirements of this paragraph, they shall be kept within the limitation of variables as given in Sec. 5.5 except where such variation would result in an increase in heat input beyond the recommendations of the producer of the quenched and tempered steel.

**AWS Sec. 4.10 Paragraph 4.10.7** -- A new paragraph 4.10.7 shall be added as follows:

If required by the engineer, a sample joint, having the same cross section as the joint to be used in construction and a length of at least 300 mm (1 ft.), shall be welded with the electrode, flux, current, arc voltage, and speed of travel that are proposed to be used; a macroetched cross section of the welded joint shall be prepared as a demonstration that the requirements of Paragraph 4.7.7 and 4.10.4 will be met. When welding current, arc voltage, and speed of travel are established by a test made in accordance with the requirements of this paragraph, they shall be kept within the limitation of variables as given in Sec. 5.5 except where such variation would result in an increase in heat input beyond the recommendations of the producer of the quenched and tempered steel.

**AWS Sec. 4.11 Paragraph 4.11.7** -- A new Paragraph 4.11.7 shall be added as follows:

If required by the engineer, a sample joint, having the same cross section as the joint to be used in construction and a length of at least 300 mm (1 ft.), shall be welded with the electrode, flux, current, arc voltage, and speed of travel that are proposed to be used; a macroetched cross section of the welded joint shall be prepared as a demonstration that the requirements of Paragraph 4.7.7 and 4.11.4 will be met. When welding current, arc voltage, and speed of travel are established by a test made in accordance with the requirements of this paragraph, they shall be kept within the limitation of variables as given in Sec. 5.5 except where such variation would result in an increase in heat input beyond the recommendations of the producer of the quenched and tempered steel.

**AWS Part F Stud Welding** -- Delete Sections 4.21 through 4.27.10.3 inclusive.

**AASHTO Section 4** -- Delete Sections 4.23 through 4.23.3 inclusive.

NOTE: Refer to Shear Connector Stud, Sec. 712.3.4 herein revised, and Sec. 1037, of the Missouri Standard Specifications for Stud Welding Specifications.
AASHTO Sec. 5.1 Paragraph 5.1.1 -- Delete paragraph 5.1.1.

AWS Sec. 5.1 Paragraph 5.1.2 -- Paragraph 5.1.2 shall be replaced with the following:

All prequalified welding procedures to be used shall be prepared by the manufacturer, fabricator, or contractor as a written procedure specification and four copies shall be submitted prior to submitting shop drawings. The shop drawings submitted for final approval shall indicate the welding procedure to be used for each joint. A proposed method of preventing toe cracking of fillet welds in quenched and tempered steel shall be indicated. A suggested form showing the information required in the procedure specification is given in Appendix E.

AWS Sec. 5.1 Paragraph 5.1.2.1 -- A new paragraph 5.1.2.1 shall be added as follows:

In lieu of requiring the contractor to furnish procedures for each project, the County will maintain a list of the procedures submitted by each fabricator and no further submittal will be required as long as the procedure identification is noted on the shop drawings. New procedures shall be submitted when changes in the variables exceed the limits noted in Section 5.

AWS Sec. 5.1 Paragraph 5.1.3 -- Delete paragraph 5.1.3

AWS Sec. 5.2 -- Sec. 5.2 shall be replaced with the following:

Other Procedures -- Except for the procedures exempted in Sec. 5.1, joint welding procedures which are to be employed in executing contract work under this Code shall be previously qualified prior to use, by tests as prescribed in Part B of this section to the satisfaction of the engineer. Qualification of joint welding procedures by other agencies will not be accepted.

AWS Sec. 5.3 Paragraph 5.3.1 -- Paragraph 5.3.1 shall be replaced with the following:

All welders, welding operators and tackers to be employed under this Code shall have been qualified by tests as prescribed in Parts C, D, and E of this section. Qualification of welders, welding operators, and tackers by other agencies will not be accepted.

AWS Sec. 5.4 -- Sec. 5.4 shall be replaced with the following:

Any cost involved in qualifying welding processes, joint welding procedures, tackers, welders and welding operators, including all costs of materials, finishing of test specimens, and transportation of test specimens to the Laboratory shall be borne by the contractor. Physical tests of finished specimens will be made at the Laboratory unless otherwise directed or approved by the engineer. Costs of commercial laboratory services employed by the engineer for testing of specimens will be borne by the County. If the contractor is permitted by the engineer to test specimens with contractor’s own laboratory testing facilities the costs of testing shall be borne by the contractor.

AWS Sec. 5.5 Paragraph 5.5.2.2(5) -- Paragraph 5.5.2.2(5) shall be replaced with the following:
(5) A change in the type of current (AC or DC) or a change of DC polarity.

AASHTO Sec. 5.10 Paragraph 5.10.1.3(1) -- Delete the words “or ultrasonic” in the first line.

AASHTO Sec. 5.10 Paragraph 5.10.1.3(2) -- Paragraph 5.10.1.3(2) shall be replaced with the following:

(2) For acceptable qualification, the weld, as revealed by radiographic testing, shall conform to the requirements of AWS Sec. 9.25.

AWS Sec. 5.11 Paragraph 5.11.6 -- Delete paragraph 5.11.6.

AASHTO Sec. 5.12 Paragraph 5.12.5 -- Delete the words “or ultrasonic” in the third line.

AWS Sec. 5.16 Paragraph 5.16.1.1 -- Paragraph 5.16.1.1 shall be replaced with the following:

Qualification established with any of the steels AASHTO M 183 (ASTM A 36), AASHTO M 222 (ASTM A 588), or AASHTO M 223 (ASTM A 572) shall be considered as qualification to weld any of the other steels listed. If quenched or tempered steel is to be welded, qualification shall be established with quenched and tempered steel, which qualification shall also be considered as qualification to weld any of the other steels listed above.

AWS Sec. 5.30 -- Sec. 5.30 shall be replaced with the following:

All welder qualifications shall be renewed annually. Renewal of shop welders qualification may be based on a letter from the fabricator certifying that the welder has been engaged in the process or processes for which he qualified without an interruption of more than 3 months, or by requalification. Requalification may be required anytime there is some specific reason to question the welder’s ability. Qualification cards will be issued by the County for field welders working on County projects. A field welder must request renewal by letter to the County Engineer, St. Charles Highway Department, St. Charles County, Missouri, 63301. No renewal card will be issued to a field welder unless the County can confirm that he or she has been engaged in the process or processes for which he or she qualified on a project inspected by the County during the preceding 12 months.

AASHTO Sec. 5.33 Paragraph 5.33.1.1 -- Paragraph 5.33.1.1 shall be replaced with the following:

Qualification established with any of the steels AASHTO M 183 (ASTM A 36), AASHTO M 222 (ASTM A 588), or AASHTO M 223 (ASTM A 572) shall be considered as qualification to weld any of the other steels listed. If quenched or tempered steel is to be welded, qualification shall be established with quenched and tempered steel, which qualification shall also be considered as qualification to weld any of the other steels listed above.
AWS Sec. 5.34 Paragraph 5.34.1 -- Paragraph 5.34.1 shall be replaced with the following:

The welding operator qualification test plate shall have a joint detail as follows:
25 mm (1 in.) plate, single-V-groove, 20 degrees included groove, 16 mm (5/8 in.) root opening with backing. Backing must be at least 9 mm x 75 mm (3/8 in. x 3 in.) if radiography is used for testing without removal of backing. Backing must be at least 9 mm x 38 mm (3/8 in. x 1 1/2 in.) for mechanical testing or for radiographic testing after the backing is removed. Minimum length of welding groove shall be 380 mm (15 in.)(See AWS 01.1-80 Fig. 5.34.1). This test will qualify the welding operator for groove and fillet welding in materials of unlimited thickness for the process and position tested.

AWS Sec. 5.41 -- Sec. 5.41 shall be replaced with the following:

All welder qualifications shall be renewed annually. Renewal of shop welders qualification may be based on a letter from the fabricator certifying that the welding operator has been engaged in the process or processes for which he qualified without an interruption of more than 3 months, or by requalification. Requalification may be required any time there is some specific reason to question the welding operator’s ability. Qualification cards will be issued by the County for field welding operators working on County projects. A field welding operator must request renewal by letter to the County Engineer, St. Charles County Highway Department, St. Charles County, Missouri 63301. No renewal card will be issued to a field welding operator unless the County can confirm that he has been engaged in the process or processes for which he qualified on a project inspected by the County during the preceding 12 months.

AASHTO Sec. 5.44 Paragraph 5.44.1.1 -- Paragraph 5.44.1.1 shall be replaced with the following:

Qualification established with any of the steels AASHTO M 183 (ASTM A 36), AASHTO M 222 (ASTM A 588), or AASHTO M 223 (ASTM A 572) shall be considered as qualification to tack weld any of the other steels listed. If quenched or tempered steel is to be tack welded, qualification shall be established with quenched and tempered steel, which qualification shall also be considered as qualification to tack weld any of the other steels listed above.

AWS Sec. 5.51 -- Sec. 5.51 shall be replaced with the following:

A tacker who passes the above test shall be considered eligible to perform tack welding in the positions and with the processes for which he is qualified unless there is some specific reason to question his ability. In such case, the tacker will be required to demonstrate his ability to make sound tack welds by again passing the prescribed tack welding test. In order to maintain qualification, certification by letter will be required annually stating that the tacker has been engaged in the process for which he qualified, without an interruption of more than 3 months.

AASHTO Sec. 6.1 Paragraph 6.1.3.1 -- Paragraph 6.1.3.1 shall be replaced with the
following:

Inspector Qualifications--When AWS Certified Welding Inspectors (AWS QC-1) are to be required, it shall be specified in the contract documents. When so specified, the following requirements shall apply.

**AASHTO Sec. 6.5 Paragraph 6.5.8** -- Paragraph 6.5.8 shall be replaced with the following:

The Inspector will record the locations of inspected areas and the findings of all nondestructive tests.

**AASHTO Sec. 6.6 Paragraph 6.6.5** -- Paragraph 6.6.5 shall be replaced with the following:

If nondestructive testing not specified in the original contract agreement is subsequently requested by the owner, the contractor shall perform any requested testing or shall permit any testing to be performed. Handling, surface preparation, repair welds, and any nondestructive testing requested by the engineer, as a result of a weld repair, shall be at the expense of the contractor.

**AASHTO Sec. 6.7 Paragraphs 6.7.1.1, 6.7.1.2, 6.7.1.3, 6.7.1.4** -- Paragraphs 6.7.1.1, 6.7.1.2, 6.7.1.3, 6.7.1.4 shall be replaced with the following:

Radiographic inspection will be required for areas of both shop and field butt welds as specified herein. One hundred percent inspection will be required for flanges of rolled beams and girders and 100 percent of transverse butt welds in webs for a distance of not less than 1/6 of the web depth from each flange and 25 percent of the remainder of the web depth. At least 1/3 of the length of all longitudinal web splices shall be radiographed at even intervals throughout the length of the splice. When a rejectable defect is found by radiography in any partially tested joint, either initially or in a later additional radiographic test, tests shall be made adjacent and either side of the rejectable test area. If a rejectable defect is found in any of these additional areas, then 100 percent of vertical web splices and an additional 10 percent of total weld length in longitudinal web splices shall be tested. The location of these additional test areas shall be as directed by the engineer.

**AASHTO Sec. 6.7 Paragraph 6.7.2.1** -- Paragraph 6.7.2.1 shall be replaced with the following:

At least 10 percent of each size and type of fillet weld between flanges and webs of all built-up members, between cover plates and flanges, between bearing stiffeners and webs, and for bearing devices and attachment of bearings to bridge members shall be tested. The 10 percent tested shall include the ends of all cover plates to flange welds. This test procedure may also be used for examination of weld passes and miscellaneous welds not specifically set out, at the discretion of the engineer. If any unacceptable defects are found in any test length of weld, the full length of the weld or 1.5 m (5 ft.) on either side of the test length, whichever is lesser, shall
be magnetic particle tested. Welds requiring repair shall be retested after repairs are made. The tests shall be located at random in the members so as to be typical for each size and type of weld. Magnetic particle testing for Q.A. shall not be performed until all welding has been completed on the piece being tested.

**AASHTO Sec. 6.7 Paragraph 6.7.2.2** -- Paragraph 6.7.2.2 shall be replaced with the following:

Any fillet weld that has one or both legs on quenched and tempered steel shall be 100 percent tested by the magnetic particle method.

**AASHTO Sec. 6.7 Paragraph 6.7.5** -- Paragraph 6.7.5 shall be replaced with the following:

Ultrasonic inspection may be used in lieu of radiographic inspection only when specifically approved in writing by the engineer. Approval will be given only for special cases. If ultrasonic inspection is approved for use, the extent of the welds to be inspected will be the same as indicated in paragraph 6.7.1.1 for radiographic inspection.

**AASHTO Sec. 6.7 Paragraph 6.7.6** -- Paragraph 6.7.6 shall be replaced with the following:

The contractor shall notify the engineer of the schedule for the work sufficiently in advance that the engineer may witness all magnetic particle inspection. The magnetic particle testing procedure shall be in accordance with the dry powder magnetic particle examination of welds using the prod method or the yoke method.

**AASHTO Sec. 6.7 Paragraph 6.7.6.1** -- Paragraph 6.7.6.1 shall be replaced with the following:

The prod method shall be performed in accordance with ASTM E 709, and the standards of acceptance shall be in accordance with AWS Sec. 9.25.

**AASHTO Sec. 6.7 Paragraph 6.7.6.2(4)** -- Paragraph 6.7.6.2(4) shall be replaced with the following:

Reports—The inspection service shall report the extent of inspection performed in linear meters (feet), location and length of defects, if any, and furnish a certification that all tests were performed in accordance with these specifications and ASTM E 709. The report shall also include the following minimum information:

A) Part identification.  
B) Date  
C) Technician’s name and certification level, and signature.  
D) Equipment make and model.  
E) Prod spacing, type of current (AC or DC), and amperage used.
F) Particles (Manufacturer’s name) and color.

AWS Sec. 6.10 Paragraph 6.10.11.2 -- Paragraph 6.10.11.2 shall be replaced with the following:

If the greatest and least thickness of a weld connecting parts of different thicknesses cannot both be rendered with adequate contrast on a single film with a single exposure, a dual film, or dual exposure technique shall be used to obtain suitable density for both the greatest and the least thickness of the weld. Penetrameters on transition joints shall be positioned as shown in Figure 6.10.7C and Figure 6.10.7D.

AASHTO Sec. 6.12 Paragraph 6.12.2 -- Paragraph 6.12.2 shall be replaced with the following:

Before a weld subject to radiographic testing by the contractor is accepted, all of its radiographs, including any that show unacceptable quality prior to repair, and a report interpreting them, shall be submitted to the engineer. The engineer shall give final approval concerning radiographic quality and acceptance of the weld, before fabrication and assembly begin.

AWS Sec. 6.12 Paragraph 6.12.4 -- A new paragraph 6.12.4 shall be added as follows:

After completion of all radiographic inspection, the contractor shall submit to the engineer one set of shop drawing details showing the location and identification numbers of all radiographs taken.

AASHTO Sec. 9.2 Paragraphs 9.2.1.3, 9.2.1.4, 9.2.1.11, 9.2.2 -- Delete paragraphs 9.2.1.3, 9.2.1.4, 9.2.1.11, 9.2.2.

AWS Sec. 9.12 Paragraph 9.12.1.6 -- Delete paragraph 9.12.1.6

AWS Sec. 9.12 Paragraph 9.22.3 -- A new paragraph 9.22.3 shall be added as follows:

Shearing and clipping shall be neatly and accurately done, and all portions of the work that will be exposed to view shall be neatly finished. Care shall be taken to maintain the full edge distance for bolts shown on the drawings, and proper allowance shall be made for milling, planing, or grinding where required. Sheared edges of plates more than 16 mm (5/8 in.) thick and carrying calculated stress shall be planed to a depth of 6 mm (1/4 in.). Re-entrant corners shall be filleted to a minimum radius of 19 mm (3/4 in.) before cutting. Planing may be omitted at the sheared ends of plates that become ends of main stress carrying members and are not otherwise specified to be milled.

AWS Sec. 9.24 -- Sec. 9.24 shall be replaced with the following:

Temporary welds shall be subject to the same welding procedure requirements as the final welds. They shall be removed unless otherwise permitted by the engineer. When they are
removed the surface shall be made flush with the original surface. Unless previously approved in writing by the engineer, there shall be no temporary welds for fabrication, transportation, erection, or other purposes on main members except at locations more than 1/6 the depth of the web from the flanges of beams and girders. Temporary welds at other locations shall be shown on shop drawings and shall be made with E70XX low-hydrogen electrodes.

**AWS Sec. 9.25 Paragraph 9.25.1.6**  --Paragraph 9.25.1.6 shall be replaced with the following:

The frequency of piping porosity in fillet welds shall not exceed one in each 100 mm (4 in.) of length, and the maximum diameter shall not exceed 2 mm (3/32 in.).

**AWS Sec. 9.25 Paragraph 9.25.2.1**  -- Paragraph 9.25.2.1 shall be replaced with the following:

For any welds, the greatest dimension of any porosity or fusion-type defect that is 1.6 mm (1/16 in.) or larger in greatest dimension shall not exceed the size, Dimension of Defect-B, indicated in Fig 9.25.2.1 for the effective throat thickness or weld size involved. The distance from any porosity or fusion-type defect described above to another such defect, to an edge, or to any intersecting weld shall not be less than the Maximum Clearance Allowed-C, indicated by Figure 9.25.2.1 for the size of defect under examination.

**AWS Sec. 9.25 Paragraph 9.25.2.2 and Figure 9.25.2.2**  -- Delete Paragraph 9.25.2.2. and Figure 9.25.2.2.

**AWS Sec. 9.25 Paragraph 9.25.2.4**  -- Paragraph 9.25.2.4 shall be replaced with the following:

The limitations given by Figure 9.25.2.1 for 38 mm (1 1/2 in.) joint effective throat shall apply to all joints or effective throats of greater thickness.

**AWS Sec. 9.25 Paragraph 9.25.3.1**  -- Paragraph 9.25.3.1 shall be replaced with the following:

Welds that are subject to ultrasonic testing in addition to visual inspection, shall conform to the requirements of Table 9.25.3.

**AWS Sec. 9.25 Paragraph 9.25.3.2**  -- Paragraph 9.25.3.2 shall be replaced with the following:

Complete joint penetration welds joining web-to-flange in plate girders shall conform to the requirements of Table 9.25.3

712.3.3.8 Milled joints shall be dressed accurately and smoothly to obtain contact throughout the depth and thickness of all component parts. The finishing of such surfaces shall be done after welding of the members is complete.
712.3.3.9 Pin holes shall be bored true to size, smooth and straight, at right angles to the axis of the member, and parallel with each other. The boring shall be done after the member is made up and welded. The distance center to center of pin holes shall be correct within 0.8 mm (1/32 in.), and the diameter of the holes shall not exceed that of the pin by more than 0.5 mm (1/50 in.) for pins 100 mm (4 in.) or less in diameter, nor more than 0.8 mm (1/32 in.) for pins larger than 100 mm (4 in.) in diameter.

712.3.3.10 Connection angles for floor beams and stringers shall be flush and shall be correct as to position and length of member. If milling is required, not more than 2 mm (1/16 in.) shall be removed from the thickness of the angles.

712.3.3.11 Pins. Pins shall be furnished true to size and shall be straight, smooth, and free from flaws. They shall be provided with hexagonal chamfered nuts. The screw ends shall be sufficiently long to permit burring the threads when members are connected. Pilot and driving nuts shall be furnished for each size of pins where required. Threads for all pins and bolts shall conform with the ANSI B 1.1 Free Fit -Class 2 Series, except that when recessed nuts are specified, pin ends requiring a threaded diameter of 35 mm (1 3/8 in.) or more shall have 6 threads per 25 mm (inch). If standard nuts are specified for this size pin, a minimum of 4 threads/25 mm (inch) shall be used.

712.3.3.12 Castings. Castings shall be free from inclusions of foreign material, casting faults, injurious blow holes, or other defects that render them unsuitable for the service intended. Castings shall be properly filleted at re-entrant angles. No tolerance will be allowed below the dimensions shown on the plans for thicknesses over an appreciable area of the casting. A reasonable oversize will not be cause for rejection.

712.3.3.13 Bent plates shall be cold bent and so taken from the stock plates that the bend line will be at right angles to the direction of rolling. The radius of bends, measured to the concave face of the metal, shall be not less and preferably shall be greater than shown in the following table in. which “T” is the thickness of the plate.

<table>
<thead>
<tr>
<th>Angle through which plate is bent</th>
<th>Minimum Radius</th>
</tr>
</thead>
<tbody>
<tr>
<td>61 degrees to 90 degrees</td>
<td>1.0T</td>
</tr>
<tr>
<td>Over 90 degrees to 120 degrees</td>
<td>1.5T</td>
</tr>
<tr>
<td>Over 120 degrees to 150 degrees</td>
<td>2.0T</td>
</tr>
</tbody>
</table>

If a shorter radius is required, the plates shall be hot bent. Hot bent plates shall also be bent at right angles to the direction of rolling. Before hot or cold bending, the corners of the plate shall be rounded to a radius of 1.6 mm (1/16 in.) throughout that portion of the plate at which the bending is to occur.

712.3.3.14 Surface Finish. Bearing plates of rolled steel not requiring a surface finish
shall be straightened to a plane surface. The surfaces of plates of rolled steel or cast material which are to be in contact shall be finished as indicated on the plans, and the final finish shall be made in a manner to give at least 50 percent contact as indicated by standard machinist’s blue test. Rockers and pedestals made from rolled steel shall be finished after welding. If a flat surface is indicated on the plans, the tolerance shall be 0.003 mm/mm (0.003 in./in.) in any direction. Flat surfaces in full contact shall be finished at right angles to each other. Bearing plates shall be assembled in sets, and each set shall be matchmarked before inspection. The surface finish of bearing and base plates and other bearing surfaces that are to come in contact with each other or with concrete shall meet the following surface roughness requirements as defined in ANSI B 46.1, Surface Roughness, Waviness and Lay, Part 1:

<table>
<thead>
<tr>
<th>Surface</th>
<th>mm (max)</th>
<th>Microinches (max)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Steel Slabs</td>
<td>0.051</td>
<td>2000</td>
</tr>
<tr>
<td>Heavy plates in contact in shoes to be welded</td>
<td>0.025</td>
<td>1000</td>
</tr>
<tr>
<td>Milled ends of compression members, stiffeners, and fillers</td>
<td>0.013</td>
<td>500</td>
</tr>
<tr>
<td>Bridge rollers and rockers</td>
<td>0.006</td>
<td>250</td>
</tr>
<tr>
<td>Pins and pin hole</td>
<td>0.003</td>
<td>125</td>
</tr>
<tr>
<td>Sliding bearings</td>
<td>0.003</td>
<td>125</td>
</tr>
</tbody>
</table>

712.3.3.15 Horizontally Curved Rolled Beams and Plate Girders. If the plans specify rolled beams or welded plate girders to be finished to a horizontal curvature, they shall be fabricated as follows: Rolled beams shall be curved by the heat curving procedure. Welded plate girders may be fabricated by cutting the flanges to the specified curvature before they are attached to the webs or, if not prohibited by the contract, may be curved by the heat curving procedure.

712.3.3.15.1 When the heat curving procedure is used, it shall comply with the following requirements:

(a) **Materials.** Heat curving of rolled beams and welded plate girders shall be limited to AASHTO M 183 (ASTM A 36), AASHTO M 222 (ASTM A 588), and AASHTO M 223 (ASTM A 572).

(b) **Type of Heating.** Beams and girders may be curved by either continuous or V-type heating.

(1) For the continuous method, strips along the edge of the top and bottom flanges shall be heated simultaneously. The strips shall be of sufficient width and temperature to obtain the required curvature.

(2) For the V-type heating, the top and bottom flanges shall be heated in truncated triangular or wedge-shaped areas having their bases along the flange edge and spaced at regular intervals along each flange as required to obtain the specified curvature. Heating shall progress along the top and bottom flange at
approximately the same rate. The apex of the truncated triangular area applied to the inside flange surface shall terminate just before the juncture of the web and the flange is reached. If the radius of curvature is 300 m (1000 ft.) or more, the apex of the truncated triangular heating pattern applied to the outside flange surface shall extend to the juncture of the flange and web. If the radius of curvature is less than 300 m (1000 ft.), the apex of the truncated triangular heating pattern applied to the outside flange surface shall extend past the web for a distance equal to 1/8 of the flange width or 75 mm (3 in.), whichever is less. The truncated triangular pattern shall have an included angle of approximately 15 to 30 degrees, but the base of the triangle shall not exceed 250 mm (10 in.). Variations in the pattern specified above may be made with the approval of the engineer.

(3) For both types of heating, the flange edges to be heated are those that will be on the inside of the horizontal curve after cooling. Heating both inside and outside flange surfaces is mandatory only when the flange thickness is 32 mm (1 1/4 in.) or greater, in which case the two surfaces shall be heated concurrently. The maximum temperature shall be as specified in subparagraph (d).

(c) Control of Web and Flange Distortion. To avoid unnecessary web distortion, special care shall be taken when heating the inside flange surfaces (the surfaces that intersect the web) so that heat is not applied directly to the web. If excessive web or flange buckling is encountered, the procedure shall be modified immediately.

(d) Temperature. The heat curving operation shall be conducted under rigid controls so the temperature of the steel does not exceed 593\(^0\) C (1100\(^0\) F) as measured by temperature-indicating crayons or other suitable means applied before heating. The heating of the steel to a temperature greater than 650\(^0\) C (1200\(^0\) F) will be considered destructive heating and will be positive cause for rejection of the steel. Quenching with water, or water and air, will not be permitted. Cooling with dry compressed air will be permitted after the steel has cooled to 315\(^0\) C (600\(^0\) F).

(e) Position for Heating. The girder may be heat curved with the web in either a vertical or a horizontal position. When curved in the vertical position, the girder must be braced or supported in such a manner that the tendency of the girder to deflect laterally during the heat curving process will not cause the girder to overturn. When curved in the horizontal position, the girder must be supported near its ends and at intermediate points, if required, to obtain a uniform curvature. When the girder is positioned horizontally for heating, intermediate safety catch blocks must be maintained at the midlength of the girder within 50 mm (2 in.) of the flanges at all times during the heating process.

(f) Sequence of Operations. Heat curving shall be completed before the girder is painted. The heat curving operation may be conducted either before or after all the required welding of transverse intermediate stiffeners is completed. However, unless provisions are made for girder shrinkage, connection plates and bearing stiffeners
shall be located and attached after heat curving. If longitudinal stiffeners are required, they shall be heat curved or oxygen-cut separately and then welded to the curved girder. When cover plates are to be attached to rolled beams, the beams shall be heat curved before the cover plates are attached. Cover plates shall be either heat curved or oxygen-cut separately and then welded to the curved beam.

712.3.3.16 Shop Assembly and Measurement

712.3.3.16.1 Shop Assembly.

(a) If required by the contract, the structural steel for bridges shall be shop assembled for inspection in their entirety, supported only at points of bearing. Long bridges required to be shop assembled in their entirety may be divided into units for assembly with each unit extending from expansion device to expansion device.

(b) Beams and girders of all other bridges shall be assembled for inspection in line assemblies with a minimum length assembled of one complete span, from bearing to bearing.

(c) During shop assembly, connecting parts shall be firmly fastened together and held in alignment with a minimum of four drift pins and four make-up bolts per flange splice plate, or similar connecting part, until assembly inspection is complete.

712.3.3.16.2 Shop Measurement of Curvature and Camber. Horizontal curvature and vertical camber will not be measured for final acceptance in the shop until all welding, drilling, and heat curving operations have been completed and the flanges have cooled to a uniform temperature. For bridges not requiring complete shop assembly, the vertical camber will be checked with the girder in a horizontal position, and the horizontal curvature will be checked with the girder in either a horizontal or vertical position. The permissible variations in specified sweep for horizontally curved beams and girders, measured in millimeters (inches), but not to exceed 13 mm (1/2 in.), shall be as follows:

\[
10 \text{ mm} \times 0.1 \times (\text{number of meters from end bearing})
\]

\[
1/8 \text{ inch} \times 0.1 \times [\text{No. of ft. from end bearing}]\]

The shop drawings shall show the required offsets for both curvature and camber at approximately 3 m (10 ft.) intervals, measured along the girder.

712.3.4 Shear Connector Studs. Shear connector studs may be attached to the beams or girders either in the fabricating shop or in the field. The contractor shall notify the engineer not less than one week before beginning to weld shear connectors to the beams or girders so the engineer may inspect for approval the proposed welding procedure and equipment, and conduct required qualification tests for welding operators. Only welding procedures, equipment, and operators meeting the approval of the engineers shall be used.

712.3.4.1 Procedure and operators shall be qualified for each diameter of stud to be used.
Each operator for welding studs shall weld, in the presence of the engineer, four studs to a test plate of composition and section similar to the material to be used in the work. Visual inspection of the welded studs will be made for uniformity and continuity of the weld collar. The weld collar shall cover not less than 75 percent of the periphery of the stud. There shall be no undercutting, lack of fusion, or other injurious defects. After the studs have been allowed to cool, they shall be bent down to the plate. If none of the four studs break or show cracks in the heat affected zone or in the weld, the operator and procedure will be approved. An immediate retest may be made if any of the four studs fall to meet requirements.

712.3.4.2 If necessary to obtain satisfactory welds, areas to which shear connectors are to be attached shall be cleaned of all foreign materials such as oil, grease, paint, excessive rust, and loose or excessively thick mill scale. Cleaning may generally be done by use of wire brushes or other methods approved by the engineer. Where a shop coat of System C primer has been applied, removal shall be limited to the minimum area necessary to apply the studs.

712.3.4.3 Shear connectors shall not be painted or galvanized and shall, at the time of welding, be free from excessive rust scale or rust pits, and free from oil or any other deleterious matter which could interfere with the welding operation. The necessity for cleaning and the method used shall be as determined by the engineer.

712.3.4.4 Visual inspection of shear connectors will be made during or after installation. Visual inspection of the welding of studs during fabrication will be similar to that made for qualification of operators and the same requirements for acceptance will be observed. After the studs have been welded to a beam or girder, at least ten studs, but not less than 3 percent shall be subjected to a bend test by hammering until the studs are bent not less than 15 degrees off the vertical in a direction lengthwise of the beam or girder, selecting the studs that have the least percentage of full fillet around the base. Studs selected for tests shall be left in place in the bent position. Studs showing signs of failure shall be removed and replaced.

712.3.4.5 Studs shall be end welded to steel beams or girders with automatically timed stud welding equipment connected to a suitable power source. Welding shall not be done when the base metal temperature is below 20°C (35°F), nor when the surface is wet or exposed to rain or snow. The stud welder, power source, and procedure shall be as recommended by the manufacturer of the studs and as approved by the engineer. If two or more stud welders are to be operated from the same power source, they shall be interlocked so that only one operator can weld at a time and so that the power source has fully recovered from making one weld before another weld is started. After a weld is made, the stud welder shall be held in position without movement until the welded metal has solidified. Before starting any stud welding, or if the welding equipment has been idle for more than one hour, trial studs shall be welded on a test plate of composition and section similar to the material to be used in the work. The welding procedure will be considered satisfactory when two studs welded consecutively and allowed to cool, can be bent down to the plate without breaks or cracks in the heat affected zone or in the weld.

712.3.4.5.1 With the approval of the engineer, studs may be fillet welded by the shielded metal-arc process, provided the following requirements are met. The fillet weld size shall be a
minimum of 5 mm (3/16 in.) and welding shall be done with low hydrogen electrodes 4 mm (5/32 in.) or 5 mm (3/16 in.) in diameter. The stud base shall be prepared so that the outside circumference of the stud fits tightly against the base metal. All rust and mill scale at the location of the stud shall be removed from the base metal by grinding and the end of the stud shall also be clean. The base metal to which studs are welded shall be preheated in accordance with Sec. 712.3.3.7, Table 4.2.

712.3.4.6 Before welding a new stud where a defective one has been removed, the area shall be ground smooth and flush, or in the case of a pull-out of metal, the pocket shall be filled with weld metal using one of the approved low-hydrogen welding processes and then ground flush. Studs on which 75 percent weld collar is not obtained may, at the option of the contractor, be repaired by adding a 5 mm (3/16 in.) fillet weld by using one of the approved low-hydrogen welding processes, or the stud may be replaced. Studs that are repaired around the collar by low-hydrogen welding shall have the base metal preheated in accordance with Sec. 712.3.3.7, Table 4.2.

712.3.4.7 If the height of studs as they are welded becomes less than specified, including tolerance, welding shall be stopped immediately and not resumed until the cause has been corrected.

712.3.4.8 If during the progress of the work, inspection and testing indicates, in the judgment of the engineer, that the shear connectors being obtained do not meet requirements, the contractor will be required at his expense to make such changes in welding procedure, welding equipment, and type of shear connector as necessary to secure satisfactory results.

712.3.5 Shipping. Fabricated material shall not be shipped before a “Fabrication Inspection Shipment Release” is issued by the engineer. All parts shall be loaded and protected in a manner to prevent damage in transit. Loading and unloading of members shall be done with equipment adequate for the purpose. Pins, nuts, bolts, and other small parts shall be boxed or crated. The “Fabrication Inspection Shipment Release” shall be delivered to the engineer at destination prior to erection of steel.

712.3.6 Handling, Transporting, Storing, and Erecting. Fabricated materials shall be properly braced and supported at all times to prevent damage from torsional, vertical, and lateral deflections. Members suspected to have been damaged during handling, transporting, storing, or erecting will be subjected to nondestructive tests as ordered by the engineer. The costs of these tests shall be borne by the contractor. Fabricated structural steel shall be stored on platforms, skids or other supports. Trough sections shall be stored in a manner to provide drainage. Long members shall be supported at frequent intervals. Girders and beams shall be handled and stored in an upright position. Any material that has become bent shall be straightened before being assembled, or shall be replaced if necessary. Material intended for use in the finished structure shall not be used by the contractor for erection or temporary purposes unless such use is provided for in the contract or by written approval of the engineer.
Construction Requirements

712.4 Falsework. Staging and falsework necessary for the erection of the structure shall be furnished and placed, and upon completion of the erection, removed by the contractor. Adequate supports shall be placed at each splice point in the lower chords of truss spans except when erection is done by the cantilever method. If required, plans for falsework shall be submitted to the engineer before starting the work, but the engineer’s acceptance of the plans will not relieve the contractor of the responsibility for obtaining satisfactory results.

712.5 Erection. Erection of all parts of the structure shall be in accordance with the erection diagram or working drawings. Surfaces to be in permanent contact shall have all burrs and loose scale removed. Before erection, machine finished surfaces shall be cleaned of the protective coating other than the primer permitted by Sec. 712.2.7, and contact surfaces shall be given a heavy coat of graphite and oil. Reamed connections match-marked in the shop shall be erected in accordance with those match-marks. Interchange or reversal of reamed connections will not be allowed. Hammering which may damage or distort the members will not be permitted.

712.5.1 Truss spans, plate girders, and continuous I-beams shall be supported to maintain required camber during erection. Fitting-up bolts and drift pins shall be furnished by the contractor. High-strength bolted field splices and primary connections, except for trusses and structures carrying live load erection stresses, shall have not less than one-half of the holes fitted with bolts and cylindrical drift pins using one-third fitting-up bolts and two-thirds pins. Splices and primary connections carrying erection traffic during erection, or truss connections, shall have not less than three-fourths of the holes filled with drift pins and bolts using one-third fitting-up bolts and two-thirds pins. The specified ratio of pins and bolts shall apply to each element of the splice; for example, top flange, web, and bottom flange of girders. Fitting-up bolts shall be the same diameter as the high-strength bolts. Drift pins shall be not less than 0.8 mm (1/32 in.) larger than the high-strength bolts to provide a driving fit. Fitting-up bolts shall be symmetrically placed so as to draw the splice pieces tight to such extent that a thin knife edge cannot be inserted between the pieces being connected. All fitting up bolts and drift pins shall be properly instilled before starting to install high-strength bolts. Bolts used for fitting up shall not be used in the final assembly. Holes that do not match shall be reamed only with the approval of the engineer. Drifting which would distort the metal will not be permitted.

712.5.2 The lead plates or preformed rubber and fabric pads shall be approximately 3 mm (1/8 in.) thick and 13 mm (1/2 in.) greater in length and width than bottom bearing plates under which they are to be placed. Lead plates shall have a weight of approximately 39 kg/m² (8 lb./sq. ft.). Preformed fabric pads shall comply with the requirements of Sec. 1038.3. Shop drawings are not required for lead plates or preformed rubber and fabric pads. Lead plates or preformed rubber and fabric pads are incidental to bearings and no direct payment will be made for furnishing or installing them.

712.6 Anchor Bolts. Anchor bolts for steel superstructures shall be set in the substructure units in accordance with the details shown on the plans. When anchor bolts are set during the placing of the concrete, they shall be accurately located and held firmly in a rigid template which
spans the concrete with sufficient clearance to permit proper finishing of the surface of the concrete. The template shall remain in place until the concrete has set. Where permitted or required, the anchor bolt wells may be omitted and in lieu thereof, holes drilled into the substructure. The anchor bolt holes shall be drilled in the exact location shown, to the required depth, perpendicular to the plane of the bridge seat, and just prior to the time of setting the anchors. The drilled holes shall not be smaller than the diameter of the holes in the steel bearing plates or castings. When the anchor bolts are set in holes or wells, they shall be grouted in by using an expansive mortar meeting the requirements of Sec. 1066. Excess mortar forced out of the holes shall be removed. The location of anchor bolts in relation to the center of slotted holes provided in movable plates and shoes shall be varied to compensate for movement of spans due to the temperature above or below 15° C (60° F). Nuts on anchor bolts through moving parts of expansion bearings shall be adjusted to provide ample clearance for free movement of the span.

712.7 Grouting. Grouting under bearing plates and castings to build them to the proper grade will not be permitted. Steel shims the full size of the plate of the bearing device may be used for this purpose. The shims shall be placed between the bottom of the stringers and the top of bearing plates if practicable. Shims shall be straightened to a plane surface.

712.8 Field Welding. All field welding shall be performed in accordance with Sec. 712.3.3.7.

712.8.1 Falsework or Supporting Devices. Falsework or supporting devices, designed to support the dead load of the beam or girder plus 100 percent, shall be provided at each joint to be field welded. Falsework plans, including location of falsework bents, or details of supporting and aligning devices, or the contractor’s alternate proposal for erection, shall be submitted to the engineer for review before shop drawings are submitted for approval. The engineer’s review will not be considered as relieving the contractor of responsibility to obtain acceptable welded joints. Field welded splices, when properly aligned to produce joints acceptable to the engineer, may be welded on the ground. The contractor shall provide safe and adequate scaffolding, ladders, and falsework.

712.8.2 Welding Procedures. Welding procedures, including pass sequences for field joints, shall be submitted to the engineer for review prior to submitting shop drawings. Weld passes shall be made symmetrically and shall alternate between both sides of the joint. The welding procedure shall indicate at what step in the welding sequence the contractor proposes to loosen or remove each alignment and support device.

712.9 Machine Bolts. Machine bolted field connections shall be made with machine bolts having American Standard Regular Heads and Nuts of hexagonal shape and shall conform to the requirements of ANSI B18.2.1 and B18.2.2. The threads shall extend slightly beyond the nut to permit burring. One plain washer meeting the requirements of ANSI B 18.22.1 shall be used at all slotted holes.

712.10 High Strength Bolts.

712.10.1 Bolted Parts. The slope of surfaces of bolted parts in contact with the bolt head
and nut shall not exceed one in 20 with respect to a plane normal to the bolt axis. Bolted parts shall fit solidly together when assembled and shall not be separated by gaskets or any other interposed compressible material. When assembled, all joint surfaces, including those adjacent to the bolt heads, nuts, or washers, shall be free of scale, and shall also be free of dirt, loose scale, burrs, other foreign material, and other defects that would prevent solid seating of the parts. Contact surfaces within friction-type joints shall be free of oil, paint (unless otherwise indicated in the contract), lacquer, rust inhibitor, and galvanizing.

712.10.2 Installation.

(a) Bolt Tension. Each fastener shall be tightened to provide, when all fasteners in the joint are tight, at least the minimum bolt tension shown in Table I for the size and grade of fastener used. Threaded bolts shall be tightened by methods described in Sec. 712.10.2(c), 712.10.2(d), or 712.10.2(e). If required because of bolt entering and wrench operation clearances, tightening may be done by turning the bolt while the nut is prevented from rotating. On non-parallel abutting surfaces where bevel washers are not required, the nut shall be torqued against the non-sloping surface. Nuts shall be placed in the least exposed position except if inaccessible for turning or on a sloping surface. Impact wrenches, if used, shall be of adequate capacity and sufficiently supplied with air to perform the required tightening of each bolt in approximately 10 seconds.
### TABLE I (Metric units)

**Bolt Tension and Projection**

<table>
<thead>
<tr>
<th>Bolt Size (Millimeters)</th>
<th>Minimum Bolt Tension (Kilo newtons)</th>
<th>Maximum Bolt Projection (Millimeters)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A-325M</td>
<td>A-490M</td>
<td></td>
</tr>
<tr>
<td>M16 X 2</td>
<td>91</td>
<td>114</td>
</tr>
<tr>
<td>M20 X 2.5</td>
<td>142</td>
<td>179</td>
</tr>
<tr>
<td>M22 X 2.5</td>
<td>176</td>
<td>221</td>
</tr>
<tr>
<td>M24 X 3</td>
<td>205</td>
<td>257</td>
</tr>
<tr>
<td>M27 X 3</td>
<td>267</td>
<td>334</td>
</tr>
<tr>
<td>M30 X 3</td>
<td>326</td>
<td>408</td>
</tr>
<tr>
<td>M36 X 4</td>
<td>475</td>
<td>595</td>
</tr>
</tbody>
</table>

### TABLE I (English units)

**Bolt Tension and Projection**

<table>
<thead>
<tr>
<th>Bolt Size (Inches)</th>
<th>Minimum Bolt Tension (Thousands of Pounds)</th>
<th>Maximum Bolt Projection (Inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A-325M</td>
<td>A-490M</td>
<td></td>
</tr>
<tr>
<td>1/2</td>
<td>................................................</td>
<td>12</td>
</tr>
<tr>
<td>5/8</td>
<td>................................................</td>
<td>19</td>
</tr>
<tr>
<td>3/4</td>
<td>................................................</td>
<td>28</td>
</tr>
<tr>
<td>7/8</td>
<td>................................................</td>
<td>39</td>
</tr>
<tr>
<td>1</td>
<td>................................................</td>
<td>51</td>
</tr>
<tr>
<td>1 1/8</td>
<td>................................................</td>
<td>56</td>
</tr>
<tr>
<td>1 1/4</td>
<td>................................................</td>
<td>71</td>
</tr>
<tr>
<td>1 3/8</td>
<td>................................................</td>
<td>85</td>
</tr>
<tr>
<td>1 1/2</td>
<td>................................................</td>
<td>103</td>
</tr>
</tbody>
</table>
**Permissible U.S. Bolt Substitutions for Metric**

<table>
<thead>
<tr>
<th>Metric Bolt Size (mm)</th>
<th>Us Bolt Sub. (in.)</th>
<th>Minimum Bolt Tension (kilo newtons)</th>
<th>Bolt Projection (millimeters)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A-325</td>
<td>M16</td>
<td>5/8</td>
<td>84</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>106</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>10</td>
</tr>
<tr>
<td>A-490</td>
<td>M22</td>
<td>7/8</td>
<td>173</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>215</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>M27</td>
<td>1 1/8</td>
<td>316</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>452</td>
</tr>
<tr>
<td></td>
<td></td>
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<td>13</td>
</tr>
<tr>
<td></td>
<td>M30</td>
<td>1 1/4</td>
<td>316</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>452</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>13</td>
</tr>
</tbody>
</table>

**Washers.** All fasteners shall have a hardened washer under the nut or bolt head, whichever is turned in tightening. Where an outer face of the bolted parts has a slope of more than one in 20 with respect to a plane normal to the bolt axis, a smooth beveled washer shall be used to compensate for the lack of parallelism.

**Calibrated Wrench Tightening.** When calibrated wrenches are used to provide the bolt tension specified in Table I, their setting shall be such as to induce a bolt tension 5 percent to 10 percent in excess of the specified value. These wrenches shall be calibrated at least once each working day by tightening, in a device capable of indicating actual bolt tension, not less than three typical bolts of each diameter from the bolts to be installed. Power wrenches shall be adjusted to stall or cut out at the selected tension. If manual torque wrenches are used, the torque indication corresponding to the selected tension shall be noted and used in the installation of all bolts of the tested lot. Nuts shall be in tightening motion when torque is measured. All bolts in the joint shall be tightened by progressing systematically from the most rigid part of the joint to its free edges. When using calibrated wrenches to install several bolts in a single joint, the wrench shall be returned to “touch up” bolts previously tightened, which may have been loosened by the tightening of subsequent bolts, until all are tightened to the selected tension. During tightening, there shall be no rotation of the part not turned by the wrench.

**Turn-of-Nut Tightening.** When the turn-of-nut method is used to provide the bolt tension, there shall first be enough bolts brought to a snug tight condition to insure that the parts of the joint are brought into full contact with each other. Snug-tight is defined as the tightness attained by a few impacts of an impact wrench, or the full effort of a person using an ordinary spud wrench. Following this initial operation, bolts shall be placed in any remaining holes in the connection and brought to snug tightness. All bolts in the joint shall then be tightened additionally by the applicable amount of nut rotation specified in Table II with tightening progressing systematically from the most rigid part of the joint to its free edges. During this operation there shall be no rotation of the part not turned by the wrench.
TABLE II
Nut Rotation\(^1\) from Snug-Tight Condition
Disposition of Outer Faces of Bolted Parts

<table>
<thead>
<tr>
<th>Bolt length measured from underside of head to extreme end of point</th>
<th>Both faces normal to bolt axis</th>
<th>One face normal to bolt axis and other face sloped not more than 1:20 (bevel washers not used)</th>
<th>Both faces sloped not more than 1:20 from normal to bolt axis (bevel washers not used)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to and including 4 diameters</td>
<td>1/3 turn</td>
<td>1/2 turn</td>
<td>2/3 turn</td>
</tr>
<tr>
<td>Over 4 diameters but not exceeding 8 diameters</td>
<td>1/2 turn</td>
<td>2/3 turn</td>
<td>5/6 turn</td>
</tr>
<tr>
<td>Over 8 diameters but not exceeding 12 diameters</td>
<td>2/3 turn</td>
<td>5/6 turn</td>
<td>1 turn</td>
</tr>
</tbody>
</table>

\(^1\)Nut rotation is relative to bolts, regardless of the element (nut or bolt) being turned. For bolts installed by 1/2 turn or less, the tolerance shall be ± 30 degrees; for bolts installed by 2/3 turn and more, the tolerance shall be ± 45 degrees.

(e) Load Indicating Bolt System. Tightening by this means is permitted provided it can be demonstrated by the following procedure that the bolt has been tightened to not less than the bolt tension indicated in Table I.

Three bolts of a representative length and of the same grade, diameter, and condition as those under inspection shall be placed individually in a calibration device capable of indicating bolt tension. There shall be a washer under the part turned in tightening each bolt. Each bolt specified shall be tightened in the calibration device until the spline drive has sheared off.

When the Load Indicating Bolt Method is used to provide the bolt tension, all bolts in the joint shall be tightened in stages to prevent or minimize slackening of the installed bolts. The first stage is to tighten all bolts to a snug-tight condition at which point all of the faying surfaces of the joint should be firmly in contact. The final stage of tightening to full tension shall be accomplished by progressing systematically from the most rigid part of the joint to its free edges.

(f) Bolt Length. Bolts, when properly tensioned, shall project not less than 7 mm (1/4 in.) beyond the nut.
712.10.3 Inspection. The engineer will observe the installation and tightening of bolts to determine that the selected tightening procedure is properly used and will determine that all bolts are tightened. The following inspection will be used for calibrated wrench or turn-of-nut tightening.

(a) Either the engineer, or the contractor in the presence of the engineer, shall use an inspecting wrench furnished by the contractor which shall be either a torque wrench or a power wrench that can be accurately adjusted in accordance with the requirements of Sec. 712.10.2(c).

(b) Three bolts of a representative length, and of the same grade, diameter, and condition as those under inspection shall be placed individually in a calibration device capable of indicating bolt tension. There shall be a washer under the part turned in tightening each bolt. When the inspecting wrench is a torque wrench, each bolt specified shall be tightened in the calibration device by any convenient means to the minimum tension specified in Table I. The inspecting wrench then shall be applied to the tightened bolt and the torque necessary to turn the nut or head 5 degrees (approximately 25 mm at 300 mm radius (1 in. at 12 in. radius)) in the tightening direction shall be determined. The average torque measured in the tests of three bolts shall be taken as the job inspecting torque to be used in the manner specified in Sec. 712.10.3(c). When the inspecting wrench is a power wrench it shall be adjusted so that it will tighten each bolt to a tension at least 5 percent but not more than 10 percent greater than the minimum tension specified for its size in Table I. This setting of wrench shall be taken as the job inspecting torque to be used in the manner specified in Sec. 712.10.3(c).

(c) Bolts represented by the sample prescribed in Sec. 712.10.3(b) which have been tightened in the structure will be inspected by applying, in the tightening direction, the inspecting wrench and its job inspecting torque to 10 percent of the bolts, but not less than two bolts, selected at random in each connection. If no nut or bolt head is turned by this application of the job inspecting torque, the connection will be accepted as properly tightened. If any nut or bolt head is turned by this application of the job inspecting torque, this torque shall be applied to all bolts in the connection, and all bolts whose nut or head is turned by the job inspecting torque shall be tightened and re-inspected, or the contractor, at his option, may re-tighten all of the bolts in the connection and then resubmit the connection for inspection.

712.11 Intentionally Blank.

712.12 Painting.

712.12.1 Description. This work shall consist of the preparation of previously unpainted steel surfaces, furnishing and applying specified paints, protection and drying of paint coatings, furnishing protection from paint spatter and disfigurement, and final cleanup.
712.12.2 **Surface Preparation.** All requirements for painting work will be listed in the project special provisions.

712.13 **Repainting.**

712.13.1 **Description.** This work shall consist of preparing surfaces to be repainted, furnishing and applying specified paints, protecting and drying paint coatings, furnishing protection from paint spatter and disfigurement, and final cleanup.

712.13.2.1 All requirements for repainting work will be listed in the project special provisions.

712.14 **Galvanized Metal.** Galvanizing shall be done after fabrication. Galvanized materials on which the galvanizing has been damaged will be rejected or may, with approval of the engineer, be repaired in the field by the zinc alloy stick method. Required field welds and adjacent areas on which galvanizing has been damaged shall be galvanized by this same method. The zinc alloy stick shall be cast from zinc, tin, and lead in combination with fluxing ingredients. The compound shall be completely liquid at a temperature not lower than 245°C (475°F). The area to be regalvanized shall be thoroughly cleaned, including the removal of slag on welds. The surface shall be heated with a torch to approximately 315°C (600°F), and the alloy stick rubbed over the surface to fix a deposit. While the alloy is still liquid, a clean wire brush shall be used to smooth the deposit evenly over the entire area being regalvanized. If a heavy deposit or build-up is required to match the original coating, more alloy shall be added immediately to the initial bond deposit and spread with a paddle or brush until the required thickness is obtained.

712.15 **Steel Bar Dams.** Steel bar dams placed at expansion devices on existing bridges to serve as headers for surfacing material shall be installed in a manner that will not interfere with the movement of the expansion devices.

712.16 **Method of Measurement.**

712.16.1 Structural steel and wrought iron weights will be computed from the approved shop drawings. The theoretical weight of the various sections will be used to compute the pay quantities of the material incorporated in the completed structure. No allowance will be made for overrun in scale weights or for erection bolts, excess field rivets or similar items, or the weight of any paint, galvanizing, or weld material. The weight of material removed for copes and cuts will not be allowed for payment. Deduction will not be made for bolt holes in the materials.

712.16.2 The weight of steel bolts for steel to steel connections will be included for payment as fabricated steel on the basis of the following weights per 100 bolts:

- M16, 15 kg; M20, 30 kg; M22, 43 kg; M24, 55 kg; M27, 75 kg; M30, 100 kg. (5/8 inch, 40 lb.; 3/4 inch, 65 lb.; 7/8 inch, 95 lb.; 1 inch, 135 lb.)

These specified weights will be considered to cover the head, nut, any required washers, and only that part of the bolt extending outside the grip of steel.
712.16.3 The weight of bolts connecting steel to concrete or steel to timber will be included for payment as fabricated structural steel and the full weight of the bolts will be computed.

712.16.4 Bolts for attaching timber members to any part of a structure will be classified as hardware and no direct payment will be made.

712.16.5 Castings will be computed on the basis of the theoretical weight of the material in the completed structure, and no allowance will be made for overrun in scale weights or for the weight of any paint, galvanizing material, or other protective coatings.

712.16.6 Weights of structural steel, wrought iron, and castings will be computed to the nearest 5 kilograms (10 pounds) of the total weight of each class of material in the completed structure.

712.16.7 If painting of steel structures is specified as a contract item, the weight of steel to be cleaned and painted will be computed to the nearest 0.10 Mg (0.10 ton).

712.16.8 If repainting of a steel structure is specified, it will be measured as a lump sum item regardless of type or size. The contract will indicate the estimated number of megagrams (tons) to be painted for informational purposes only.

712.16.9 A steel bar dam consists of the complete assembly on both sides of the expansion joint and will be considered a unit.

712.16.10 The weight of shear connectors will be based on the theoretical weight and will be included for payment in the weight of the material to which the connectors are attached.

712.17 Basis of Payment

712.17.1 The accepted quantity of fabricated structural steel, fabricated wrought iron, steel castings, and gray iron castings will be paid for at the contract unit bid price per kilogram (pound) for each class of material included in the contract that has been satisfactorily incorporated in the structure. No direct payment will be made for the shop coat of paint, painting of inaccessible surfaces and bolted field connections, galvanizing, applying protective coating to machined surfaces, or for cleaning paint and rust streaks from finished concrete.

712.17.2 If specified as a contract item, the accepted quantity of painting structural steel will be paid for at the contract unit bid price for painting; otherwise no direct payment will be made.

712.17.3 The accepted quantity of repainting will be paid for at the contract unit bid price for repainting each bridge specified in the contract.

712.17.4 The accepted number of steel bar dams will be paid for at the contract unit bid
price.
SECTION 713
BRIDGE GUARD RAIL

713.1 Description. This work shall consist of furnishing and erecting steel beam guard rail as designated on the plans, including beams, posts, and all appurtenances, complete in place.

713.2 Materials. All materials shall conform to the general requirements of Division 1000, Materials Details, and specifically as follows:

<table>
<thead>
<tr>
<th>Item</th>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>Guard Rail, Guard Cable, and Guard Fence</td>
<td>1040</td>
</tr>
<tr>
<td>Materials</td>
<td></td>
</tr>
</tbody>
</table>

713.3 Construction Requirements. Anchor bolts for posts shall be set with suitable templates in exact position and securely fixed to prevent displacement during the concreting operations. If posts are to be set on concrete, the areas upon which their bases are to bear shall be dressed smooth to a true plane by grinding or rubbing. Posts shall be aligned by the use of shims so that in final adjustment no post shall deviate more than 3 mm (1/8 in.) from true alignment.

713.4 Method of Measurement. Measurement of bridge guard rail will be made to the nearest 0.10 meter (nearest linear foot) for each structure, measured along the face of the beam and from center to center of end posts. Final measurement of the completed bridge guard rail will not be made except for authorized changes during construction, or where appreciable errors are found in the contract quantity. The revision or correction will be computed and added to or deducted from the contract quantity.

713.5 Basis of Payment. The accepted quantity of bridge guard rail, complete in place, will be paid for at the unit bid price for each of the pay items included in the contract.
SECTION 715
VERTICAL DRAIN AT END BENTS

715.1 Description. This work shall consist of furnishing and installing a vertical drain with a discharge pipe as shown on the plans.

715.2 Materials

715.2.1 Vertical Drain. The prefabricated vertical drain shall consist of a plastic core with a geotextile attached to one or both sides. The drain shall have the capacity for a minimum flow of water of 1.0 L/s/m of width (5 gal./min./ft. of width) in either principal direction. The drain shall have a minimum compressive strength of 290 kPa (6000 psf) at a maximum deformation of 10 percent of the original thickness when tested in accordance with ASTM D 1621. The core shall be composed of a plastic that is physically and chemically stable under a normal range of service conditions. The core shall be not less than 9.5 mm (3/8 in.) nor more than 25 mm (1 in.) in thickness. The geotextile shall be manufactured from fibers consisting of long chain synthetic polymers, composed of at least 85 percent by weight of polyolefin, polyesters, or polyamides. The geotextile may be woven or non-woven and shall have an apparent opening size (AQS number) not less than 0.15 mm (50) nor more than 0.30 mm (100) when tested in accordance with ASTM D 4751, and a minimum grab tensile strength in either principal direction of 0.35 kN (80 lb.) when tested in accordance with ASTM D 4632.

715.2.2 Drain Pipe. Drain pipe shall be of the type and diameter shown on the plans and shall comply with the requirements as specified herein.

715.2.2.1 Corrugated metal drain pipe shall comply with Sec. 1022.

715.2.2.2 Corrugated polyvinyl chloride (PVC) drain pipe shall comply with the requirements of ASTM F 949.

715.2.2.3 Corrugated polyethylene (PE) drain pipe shall comply with the requirements of AASHTO M 252.

715.2.3 Acceptance.

715.2.3.1 The vertical drain will normally be accepted on the basis of the manufacturer’s certification, and visual inspection by the engineer. The contractor shall furnish to the engineer a certification in triplicate stating that the vertical drain complies with these specifications. The certification shall also include the AOS and grab tensile strength of the geotextile, the compressive strength and deformation characteristics of the core, and the flow capacity of the drain, in an uncompressed condition in liters/second/meter of width (gal./min./ft. of width).

715.2.3.2 Polyvinyl chloride and polyethylene drain pipe will be accepted on the basis of
the manufacturer’s certification, and visual inspection by the engineer. The contractor shall furnish to the engineer a certification in triplicate stating that the drain pipe complies with these specifications.

715.2.3.3 The engineer reserves the right to sample and test all materials prior to use.

715.3 Construction Requirements.

715.3.1 The contractor shall furnish the engineer, at least two weeks prior to installation, a copy of the manufacturer’s printed instructions for installing the vertical drain. Except as herein noted, the installation of the drain shall be in accordance with the manufacturer’s printed instructions.

715.3.2 During all periods of shipment and storage, the drain shall be wrapped and protected from direct exposure to sunlight, ultraviolet rays, mud, dirt, and debris. The vertical drain shall not be exposed to sunlight for more than 14 days total until covered with soil, rock, concrete, etc.

715.3.3 If the core of the drain is not perforated, 13 mm (1/2 in.) holes shall be punched or drilled on 150 mm (6 in.) centers approximately 75 mm (3 in.) from the bottom of the drain or approximately the centerline of the drain pipe.

715.3.4 Vertical and horizontal joints shall be constructed so as to form an uninterrupted drain face after compaction is completed. All joints shall have an overlap of geotextile to prevent any intrusion of fill material into the drain. Horizontal joints shall be designed to drain downward. Any cracks or openings in the drain adjacent to the fill will be cause for rejection and replacement of the drain.

715.3.6 A rodent screen shall be inserted inside the outlet pipe 150 to 300 mm (6 to 12 in.) from the outlet coupler. This screen shall be press formed of 3 or 4 mesh, 0.8 mm (21 gage) or heavier, hot-dipped galvanized wire screen to create a cup-shaped screen which will produce a friction-tight fit when inserted into the drain pipe.

715.3.7 The backfill material shall be placed and compacted in accordance with Sec. 206. The backfill shall be placed in a manner to prevent damage to the drainage system. The backfill material and approach pavement shall be as approved by the engineer.

715.4 Measurement and Payment. The accepted drainage system, complete in place, will be paid for at the contract unit price for vertical drain at end bents, per each. No direct payment will be made for excavation, backfilling, compaction, drain pipe, or other materials and work incidental to the drainage system.
SECTION 725
METAL PIPE AND PIPE-ARCH CULVERTS

725.1 Description.

725.1.1 This work shall consist of providing corrugated metal pipe of the diameter or shape designated, laid upon a firm bed and backfilled as specified.

725.1.2 The contract will specify either the type of pipe or the group of permissible types of pipe. If a group of permissible types is specified, the contractor shall use any of the types listed within the specified group as follows:

Group I
Reinforced Concrete Pipe
Vitrified Clay Culvert and Sewer Pipe
Corrugated Metallic-Coated Steel Pipe

Group II
Reinforced Concrete Pipe
Corrugated Metallic-Coated Steel Pipe
Corrugated Aluminum Alloy Pipe

Group III
Reinforced Concrete Pipe
Corrugated Metallic-Coated Steel Pipe
Corrugated Aluminum Alloy Pipe
Corrugated Polyethylene Pipe

725.1.4 If the contract specifies corrugated metallic-coated steel pipe culverts or corrugated aluminum alloy pipe, or if the contract specifies culverts by group number, and the contractor elects to furnish corrugated metallic-coated steel pipe or corrugated aluminum alloy pipe, the thickness of metal and size of corrugation for the respective pipe sizes shall be in accordance with Table I or II, as applicable, unless otherwise specified. The overfill height shown on the plans or in the contract shall be used to determine the proper sheet thickness and size of corrugation for individual pipe culvert.

725.1.5 If the contract specifies pipe culverts by group number, and the contractor elects to furnish vitrified clay or reinforced concrete pipe, the culvert shall be constructed as directed by the engineer. If the contractor elects to furnish corrugated polyethylene pipe, the culvert shall be constructed as directed by the engineer.

725.1.6 The thickness of metal or size of corrugation shall not be changed throughout the length of any individual pipe culvert.
725.1.7 The type of pipe permitted in extending an existing pipe shall, in general, conform to the type used in place, except as otherwise specified in the contract, or unless prohibited by any of the requirements set out herein.

725.1.8 Corrugated metal pipe-arch shall only be used when specified in the contract or shown on the plans. Allowable overfill heights shown in Tables I and II do not apply to pipe-arch.
TABLE I (Metric Units)
Corrugated Galvanized Metal Circular Pipe
Maximum Allowable Overfill Heights (meters)

<table>
<thead>
<tr>
<th>Specified Diameter of Pipe (millimeters)</th>
<th>Specified Thickness of Galvanized Sheet, millimeters</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1.6</td>
</tr>
<tr>
<td>300</td>
<td>24</td>
</tr>
<tr>
<td>375</td>
<td>20</td>
</tr>
<tr>
<td>450</td>
<td>17</td>
</tr>
<tr>
<td>525</td>
<td>12</td>
</tr>
<tr>
<td>600</td>
<td>11</td>
</tr>
<tr>
<td>750</td>
<td>8</td>
</tr>
<tr>
<td>900</td>
<td>8</td>
</tr>
<tr>
<td>1050</td>
<td>6</td>
</tr>
<tr>
<td>1200 (Round)</td>
<td>6</td>
</tr>
<tr>
<td>1200**</td>
<td>8</td>
</tr>
<tr>
<td>1350**</td>
<td>—</td>
</tr>
<tr>
<td>1500**</td>
<td>—</td>
</tr>
<tr>
<td>1650**</td>
<td>—</td>
</tr>
<tr>
<td>1800**</td>
<td>—</td>
</tr>
<tr>
<td>1950**</td>
<td>—</td>
</tr>
<tr>
<td>2100**</td>
<td>—</td>
</tr>
<tr>
<td>2250**</td>
<td>—</td>
</tr>
<tr>
<td>2400**</td>
<td>—</td>
</tr>
<tr>
<td>2550**</td>
<td>—</td>
</tr>
<tr>
<td>2700**</td>
<td>—</td>
</tr>
<tr>
<td>2900**</td>
<td>—</td>
</tr>
<tr>
<td>3000**</td>
<td>—</td>
</tr>
</tbody>
</table>

* A = 68 x 13 millimeter corrugations  
B = 76 x 25 millimeter corrugations  
** Shop elongated in accordance with Sec. 725.5
## TABLE I (English Units)
Corrugated Galvanized Metal Circular Pipe
Maximum Allowable Overfill Heights (feet)

<table>
<thead>
<tr>
<th>Specified Diameter of Pipe (inches)</th>
<th>Minimum Cover (feet)</th>
<th>Specified Thickness of Galvanized Sheet, inches</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.064 A* B*</td>
<td>0.079 A* B*</td>
</tr>
<tr>
<td></td>
<td>0.109 A* B*</td>
<td>0.138 A* B*</td>
</tr>
<tr>
<td></td>
<td>0.168 A* B*</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>1</td>
<td>80</td>
</tr>
<tr>
<td>15</td>
<td>1</td>
<td>65</td>
</tr>
<tr>
<td>18</td>
<td>1</td>
<td>55</td>
</tr>
<tr>
<td>21</td>
<td>1</td>
<td>40</td>
</tr>
<tr>
<td>24</td>
<td>1</td>
<td>35</td>
</tr>
<tr>
<td>30</td>
<td>1</td>
<td>25</td>
</tr>
<tr>
<td>36</td>
<td>1</td>
<td>25</td>
</tr>
<tr>
<td>42</td>
<td>1</td>
<td>20</td>
</tr>
<tr>
<td>48 (Round)</td>
<td>1</td>
<td>20</td>
</tr>
<tr>
<td>48**</td>
<td>1</td>
<td>25</td>
</tr>
<tr>
<td>54**</td>
<td>1</td>
<td>20</td>
</tr>
<tr>
<td>60**</td>
<td>1</td>
<td>20</td>
</tr>
<tr>
<td>66**</td>
<td>1</td>
<td>20</td>
</tr>
<tr>
<td>72**</td>
<td>1</td>
<td>20</td>
</tr>
<tr>
<td>78**</td>
<td>1</td>
<td>20</td>
</tr>
<tr>
<td>84**</td>
<td>1</td>
<td>20</td>
</tr>
<tr>
<td>90**</td>
<td>1</td>
<td>20</td>
</tr>
<tr>
<td>96**</td>
<td>1</td>
<td>20</td>
</tr>
<tr>
<td>102**</td>
<td>2</td>
<td>20</td>
</tr>
<tr>
<td>108**</td>
<td>2</td>
<td>20</td>
</tr>
<tr>
<td>114**</td>
<td>2</td>
<td>20</td>
</tr>
<tr>
<td>120**</td>
<td>2</td>
<td>20</td>
</tr>
</tbody>
</table>

* A = 2 2/3 x 1/2 inch corrugations B = 3 x 1 inch corrugations.
** Shop elongated in accordance with Sec. 725.5
### TABLE II (Metric Units)

**Corrugated Aluminum Alloy Circular Pipe**  
68 x 13 millimeter Corrugations

**Allowable Overfill Heights (meters)**

<table>
<thead>
<tr>
<th>Specified Diameter of Pipe (millimeters)</th>
<th>Specified Sheet Thickness, millimeters</th>
<th>1.9</th>
<th>2.7</th>
<th>3.4</th>
<th>4.2</th>
</tr>
</thead>
<tbody>
<tr>
<td>300</td>
<td>0.3-11</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>375</td>
<td>0.3-10</td>
<td>10-12</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>450</td>
<td>0.3-6</td>
<td>9-11</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>525</td>
<td>0.3-8</td>
<td>8-9</td>
<td>9-11</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>600</td>
<td>--</td>
<td>0.3-9</td>
<td>9-10</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>750</td>
<td>--</td>
<td>0.3-7</td>
<td>7-9</td>
<td>9</td>
<td>--</td>
</tr>
<tr>
<td>900</td>
<td>--</td>
<td>--</td>
<td>0.3-5</td>
<td>6-7</td>
<td>--</td>
</tr>
<tr>
<td>1050</td>
<td>--</td>
<td>--</td>
<td>0.3-5</td>
<td>6-7</td>
<td>--</td>
</tr>
<tr>
<td>1200 (Round)</td>
<td>--</td>
<td>--</td>
<td>0.3-3</td>
<td>4-5</td>
<td>--</td>
</tr>
</tbody>
</table>

### TABLE II (English Units)

**Corrugated Aluminum Alloy Circular Pipe**  
2 2/3 x 1/2 inch Corrugations

**Allowable Overfill Heights (feet)**

<table>
<thead>
<tr>
<th>Specified Diameter of Pipe (inches)</th>
<th>Specified Sheet Thickness, inches</th>
<th>0.075</th>
<th>0.105</th>
<th>0.135</th>
<th>0.164</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>1-37</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>15</td>
<td>1-33</td>
<td>34-38</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>18</td>
<td>1-29</td>
<td>30-35</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>21</td>
<td>1-25</td>
<td>36-30</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>21</td>
<td>1-25</td>
<td>26-30</td>
<td>31-35</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>24</td>
<td>--</td>
<td>1-29</td>
<td>30-33</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>30</td>
<td>--</td>
<td>1-23</td>
<td>24-28</td>
<td>29-30</td>
<td>--</td>
</tr>
<tr>
<td>36</td>
<td>--</td>
<td>--</td>
<td>1-22</td>
<td>23-27</td>
<td>--</td>
</tr>
<tr>
<td>42</td>
<td>--</td>
<td>--</td>
<td>1-17</td>
<td>18-24</td>
<td>--</td>
</tr>
<tr>
<td>48 (Round)</td>
<td>--</td>
<td>--</td>
<td>1-11</td>
<td>12-17</td>
<td>--</td>
</tr>
</tbody>
</table>
725.2 Materials.

725.2.1 All materials shall conform to Division 1000, Materials Details, and specifically as follows:

<table>
<thead>
<tr>
<th>Item</th>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corrugated Metallic-Coated Steel Culvert Pipe, Pipe-Arches, and End Sections</td>
<td>1020</td>
</tr>
<tr>
<td>Corrugated Aluminum Alloy Culvert Pipe</td>
<td>1024</td>
</tr>
</tbody>
</table>

725.3.1 Excavation. If the pipe is to be laid below the ground line, the trench shall be excavated to the required depth. The bottom of the trench shall be shaped to conform to the bottom of the pipe for at least 10 percent of its overall height and shall afford a uniformly firm bed throughout its entire length. In lieu of shaping the trench, the pipe may be placed on a 50 mm (2 in.) thick bed of sand and backfilled in accordance with the requirements of Sec. 725.6.1. If rock is encountered, the trench shall be excavated 150 mm (6 in.) below the bottom of the pipe, and backfilled with suitable material thoroughly compacted and shaped. Soft or yielding material shall be removed and replaced with suitable material tamped thoroughly into place. If the pipe is not laid in a trench, a uniformly firm bed shall be provided.

725.4 Laying Pipe.

725.4.1 The pipe shall be carefully laid true to lines and grades given, with the outside laps of circumferential joints pointing upstream and with longitudinal laps on the sides. If pipe sections are joined on the work, the ends shall be butted as closely as the corrugations will permit and shall be joined with a firmly bolted coupling band of the same material as the pipe. Multiple culverts, unless noted otherwise on the plans, shall be laid with 1/2 span of the pipe, or a minimum of 300 mm (1 ft.), whichever is the greater, between the culverts. Any pipe which is not in true alignment or which shows any undue settlement after laying shall be taken up and relaid at the contractor’s expense. When shown on the plans, or directed by the engineer, camber shall be built into the pipe structure to compensate for settlement from fill loads.

725.4.2 Proper care shall be taken during handling and installation to avoid damage to spelter or cladding. Pipe on which such coatings have been damaged may, unless repaired to the satisfaction of the engineer, be rejected at the site of the work regardless of previous approvals.

725.4.3 Pipe having any localized bends in excess of 5 percent of the nominal pipe diameter, or any dent in excess of 13 mm (1/2 in.), will be rejected. Pipe rejected because of these defects may be used if satisfactorily repaired. Repair may be made by jacking or by any other method meeting the approval of the engineer.

725.5 Shop Elongation. Round corrugated metal pipe of 1350 mm (54 in.) or over in diameter shall be shop elongated. Corrugated galvanized metal pipe 1200 mm (48 in.) in diameter may be furnished round or shop elongated in accordance with Table I. The contractor shall be responsible for maintaining elongation during backfilling and embankment construction such that the vertical height of the opening after the embankment has been completed shall be
not less than the diameter of the pipe, nor greater than the pre-elongated height.

725.6 **Backfilling.** Suitable backfill and embankment material, free from large lumps, clods, or rocks, shall be placed alongside the pipe in loose layers not exceeding 150 mm (6 in.) in thickness to provide a berm of compacted earth, on each side of the pipe, at least as wide as the diameter of the pipe. Each 150 mm (6 in.) layer shall be thoroughly compacted to the same density required for the adjacent fill. Backfill material shall be moistened, if necessary, to facilitate compaction. Where shop elongated pipe is used, special care will be required in bringing backfill materials up uniformly on both sides of the pipe simultaneously. Filling and compacting shall be continued until the embankment is level with the top of the pipe if the top of the pipe is above the original surface, otherwise it shall be continued until the embankment is level with the original surface.

725.6.1 Pipe laid on a sand bed shall be backfilled with sand for at least 10 percent of its overall height. The sand shall be thoroughly compacted by the use of tampers or by flooding. The remainder of the backfill shall be in accordance with the requirements of Sec. 725.6.

725.7 **Beveled End Section.** The plans will indicate those corrugated metal pipe culverts that are to have beveled end sections and the slope of the cutting line. The required slope on opposite ends of any individual structure will be identical in order that the portion of pipe cut off in forming the required beveled end section on one end of the structure can be used on the opposite end of the structure. On skewed round structures with beveled end sections, the end sections shall be rotated as required to better fit the adjacent roadway slope. Shop elongation will be required in accordance with Sec. 725.5.

725.8 **Corrugated Metal Drop Inlets.** The contractor shall install corrugated metal drop inlets of the proper size and length at the locations shown on the plans. The drop inlet shall be constructed of the same base metal and thickness of corrugated metal as used in the culvert pipe and shall meet the requirements of Sec. 1020 or 1024, as applicable.

725.9 **Corrugated Metal Curtain Walls.** The contractor shall install metal curtain walls of the proper size and shape at locations shown on the plans. The metal curtain walls shall be constructed of the same base metal used in the culvert pipe, shall be of the thickness of metal shown on the plans, and shall meet the requirements of Sec. 1020 or 1024, as applicable.

725.10 **Method of Measurement.**

725.10.1 Measurement of corrugated metal pipe or pipe-arch, complete in place, will be made to the nearest 0.5 m (nearest foot) along the geometrical center of the pipe. Final measurement will not be made except for authorized changes during construction, or where appreciable errors are found in the contract quantity. The revision or correction will be computed and added to or deducted from the contract quantity.

725.10.2 Excavation for placing pipe, pipe-arches, corrugated metal drop inlets, and metal curtain walls will be measured and paid for as Class I excavation in accordance with Sec. 206.
725.11 Basis of Payment.

725.11.1 The accepted quantities of pipe, complete in place, including all necessary tees, bends, wyes, coupling bands, cutting, and joining new pipe to existing pipe or structures unless otherwise specified, will be paid for at the unit bid price for each of the pay items included in the contract. No direct payment will be made for furnishing or placing filling or backfilling materials.

725.11.2 No direct payment will be made for beveling, skewing, nor for any additional work required in laying pipe with beveled or skewed ends, nor work involved in elongating, nor for any backfilling required except as specified in Sec. 206.6.3.

725.11.3 The accepted quantities of corrugated metal drop inlets, and metal curtain walls, complete in place, including coupling bands, toeplates, nuts, and bolts will be paid for at the unit bid price for each of the pay items included in the contract.
Division 800

ROADSIDE DEVELOPMENT
SECTION 801
FERTILIZING

801.1 Description. This work shall consist of the application of lime and commercial fertilizer, and soil preparation for seeding and sodding on areas indicated on the plans, or designated by the engineer.

801.2 Materials.

801.2.1 Material used for soil neutralization, unless otherwise specified, shall be agricultural lime with not less than 90 percent passing the 2.36 mm (No. 8) sieve and containing not less than 65 percent calcium carbonate equivalent.

801.2.2 The rate of application of lime shall be that required to provide at least the quantity of effective neutralizing material per hectare (acre) specified in the contract or when not specified will be one metric ton (ton) per hectare (acre) of effective neutralizing material. When agricultural lime is to be furnished from a source that has not been tested and certified, an average rate of four metric tons (tons) of lime per hectare (acre) will equal one metric ton (ton) of effective lime per hectare (acre).

801.2.3 Fertilizer shall be a standard commercial product which, when applied at the proper rate, will supply the quantity of total nitrogen (N), available phosphoric acid (P₂O₅) and soluble potash (K₂O), as specified in the contract. Material may be accepted on the basis of bag label analysis or supplier’s certification and shall comply with all applicable Missouri Fertilizer Laws. Commercial fertilizer shall have a minimum composition of 12% nitrogen, 12% available phosphoric acid and 12% soluble potash (12-12-12 Formula). The application of commercial fertilizer shall be at the rate of 335 kg -365 kg (300 lbs.-325 lbs.) per hectare (acre) or as otherwise directed by the engineer.

801.3 Equipment. Lime and commercial fertilizer shall be applied by mechanical equipment designed for this purpose. Small areas may be applied by hand methods with prior approval of the engineer.

801.4 Construction Requirements.

801.4.1 The area to be limed and fertilized will be the area designated within the limits of construction; shall have a uniform surface free from rills, washes, and depressions; and shall conform to the finished grade and cross section as shown on the plans. The soil, while in a tillable condition, shall be thoroughly broken up, worked, tilled, and loosened to a minimum depth of 50 mm (2 in.). The seedbed or sodbed shall be prepared by loosening the existing soil on the slope, rather than by the addition of loose soil, except when required by the contract.
801.4.2 Lime and fertilizer shall be applied evenly at the rates designated in the contract, and only when the soil is in a tillable condition. After application, the lime and fertilizer shall be mixed into the soil by disk ing, harrowing, or raking to a minimum depth of 50 mm (2 in.) unless applied hydraulically on slopes steeper than 2:1 in accordance with Sec 805.3.2.1.

801.4.3 Lime and fertilizer shall be applied separately, but may be incorporated into the soil in one operation. Lime and fertilizer shall be applied not more than 48 hours before the seed is sown unless authorized by the engineer.

801.5 Method of Measurement. Measurement of the area which has been limed and fertilized will be made to the nearest 0.10 hectare (1/10 acre).

801.6 Basis of Payment. The accepted quantity of liming and fertilizing will be paid for at the contract unit bid price. No direct payment will be made for liming and fertilizing areas for which seeding or sodding items are included in the contract.
SECTION 802
MULCHING

802.1 Description. This work shall consist of the application of a mulch covering of the type specified in the contract. All seeded areas except shoulders shall be mulched. Disturbed areas outside of authorized construction limits shall be mulched at the contractor’s expense.

802.2 Materials.

802.2.1 All materials used for mulching shall conform to the following:

802.2.1.1 Type 1 Mulch (Vegetative). The vegetative mulch shall be the prairie hay or straw from oats, rye, wheat, or barley. Prairie hay shall consist of any combination of any of the following plants: big bluestem, little bluestem, indiangrass, sideoats grama and native wildflowers. The mulch shall be free of prohibited weed seed as stated in the Missouri Seed Law, and shall be relatively free of all other noxious and undesirable seeds. The mulch shall be clean and bright, relatively free of foreign material, and be dry enough to spread properly. If the above specifications cannot be met practicably, hay of the following plants may, with the engineer’s approval, be substituted: smooth brome, timothy, orchard grass, reed canary grass, tall fescue, red top, Kentucky blue grass, alfalfa, and birdsfoot trefoil.

802.2.1.2 Type 2 Mulch (Vegetative with Asphalt Emulsion). The asphalt emulsion shall be SS-1, SS-1h, CSS-1 or CSS-1h conforming to the requirements of AASHTO M 140-70 or AASHTO M 208-72. The vegetative mulch shall be as specified in Sec 802.2.1.1.

802.2.1.3 Type 3 Mulch (Vegetative with an Overspray). The vegetative mulch shall be as specified in Sec 802.2.1. The overspray material may be virgin wood cellulose fibers or recycled slick paper as herein specified. It shall not contain any germination or growth inhibiting substances. The overspray shall be green in color after application and shall have the property to be evenly dispersed and suspended when agitated in water. When sprayed uniformly over vegetative mulch, the mulch fibers shall form an absorbent cover, allowing percolation of water to the underlying soil. The mulch shall be packaged in moisture resistant bags with the net weight of the packaged material plainly shown on each bag. The mulch fibers shall not be water soluble.

802.2.1.4 Type 4 Mulch (Embedded). The vegetative mulch shall meet the requirements of Sec 802.2.1.1. The mulch shall be embedded by a disc type roller having flat serrated discs spaced not more than 250 mm (10 in.) apart and cleaning scrapers shall be provided.

802.3 Construction Requirements.

802.3.1 Type 1 Mulch (Vegetative) shall be applied at the rate of 2.5 metric tons (tons)
Type 2 Mulch (Vegetative with Asphalt Emulsion) shall be applied by mechanical mulch spreaders equipped to eject, by means of a constant air stream, controlled quantities of the vegetative mulch and emulsified asphalt in a uniform pattern over the specified area. The mulching machine shall be so designed that the asphalt will be injected at the proper rate directly into the air stream carrying the straw, resulting in a uniform spotty tacking of the vegetative mulch with asphalt. The vegetative mulch shall be applied at the rate of 2.5 metric tons (tons) per hectare (acre). The normal application rate for the asphalt emulsion shall be 400 L (100 gallons) per metric ton (ton) of straw.

Type 3 Mulch (Vegetative with an Overspray) shall be hydraulically applied over the vegetative mulch as a separate operation. Recycled slick paper shall be applied at the rate of 840 kg per hectare (750 pounds per acre). Virgin wood cellulose fibers with 90 percent or more organic matter shall be applied at the rate of 840 kg per hectare (750 pounds per acre) and that with 80 to 89 percent inclusive shall be applied at a rate calculated as follows:

Metric Unit:

\[
\text{Rate kg/hectare} = \frac{100}{\text{Actual Percent Organic Matter}} \times 840 \text{ kg/hectare}
\]

English Unit:

\[
\text{Rate lb/acre} = \frac{100}{\text{Actual Percent Organic Matter}} \times 750 \text{ lb/acre}
\]

The overspray material shall be mixed with water in a manner to provide a homogeneous slurry. Equipment for mixing and applying the slurry shall be capable of applying it uniformly over the entire vegetative mulched area. The slurry mixture shall be agitated during application to keep the ingredients thoroughly mixed.

Type 4 Mulch (Embedded) shall be applied at the rate of 2.5 metric tons (tons) per hectare (acre). The mulch roller shall be operated approximately parallel to the roadway grade. The mulch shall be embedded in the soil a sufficient depth to prevent loss of mulch by wind or water erosion.

All mulch shall be distributed evenly over the area to be mulched within 24 hours following the seeding operation. Following the mulching operation, precautions shall be taken to prohibit foot or vehicular traffic over the mulched area. Any mulch which is displaced shall be replaced at once, but only after the work preceding the mulching which may have been damaged as a result of the displacement has been acceptably repaired.
802.4 Method of Measurement.

802.4.1 Measurement of Type 1, 2, 3, and 4 Mulch will be made to the nearest 0.10 hectare (1/10 acre) of the area mulched. For the Type 2 Mulch, the cost of emulsion will be included in price of mulch.

802.5 Basis of Payment. The accepted quantities of mulching will be paid for at the unit bid price of the pay items included in the contract. No direct payment will be made for moistening the seedbed.
SECTION 803
SODDING

803.1 Description. This work shall consist of preparing the areas for sodding and placing approved live sod. The entire area designated for sodding shall be covered with sod.

803.2 Materials. Unless otherwise specified in the contract, the sod shall be Kentucky Bluegrass, densely rooted and thrifty. The sod shall contain a growth of not more than 25 percent of other grasses and clovers, and be free of all weeds. The sod shall be cut in strips of uniform thickness with each strip containing at least 0.25 m² (1/3 sq. yd.) and not more than one square meter (one square yard). Sod shall be cut into strips, not less than 300 mm (12 in.) in width nor more than 2.7 m (9 ft.) in length. At the time of sod lifting, the top growth shall not exceed 75 mm (3 in.) in length. The thickness of the sod shall be determined by stacking ten pieces alternately with the soil of the first piece on the bottom. The height of the stack, without compression, shall exceed 275 mm (11 in.) and the thickness of the soil portion of each piece shall be not less than 19 mm (3/4 in.). All sod shall conform to the laws of Missouri and shall be obtained from sources meeting the approval of the Department of Agriculture, Plant Industries Division.

803.3 Construction Requirements.

803.3.1 Sod shall not be placed during a drought nor during the period from June 1 to September 1 unless authorized by the engineer, and shall not be placed on frozen ground. No dry or frozen sod shall be used.

803.3.2 The sodbed shall be prepared, limed, and fertilized in accordance with Sec 801. The bed shall be in a firm but uncompacted condition with a relatively fine texture at the time of sodding. Sod shall be moist and shall be placed on a moist earth bed. Sod strips shall be laid along contour lines, by hand, commencing at the base of the area to be sodded and working upward. The transverse joints of sod strips shall be broken, and the sod carefully laid to produce tight joints. The sod shall be firmed, watered, and refirmed immediately after it is placed. The firming shall be accomplished by use of a lawn roller or tamper. On slopes greater than 3:1, the sod shall be pegged with wood pegs approximately 13 mm square x 300 mm (1/2 in. square x 12 in.) in length driven into the ground, leaving about 13 mm (1/2 in.) of the peg above sod, and spaced not more than 0.5 m (2 ft.) apart. Pegging of sod shall be done immediately after the sod has been firmed. When sodding is completed, the sodded areas shall be cleared of loose sod, excess soil, or other foreign material, and a thin application of topsoil shall be scattered over the sod as a top dressing, and the areas thoroughly moistened.

803.3.3 The contractor shall keep all sodded areas thoroughly moist for 21 days after laying. The sod shall be living at the time of acceptance.
803.4 Method of Measurement. Measurement will be made to the nearest square meter (nearest square yard) of approved sodded surface area.

803.5 Basis of Payment. The accepted quantities of sodding will be paid for at the unit price for each of the pay items included in the contract. No direct payment will be made for liming or fertilizing sodded areas.
SECTION 804
TOPSOIL

804.1 Description. This work shall consist of approved selected topsoil furnished and placed at the locations shown on the plans in the manner specified.

804.2 Materials. Topsoil shall be obtained from approved sources. It shall be a fertile, friable, and loamy soil of uniform quality, without admixture of subsoil materials, and shall be free from materials such as hard clods, stiff clay, hardpan, partially disintegrated stone, pebbles larger than 25 mm (one inch) in diameter, and any other similar impurities. Topsoil shall be relatively free from grass, roots, weeds, and other objectionable plant material or vegetable debris undesirable or harmful to plant life or which will prevent the formation of a suitable seedbed.

804.3 Construction Requirements.

804.3.1 The engineer shall be notified sufficiently in advance of the opening of any material source to permit the engineer to prepare for necessary checking and measurement. Topsoil shall be secured from areas from which the topsoil has not been previously removed, either by erosion or mechanical methods. The soil shall not be removed in excess of the depth approved by the engineer. Unless otherwise shown on the plans, the source of material shall be furnished by the contractor. During the period of removal of the topsoil material, the site shall be kept drained, and when all material has been removed, the site shall be left in a neat and presentable condition.

804.3.2 The surface on which the topsoil is to be placed shall be free of all loose rock and foreign material greater in any dimension than one-half the depth of the topsoil to be added. It shall be raked or otherwise loosened just prior to being covered with topsoil. Topsoil shall be placed and spread over the designated areas to a depth sufficiently greater than shown on the plans so that after settling, the completed work will conform with the thickness shown on the plans. After spreading, all large clods and foreign material shall be removed by the contractor.

804.4 Method of Measurement. Topsoil will be measured to the nearest cubic meter (nearest cu. yd.) of material in vehicles at the point of delivery.

804.5 Basis of Payment. The accepted quantity of topsoil will be paid for at the contract unit bid price. Overhaul will not be paid on topsoil.
SECTION 805
SEEDING

805.1 Description. This work shall consist of preparing, liming, and fertilizing a seedbed, and the furnishing and sowing of seeds as specified in the contract. All disturbed areas shall be seeded except: (1) sodded areas, (2) surfaced areas, (3) solid rock, and (4) slopes consisting primarily of broken rock. Disturbed areas outside of authorized construction limits shall be seeded at the contractor’s expense.

805.2 Materials.

805.2.1 The seed shall be grown and processed in the United States or Canada and comply with the requirements of the Missouri Seed Law. The following percentages for purity and germination or pure live seed will be the minimum requirements in the acceptance of seed, unless otherwise permitted by the engineer.

<table>
<thead>
<tr>
<th>Seed Type</th>
<th>Purity</th>
<th>Germination Including Hard Seed</th>
<th>Pure Live Seed</th>
<th>Germination(a) Excluding Hard Seed</th>
<th>Maximum Percent Weed Seed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bermuda Grass</td>
<td>95</td>
<td>80</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Smooth Brome Grass</td>
<td>85</td>
<td>80</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Kentucky Bluegrass</td>
<td>85</td>
<td>80</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Orchard Grass</td>
<td>85</td>
<td>80</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Perennial Rye Grass</td>
<td>98</td>
<td>85</td>
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<tr>
<td>Sudan Grass</td>
<td>98</td>
<td>85</td>
<td></td>
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<tr>
<td>Reed Canary Grass</td>
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<tr>
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<td>Rye Grain</td>
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<tr>
<td>Wheat Grain</td>
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<td>Korean Lespedeza</td>
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<tr>
<td>Alsike Clover</td>
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<tr>
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<td>Seed Species</td>
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<td>Indiangrass (Debearded)</td>
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<td>Weeping Lovegrass</td>
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<td>0.20</td>
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<td></td>
</tr>
</tbody>
</table>

(a) Does not apply if unhulled or unscarified seed is specified.

805.2.1.1 If the specified quantity is in kilograms (pounds) of seed, no reduction will be permitted in the specified quantity of seed if the purity or germination, or both, are higher than the minimum required by the specification. If the specified quantity is in kilograms (pounds) of pure live seed, the pure live seed quantity shall be determined from the actual percentage shown by the supplier for native grasses or by multiplying the actual percentages of purity times the actual percentage of germination including hard seed for other seed.

805.2.2 All leguminous seeds shall be inoculated or treated with the proper quantity of cultures approved for the particular legume to be sown. Leguminous seeds include Alsike Clover, Korean Lespedeza, Red Clover, Sericea Lespedeza, Sweet Clover, White Clover, Hairy Vetch, Crown Vetch and Birdsfoot Trefoil.

805.2.2.1 The inoculant for treating leguminous seeds shall be a pure culture of nitrogen-fixing bacteria. The containers of the inoculant shall be plainly marked with the expiration date for use and the manufacturer’s directions for inoculating seed.

805.2.2.2 The process of inoculation shall be in accordance with the manufacturer’s directions for the particular species of legume. The time lapse for sowing the seed following inoculation shall not exceed 24 hours. When hydraulic slurry seeding is used, an amount of inoculant equal to five times the normal rate required to inoculate only the legume seed shall be used. The inoculant shall be placed directly into the slurry and thoroughly mixed immediately before seeding. When other than the hydraulic slurry method is used, the legume seed may be inoculated at the normal rate if it is to be sown alone or if the legume seed is inoculated prior to mixing with other seed. A seed mixture which contains a legume that was not inoculated prior to mixing and is not to be seeded by the slurry method, shall be inoculated with sufficient inoculant to cover all seed.

805.2.2.3 Prohibited Weed Seeds. No tolerance will be applied to grass mixtures for prohibited weed seeds, namely: Field Bindweed (Convelvulus arvenis), Johnson Grass (Sorghum halerenge), and Canada Thistle (cirsium arvense).

805.3 Construction Requirements.

805.3.1 The seedbed shall be prepared, limed, and fertilized in accordance with Sec 801
and shall be a firm but uncompacted condition with a relatively fine texture at the time of seeding. Unless otherwise shown in the plans, the rate of application will be 235 kg/hectare (210 lb./acre) consisting of 110 kg (100 lb.) tall fescue, 110 kg (100 lb.) perennial rye grass, and 15 kg (10 lb.) Kentucky Bluegrass.

805.3.2 During the months of December through May, August, and September, all lime, fertilizer, seed and mulch shall be applied to the finished slopes. During the months of June, July, October, and November, lime, fertilizer, seed, and mulch shall be applied at the following rates:

- Lime -- 100 percent of the specified quantity.
- Fertilizer -- 75 percent of the specified quantity.
- Seed -- 50 percent of the specified quantity.
- Mulch -- 100 percent of the specified quantity.

Alternate methods of seeding will be considered when submitted for approval but will not relieve the contractor of compliance with Sec 805.5.1.

Seeding shall be done before the proposed seedbed becomes eroded, crusted over, or dried out and shall not be done when the ground is in a frozen condition or covered with snow. When the partial application has been made during June, July, October, or November, the remainder of the fertilizer plus 75 percent of the specified quantity of seed shall be applied by overseeding during August, September, December, January, or February. Seeds shall be uniformly applied at the rates prescribed. Provisions shall be made by markers or other means to insure that the successive seeded strips will overlap or be separated by a space no greater than the space left between the rows planted by the equipment being used. If inspection during the seeding operations indicates that strips wider than the space between rows planted have been left unplanted, additional seed shall be planted on these areas. Hand seeding will be permitted in isolated areas with prior approval of the engineer.

805.3.2.1 Hydraulic Seeding and Fertilizing. In lieu of mechanical application of seed and fertilizer, hydraulic application may be used. Seed and fertilizer may be applied hydraulically provided the seed and fertilizer are applied separately. The seed and fertilizer shall be incorporated into the soil as specified in Secs 801.4.2 and 805.3.2.2, in separate operations except that raking will not be required when seeding a previously seeded and mulched area. On slopes steeper than 2:1, or when seeding is applied to a previously seeded and mulched area, seed and fertilizer may be applied hydraulically in a single operation, and incorporation into the soil will not be required. Seed and fertilizer, separately or in combination, shall be mixed with water and constantly agitated so that a uniform mixture can be applied hydraulically to the designated areas. The ratio of seed and fertilizer to water shall be calculated by determining the surface area covered by a given quantity of water. Seed shall not be added to the water more than 4 hours before application.

805.3.2.2 Dry Seeding. Dry seeding shall be done mechanically with equipment designed for even distribution of dry seed. The equipment may either be hand operated, such as knapsack seeder, or be tractor-drawn, such as seed drill, except that tractor-drawn equipment will not be permitted on a previously seeded and mulched area. After completing the seeding
operation, if in the judgment of the engineer the seedbed is either too loose or contains clods which would reduce the germination of the seed, the contractor shall firm the area by rolling. When rolling is required, a lawn-type roller shall be used and care shall be taken to avoid over-compacting the soil.

805.4 Method of Measurement. Measurement will be made of the area seeded to the nearest 0.10 hectare (nearest 1/10 acre).

805.5 Basis of Payment. The accepted quantity of seeding will be paid for at the contract unit bid price. No direct payment will be made for liming or fertilizing seeded areas. No direct payment will be made for additional work and seed required when seeding during the months of June, July, October, and November.

805.5.1 Final payment for seeding will be contingent upon project acceptance. Seed must have germinated and produced a green and growing ground cover, regardless of method used to apply seed, before acceptance will be made.
SECTION 806
EROSION AND SEDIMENT CONTROL

806.1 Description. This work shall consist of furnishing, installing, maintaining and removing temporary erosion and sediment control measures; furnishing and placing permanent erosion control features; or a combination of both as shown on the plans or as designated by the engineer for road improvement projects. The work shall consist of controlling water pollution in accordance with these specifications.

806.1.1 The contractor shall exercise best management practices throughout the life of the project to control water pollution. Pollutants such as chemicals, fuels, lubricants, bitumen, raw sewage or other harmful material shall not be discharged on or from the project. Temporary pollution control measures shall be coordinated with permanent erosion control features specified in the contract to ensure economical, effective and continuous erosion and pollution control. This work shall also apply to work within easements designated by the County Engineer.

806.2 Schedule of Work. Prior to the preconstruction conference and the start of construction, the contractor shall submit schedules for the implementation of temporary and permanent erosion control work, as applicable for construction operations including clearing and grubbing, grading, bridges and other structures at watercourses, construction, and paving. The contractor’s schedule shall address specifically the pollution and erosion control measures planned at all streams or other bodies of water. No work shall be started until the pollution and erosion control schedules and methods of operations have been approved by the engineer.

806.3 Material. All material shall conform to Division 1000, Materials Details, and specifically as follows:

<table>
<thead>
<tr>
<th>Item</th>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fertilizer and Lime</td>
<td>801</td>
</tr>
<tr>
<td>Straw for Bales</td>
<td>802</td>
</tr>
<tr>
<td>Mulching</td>
<td>802</td>
</tr>
<tr>
<td>Seed</td>
<td>805</td>
</tr>
<tr>
<td>Geotextile Fabric</td>
<td>1074</td>
</tr>
</tbody>
</table>

806.4 Construction Requirements. The engineer may limit the surface area of erodible earth material exposed by clearing and grubbing or by excavation, borrow and fill operations. The engineer may direct the contractor to provide immediate permanent or temporary pollution control measures to prevent contamination of adjacent streams or other watercourses, lakes, ponds or other areas of water impoundment. Such work may involve the construction of temporary berms, dikes, dams, sediment basins, slope drains, and use of temporary mulches, seeding or other control devices or methods as necessary to control erosion.
806.4.1 The contractor shall incorporate all permanent erosion control features into the project at the earliest practicable time. Temporary measures shall be used to correct conditions that develop during construction which were not foreseen during the design stage; that are needed prior to installation of permanent pollution control features; or that are needed temporarily to control erosion that develops during normal construction practices, but are not associated with permanent control features on the project.

806.4.2 Clearing and grubbing operations shall be scheduled and performed so grading operations and erosion control features will follow immediately thereafter. The surface area of erodible earth material exposed at one time by clearing and grubbing, excavating fill or borrow shall not exceed $4,050 \text{ m}^2 (43,560 \text{ sq. ft.})$ within any individual drainage area without installation of erosion controls for that drainage area. The total erodible surface area exposed at one time for the entire project shall not exceed $70,000 \text{ m}^2 (750,000 \text{ sq. ft.})$ without documented approval by the engineer.

806.4.3 The engineer will limit the area of clearing and grubbing, excavation, borrow and embankment operations with the contractor's progress in keeping the finished grading, mulching, seeding and other such permanent erosion control measures current and properly maintained. Should seasonal limitations make such operations unrealistic, temporary erosion control measures shall be taken immediately.

806.4.4 Unless otherwise provided or approved in writing by the engineer, construction operations in rivers, streams or other bodies of water shall be restricted to those areas which must be entered for the construction of temporary or permanent structures. Rivers, streams and other bodies of water shall be promptly cleared of all falsework, piling, debris or other obstructions placed therein or caused by construction operations.

806.4.5 Frequent fording of streams or other bodies of water with construction equipment will not be permitted. Temporary bridges or other structures shall be used wherever an appreciable number of stream or other bodies of water crossings are necessary. Unless otherwise approved in writing by the engineer, mechanized equipment shall not be operated in streams or other bodies of water except as may be required to construct channel changes and temporary or permanent structures. If a Corps of Engineer Section 404 or Department of Natural Resources Section 401 permit is applicable for a project, the permit requirements and conditions shall prevail.

806.4.6 The location of all local material pits, other than commercially operated sources, and all excess material sites shall be subject to the approval of the engineer. Erosion from construction operations and pollution control measures shall not cause water pollution.

806.4.7 In the event of conflict between these requirements and the pollution control laws, rules or regulations of other federal, state or local agencies, the more restrictive laws, rules or regulations shall apply.

806.4.8 Unless otherwise specified by the engineer, all temporary erosion control
measures shall be removed by the contractor after permanent erosion control measures are established.

806.10 Temporary Berms.

806.10.1 Description. This work shall consist of constructing temporary berms of compacted soil at the top of fill slopes or transverse to the centerline of fills.

806.10.2 Material. Temporary berms shall consist of graded material from within the project limits, or any other suitable material approved by the engineer.

806.10.3 Construction Requirements.

806.10.3.1 Type A Berms. Type A berms shall be constructed to the approximate dimensions as shown on the plans. These berms shall be machine compacted with a minimum of one pass over the entire width of the berm.

806.10.3.2 Type B Berms. Type B berms shall be constructed to the approximate dimensions as shown on the plans. These berms shall be machine compacted with a minimum of three passes over the entire width of the berm. Material removed from Type B berms shall be incorporated in the embankment when possible. The contractor shall dispose any excess or unsuitable material to a location as directed by the engineer.

806.10.3.3 Type A and Type B Berms. Temporary berms shall drain to a compacted outlet at a slope drain. On transverse berms, the top width of the berms may be wider and the side slopes flatter to allow equipment to pass over these berms with a minimal disruption.

806.10.4 Method of Measurement.

806.10.4.1 Measurement of Type A, berms will not be made directly as this item is a part of the excavation operations which will be included in other grading operations measured to the nearest cubic meter (cubic yard).

806.10.4.2 Measurement of Type B temporary berms will be made to the nearest linear meter (foot).

806.10.5 Basis of Payment.

806.10.5.1 Payment for the accepted quantities of Type A berms will be made at the contract unit price for the applicable item of Class A or Unclassified Excavation and will be full compensation for all work involved in constructing, maintaining and removing Type A Berms.

806.10.5.2 Payment for Type B berms will be made at the contract unit price per linear meter (foot) and will be full compensation for installation, maintenance, removal and any other work noted on the plans.
806.10.5.3 Any hand work at slope drain inlets will be considered part of the contract unit price for slope drains.

806.20 Temporary Slope Drains.

806.20.1 Description. This work shall consist of constructing temporary slope drains to carry water down slopes and reduce erosion. The method selected shall be approved by the engineer prior to construction.

806.20.2 Construction Requirements. Temporary slope drains shall consist of a temporary facility of stone, concrete or asphalt gutters, half-round pipe, metal pipe, plastic pipe or flexible rubber pipe. The contractor shall provide temporary slope drains to carry water or water with suspended solids from cut sections down fill slopes until permanent erosion control measures are established. The contractor shall provide temporary slope drains on fill slopes at approximately 150 m (500 ft.) intervals or as directed by the engineer. All temporary slope drains shall be adequately anchored to the slope to prevent disruption of flow. The inlet ends shall be properly constructed to channel water into the temporary slope drain. The outlet ends shall have some means of dissipating the energy of the water to reduce erosion downstream. Unless otherwise specified by the engineer, all temporary slope drains shall be removed by the contractor after permanent facilities are installed. The contractor shall restore the site to the satisfaction of the engineer.

806.20.3 Method of Measurement. Measurement of temporary slope drains will be made to the nearest linear meter (foot).

806.20.4 Basis of Payment. The accepted quantities of temporary slope drains will be paid for at the contract unit price and will be full compensation for all labor, equipment and material to complete the described work.

806.30 Temporary Ditch Checks.

806.30.1 Description. This work shall consist of constructing temporary ditch checks, removing sediment deposits from these ditch checks and disposing of the sediment at a location approved by the engineer.

806.30.2 Construction Requirements.

806.30.2.1 Rock Ditch Checks. Rock ditch checks shall be constructed of 50 mm (2 in.) to 75 mm (3 in.) clean gravel or limestone. The gravel shall be placed according to the configuration shown on the plans. Hand or mechanical placement will be allowed. Rock ditch checks shall completely cover the ditch or swale, and the center of the rock ditch checks shall be lower than the edges.

806.30.2.2 Straw Bale Ditch Checks. Straw bale ditch checks shall be constructed according to the plans and specifications.
806.30.3 Maintenance. The contractor shall replace ditch checks at the request of the engineer. Periodic sediment removal shall include removal and disposal of sediment to a location where it will not erode into construction areas, streams or other bodies of water.

806.30.3.1 Ditch Checks. The contractor shall check the ditch checks for sediment accumulation after each storm event and shall remove the sediment when deposits reach approximately one-half of the original height. Sediment removal shall include removal and disposal.

806.30.3.2 For rock ditch checks, the contractor shall make regular inspections to ensure the center of the check is lower than the edges. The contractor shall immediately correct erosion caused by high flows around the edges of the check.

806.30.4 Method of Measurement. Measurement of sediment removal will be made to the nearest cubic meter (cubic yard).

806.30.5 Basis of Payment.

806.30.5.1 The accepted quantities of temporary ditch checks completed, accepted, and in-place will be paid for at the contract unit price per each pay item included in the contract and will be full compensation for all labor, equipment and material to complete the described work. This includes constructing, maintaining, repairing and removing and disposing of the ditch check after completion of the work. The contractor will be compensated if the engineer determines unusual conditions warrant a repair or replacement of a ditch check.

806.30.5.2 The removal of accumulated quantity of sediment will be paid for at the contract unit price per cubic meter (cubic yard). Payment will be full compensation for all labor, equipment and material to complete the described work and for sediment removal and disposal.

806.40 Sediment Basins.

806.40.1 Description. This work shall consist of constructing sediment basins as shown on the plans or as determined by the engineer to trap and store sediments that occur in spite of temporary erosion control measures in use.

806.40.2 Construction Requirements. The area where a sediment basin is to be constructed shall be cleared of vegetation to enable sediment removal. The sediment basin shall be an excavated or dammed storage area with defined side slopes. Inlet and outlet areas shall be lined with rock riprap.

806.40.2.1 The inlet of a sediment basin shall be constructed with a wide cross-section and a minimum grade to prevent turbulence and to allow deposition of soil particles. When the depth of sediment reaches 1/2 the original depth of the structure in any part of the pool, all accumulation shall be removed.
806.40.2.2 Sediment basins shall remain in service until all disturbed areas draining into the structure have been satisfactorily stabilized. When use of a temporary sediment basin is to be discontinued, the contractor shall remove any sediment, backfill, and properly compact all excavations and restore the existing ground to its natural or intended condition. The contractor shall dispose of accumulated sediment and excavated material removed during the construction of the sediment basin in locations where it will not erode into the construction areas, or into natural waterways.

806.40.3 Method of Measurement. Measurement of sediment basin excavation and removal of accumulated sediment in temporary sediment basins will be made to the nearest cubic meter (cubic yard). Measurement of all seeding and mulching required after the sediment basin is built, after removal of the sediment basin, and site restoration will be made to the nearest 0.05 hectare (0.10 acre).

806.40.4 Basis of Payment.

806.40.4.1 The accepted quantities for excavation of a sediment basin will be paid for at the contract unit price per cubic meter (cubic yard) and will be full compensation for all excavation, disposal of excavated material, removal and restoration when no longer required, along with the furnishing of rock riprap for inlet and outlet control. Sediment removal from sediment basins will be paid for at the contract unit price per cubic meter (cubic yard). All seeding and mulching required after the sediment basin is built, after removal of the sediment basin and site restoration, will be paid for at the contract unit price for the applicable temporary or permanent seeding and mulching.

806.40.4.2 If additional clearing and grubbing is necessary for construction of a sediment basin, payment will be included in the contract unit price for sediment basin.

806.50 Temporary Seeding And Mulching.

806.50.1 Description. This work shall consist of furnishing and applying fertilizer, seed, Type 1 mulch or other acceptable cover authorized by the engineer. This work shall produce a quick ground cover to reduce erosion in disturbed areas expected to be redisturbed at a later date. Finish grading of areas will not be required. Hydraulic seeding and fertilizing in accordance with Sec 805 will be allowed.

806.50.2 Construction Requirements. Seeding and mulching shall be a continuous operation on all cut and fill slopes, excess material sites and borrow pits during the construction process. All disturbed areas shall be seeded and mulched as necessary to eliminate erosion.

806.50.2.1 The contractor shall provide permanent seeding and mulching as shown on the plans following temporary seeding.

806.50.2.2 Temporary seeding mixtures of oats shall be applied at a rate of 130 kg/ha (120 lbs./ac.) and temporary seeding mixtures of cereal rye or wheat shall be applied at a rate of 165 kg/ha (150 lbs./ac.). Temporary seeding mixtures of oats shall be applied only during the
months of December through May.

806.50.2.3 Temporary mulch placed over temporary seed mixtures shall be applied in accordance with Sec 802.2.1.

806.50.2.4 Fertilizer shall be applied at a rate of 45 kg (40 lbs.) nitrogen (N) per hectare (acre).

806.50.2.5 Lime will not be required for temporary seeding.

806.50.3 Method of Measurement. Measurement of all temporary seed mixtures and accompanying mulch will be made to the nearest 0.05 ha (1/10 ac.).

806.50.4 Basis of Payment. The accepted quantities of all temporary seed mixtures and the accompanying mulch will be paid for at the contract unit price per hectare (acre).

806.60 Straw Bales.

806.60.1 Description. This work shall consist of furnishing, installing, maintaining and disposing of bales of straw or other approved foliage used as a means of controlling pollution and erosion.

806.60.2 Material. Bales shall be Type I mulch in accordance with Sec 802.

806.60.3 Construction Requirements.

806.60.3.1 The contractor shall place bales at the bottom of embankment slopes to divert runoff from sheet flow and to catch some of the sediment picked up in the sheet flow, as ditch checks in small ditches and drainage areas, or on the lower side of cleared areas to catch sediment from sheet flow. When used to trap sediment or divert runoff, the bales shall be adequately anchored to withstand the applied load. When used as a ditch check in small ditches and drainage areas, the bales shall be embedded.

806.60.3.2 If directed by the engineer, the contractor shall dispose of bales used in ditch checks at an approved location.

806.60.4 Method of Measurement. Measurement of bales will be made to the nearest 0.5 m (linear foot).

806.60.5 Basis of Payment. The accepted quantities of bales for temporary erosion will be paid for at the contract unit price per 0.5 meter (linear foot). Payment will be full compensation for all labor, equipment and material to complete the described work, including the removal and disposal of the bales when no longer required.
806.70 Temporary Silt Fence.

806.70.1 Description. This work shall consist of furnishing, installing, maintaining, removing and disposing a wire-supported or self-supported geotextile silt fence designed to remove suspended particles from sheet flow passing through the fence and prevent sediment from polluting nearby streams or other bodies of water. The quantities of temporary silt fence shown on the plans may be increased or decreased at the direction of the engineer. At the engineer’s discretion, the location may be modified to fit field conditions. Such variations in quantity will not be considered as alterations in the details of construction or a change in the character of the work.

806.70.2 Material. All material shall conform to Division 1000, Materials Details, and specifically as follows:

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<td>Geotextile, Type 2</td>
<td>1074</td>
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806.70.2.1 Posts. Wood, steel or synthetic posts may be used. Posts shall be of sufficient length, not less than 1.2 m (4 ft.) to ensure adequate embedment while fully supporting the silt fence and shall have sufficient strength to resist damage during installation and to support applied loads while in service.

806.70.2.2 Support Fence. All geotextile silt fence shall be supported either externally by wire or other approved mesh to a height of at least 600 mm (24 in.) or by a suitable designed-in support system capable of keeping the material erect. Either method shall be strong enough to withstand applied loads.

806.70.2.3 Prefabricated Fence. Prefabricated fence systems may be used provided they meet all of the above material requirements.

806.70.3 Construction Requirements.

806.70.3.1 The contractor shall install temporary silt fence as shown on the plans and at other locations directed by the engineer. Fence construction shall be adequate to handle the stress from hydraulic and sediment loading. Fabric at the bottom of the fence shall be buried a minimum of 150 mm (6 in.) so that no flow can pass under the barrier. The trench shall be backfilled and the soil compacted over the fabric. The fabric shall be spliced together only at a support post with a minimum 150 mm (6 in.) overlap. Any installation method acceptable to the engineer will be allowed as long as the effectiveness and intent of the silt fence is achieved. All geotextile construction shall be in accordance with Sec 624.

806.70.3.2 Post spacing shall not exceed 1.5 m (5 ft.). Posts shall be driven a sufficient depth into the ground or placed on closer spacing as necessary to ensure adequate resistance to applied loads.

806.70.3.3 The silt fence shall be fastened securely to the upslope side of the post. When
wire support fence is used, the wire shall extend into the trench a minimum of 50 mm (2 in.).

806.70.3.4 The contractor shall maintain the integrity of silt fences as long as they are necessary to contain sediment runoff. The contractor shall inspect all silt fences immediately after each rainfall and at least daily during prolonged rainfalls. Any deficiencies shall be immediately corrected by the contractor. In addition, the contractor shall make a daily review of the silt fences in areas where construction activities have changed the natural contour and drainage runoff to ensure the silt fences are properly located for effectiveness. Where deficiencies exist, additional silt fences shall be installed as approved or directed by the engineer.

806.70.3.5 The contractor shall remove and dispose of sediment deposits after each prolonged rainfall event or sooner when directed by the engineer. If required by heavy sediment loading, a second silt fence shall be installed as directed by the engineer.

806.70.3.6 The silt fence shall remain in place until removal is directed by the engineer. Upon removal, the contractor shall remove and dispose of any excess silt accumulations, grade and dress the area to the satisfaction of the engineer, and establish vegetation on all bare areas in accordance with the contract requirements. The fence material shall remain the property of the contractor and may be used at other locations, provided the material continues to meet the requirements of this specification, is sound and not weakened by exposure to the elements.

806.70.4 Method of Measurement. Measurement of temporary silt fence will be made to the nearest meter (linear foot). The temporary silt fence will be measured in place from end post to end post of each separate installation completed and approved in place.

806.70.5 Basis of Payment. The accepted quantities of temporary silt fence completed, accepted and in-place will be paid for at the contract unit price per linear meter (linear foot) and will be full compensation for all labor, equipment and material to complete the described work.

806.80 Temporary Pipe.

806.80.1 Description. This work shall consist of installing temporary pipe of any material acceptable to the engineer, utilized to carry water under temporary roadways, silt fences, berms or other locations determined by the engineer and to prevent the contractor’s equipment from coming in direct contact with water when crossing an active stream or other bodies of water or intermittent streams created during heavy rainfalls.

806.80.2 Construction Requirements. Installation of temporary pipe shall be in accordance with the specifications for permanent pipe and shall prevent water from causing erosion around the pipe. All backfill material for pipes shall be placed in 150 mm (6 in.) lifts and mechanically compacted. Compaction tests will not be required.

806.80.3 Method of Measurement. Measurement of temporary pipe will be made to the nearest 0.5 m (linear foot).

806.80.4 Basis of Payment. The accepted quantities of temporary pipe complete,
accepted and in-place will be paid for at the contract unit price per 0.5 meter (linear foot) and will be full compensation for all labor, equipment and material to complete the described work.

806.90 Blankets and Netting.

806.90.1 Description. This work shall consist of furnishing and placing erosion control blankets or netting at locations shown on the plans or as designated by the engineer.

806.90.2 Material.

806.90.2.1 Plastic Netting. Netting shall consist of a green degradable polypropylene extruded oriented plastic net with bonded joints having openings not to exceed 2900 mm² (4 1/2 sq. in.) with either dimension not to exceed 75 mm (3 in.). Excelsior blanket, Sec 806.90.2.2, may be used in lieu of plastic netting, in which case the excelsior blanket will serve as a substitute for both netting and mulch.

806.90.2.2 Excelsior Blanket. Excelsior blanket shall consist of a machine produced mat of wood excelsior with approximately 80 percent of the fibers having a minimum length of 150 mm (6 in.). The wood from which the excelsior is cut shall be properly cured to achieve adequately curled and barbed fibers. The blanket shall be of consistent thickness, with the fibers evenly distributed over the entire area of the blanket. The blanket shall be covered on the top side with a netting having a maximum mesh size of 38 mm x 75 mm (1 1/2 in. x 3 in.), composed of cotton cord, twisted Kraft paper yarn or degradable extruded plastic. The netting shall be entwined with the excelsior mat for maximum strength and ease of handling. The blanket shall be made smolder resistant with a treatment that shall be nonleaching, non-toxic to vegetation and shall not be toxic or injurious to humans. The blanket shall meet the following requirements:

(a) Weight (Mass) – 0.4 kg/m² (0.75 lb./sq. yd.), minimum.

(b) Smolder Resistance – Blanket in air-dry condition shall not flame or smolder for a distance of more than 300 mm (12 in.) from where a lighted cigarette is placed on the surface.

806.90.2.3 Staples. Staples for plastic netting or excelsior blanket shall be of 3 mm diameter (no. 11 gage) or heavier, ungalvanized steel wire, “U” shaped, with approximately a 25 mm (1 in.) or larger crown and have a length of not less than 150 mm (6 in.).

806.90.2.4 The contractor shall furnish a manufacturer's certification stating the material furnished complies with the requirements of these specifications.

806.90.3 Construction Requirements.

806.90.3.1 Plastic Netting. The area to be covered shall be seeded, fertilized and mulched in accordance with the requirements of the contract before the plastic netting is installed. The netting shall be rolled loosely over the specified areas as soon as practicable following the mulching operation. The netting shall be installed 8.5 m (28 ft.) wide in median
ditches and 300 mm (1 ft.) above the flowline on other ditches. Lifting and stretching of the material will not be permitted. Any mulched areas disturbed by the installation of the netting shall be repaired at the contractor’s expense. Rolling will not be required. Material shall overlap not less than 75 mm (3 in.) at all joints with the upper or upstream netting on top. All joints shall be stapled on 300 mm (1 ft.) centers. Staples at other locations shall be installed as shown on the plans. If excelsior blanket is used in lieu of plastic netting, it shall be installed as specified in Sec 806.90.3.2.

806.90.3.2 Excelsior Blanket. The area to be covered shall be seeded and fertilized in accordance with the requirements of the contract before the excelsior blanket is installed. The blanket shall be unrolled in the direction of water flow, with the netting on top and the fibers in contact with the soil. A longitudinal joint of adjoining blankets, shall not be placed on the centerline of the ditch. The blanket shall not be stretched or pulled tight. Successive rolls shall be snugly butted at ends and edges. The blanket shall be stapled along each edge and along the center of each blanket with staples at 2 meter (6 ft.) centers and across each end of each roll with four staples. The center row of staples shall be staggered 1 meter (3 ft.) from the edge staple spacing. A row of staples across the blanket, spaced a 150 mm (6 in.) centers and at right angles to the ditch line shall be placed within each 15 meters (50 ft.) on ditch grades of 4 percent or less and within each 7.5 meters (25 ft.) on ditch grades greater than 4 percent.

806.90.4 Method of Measurement. Measurement of blankets or netting will be made to the nearest square meter (sq. yd.) of surface area covered by the competed net.

806.90.5 Basis of Payment. The accepted quantity of blanket or netting complete, accepted and in-place will be paid for at the contract unit price per square meter (sq. yd.) for each of the pay items included in the contract and will be full compensation for all labor, equipment and material to complete the described work. If excelsior blanket is used in lieu of netting and mulch, payment will be made at the unit price for the pay items in the contract for the respective items which the excelsior blanket replaces.
SECTION 808
PLANTING TREES, SHRUBS, AND
OTHER PLANTS

808.1 Description. This work shall consist of furnishing and planting materials in the locations designated on the plans or established by the engineer.

808.1.1 Shrubs designated to be removed and relocated shall be protected as required for new stock during the temporary removal interim, and then be replanted as hereinafter specified.

808.2 Materials.

808.2.1 Plants.

808.2.1.1 Unless otherwise specified or permitted by the engineer, trees, shrubs, and other plants shall be nursery stock and shall be true to type and name in accordance with the current edition of Standardized Plant Names published by the American Joint Committee on Horticultural Nomenclature. A nursery is defined as a place where trees and plants are grown in established rows for the purpose of replanting at a new location. The nursery stock shall have well developed branch systems and vigorous healthy root systems. All stock shall be well formed and the trunks of trees shall be uniform. All plants shall have a normal habit of growth and shall be sound, healthy, and vigorous. They shall be free from insects, disease, and defects such as knots, sun-scald, injuries, serious abrasions of the bark, or objectionable disfigurements. Thin weak plants will not be accepted. All nursery stock shall qualify under the AAN Horticultural Standards of the current American Standard for Nursery Stock, ANSI Z 60.1. Substitution of plant stock of other materials will not be permitted except by approval of the engineer.

808.2.1.2 All measurements for height, spread, branching, diameter, and root spread or ball size shall be as specified in the current AAN American Standard for Nursery Stock, ANSI Z 60.1, except as modified herein. For bare root trees, the minimum root spread in millimeters (inches) shall be equal to 300 mm (12 in.) for each 25 mm (inch) diameter, plus 300 mm (12 in.), except that if the natural root spread does not meet this requirement, the plant may be accepted provided no roots have been cut. Pine and spruce trees shall be full to the base and have a ratio of approximately 5 height to 3 spread. All trees for which the number of branches are shown shall have not less than the number specified. A branch shall have a minimum length of 600 mm (24 in.). For trees and shrubs having a spread or base width specified, the spread or base width shall be measured not more than 250 mm (10 in.) from the ground line from tip to tip of branches in their natural position. The height of all plants shall be measured from the ground line to the tip of the uppermost branch.

808.2.1.3 Inspection of nursery stock may be made at the nursery by the engineer. Approval of material on such inspection shall not be construed as an acceptance. Inspection and
acceptance of plant materials will be made only at the planting site following the completion of the planting work with the exception that acceptance for height, spread, and number of branches will be made before pruning the plant. Each shipment shall be accompanied by an invoice showing sizes and varieties of materials included.

808.2.1.4 Invoices showing size and grade of materials shipped, plus all necessary state, federal, and other inspection certificates, showing the source of origin and the health of the plant materials shall be presented to the County Engineer prior to final acceptance.

808.2.1.5 All stock shall be dug and packed with special care to avoid unnecessary injury to or removal of roots. Each variety shall be packed in separate bundles, clearly and accurately labeled. Roots shall be carefully protected with wet straw, moss, or other material so that the plants arrive with roots in a moist and healthy condition. All stock shall have been grown within a 250 km (150 mile) radius of St. Charles.

808.2.1.6 Plants indicated by ball diameter shall be balled and burlapped and shall be lifted from the ground so as to retain as many roots as possible. Such plants shall be so dug and transported as to provide and retain a firm ball of the original soil. The ball shall be wrapped with burlap and securely tied to keep the ball firm and intact. Balls shall be adequately protected from rain or sudden changes in weather. Trees or other plants will not be accepted if the balls of earth are loosened or broken. Plants specified as container grown shall have grown in that container sufficiently long for new fibrous roots to have developed so that the root mass will retain its shape and hold together when removed from the containers; however it shall not have grown in container long enough to have become pot bound. The container shall be sufficiently rigid to hold the ball shape protecting the root mass during shipping. The containers of all container grown plants, except Crown Vetch, shall be removed just prior to planting.

808.2.1.7 It is the intention of the County to allow the property owners to voice an opinion in the types of trees to be planted in specific areas. Accordingly, a percentage not more than 15 percent of the below listed trees may be requested for planting. Exact numbers of specific tree types will be determined after consultation with the property owners and representatives of the Department. Tree types not shown on this listing may be ordered to meet special requirements of an area or project as directed by the County Engineer.

Types of Trees

Acer platanoides Norway maple
Acer rubrum native red or scarlet maple
Cercis canadensis red bud
Crataegus cordata Washington hawthorn
Fraxinus ornus flowering ash
Fraxinus lanceolata green ash
Fraxinus velutina glabra Modesto ash (seedless male ash)
Ginkgo biloba maidenhair tree
Liriodendron tulipifera tulip tree
Liquidambar styraciflua sweet gum
Prunus kwazan flowering cherry
Quercus palustris true pin oak
Quercus rubra northern red oak
Sophora japonica Japanese pagoda tree
Taxodium distichum bald cypress
Pinus sylvestris Scotch pine
Pinus nigra Austrian pine
Pinus strobus white pine

Evergreen Shrubbery

Juniperus phitizernana blue pfitzer juniper
Juniperus gluaca hetzi blue hetzi
Juniperus excelsa stricta spiny green juniper
Juniperus virginiana gluaca blue juniper
Juniperus virginiana burki burk juniper

808.2.2 Mulching Material. The mulching material shall be wood chips substantially free of foreign material.

808.2.3 Tree Wrapping Paper and Binder Twine. Wrapping paper for trees shall be a waterproofed tree wrapping paper of good commercial quality furnished in 100 mm (4 in.) width. Twine for tying paper shall be any approved commercially available binder twine.

808.2.4 Supporting Stakes for Trees. Supporting stakes for trees shall be an approved 50 mm x 50 mm x 1.8 m (2 in. x 2 in. x 6 ft.) posts of sound wood and free from knots that would affect the serviceability of the posts.

808.2.5 Peat Moss. Peat moss shall be a natural domestic product consisting of partially decomposed stems and leaves of any variety of sphagnum mosses and shall be substantially free of woody substances and mineral matter such as sulphur and iron. Peat moss shall be granulated and used in an air-dry, loose condition.

808.3 Construction Requirements.

808.3.1 Planting Dates. Planting shall be performed during either the fall phase or the spring phase or both, as designated in the contract. The beginning dates established in the contract for the respective phases shall be considered to be the effective date of the Notice to Proceed.

808.3.2 On roadways open to traffic, the contractor shall avoid crossing the pavement with men, equipment, or materials.

808.3.3 Care of Plants Before and During Planting. Immediately following delivery and inspection at the job site, all bare root plants shall be “heeled in” in a manner satisfactory to the engineer. All “heeled in”, balled and burlapped, and container grown plants shall be
protected and their roots kept moist until planted. While bare root plants are being transported to and from “heeling in” grounds, distributed in planting beds, or awaiting planting after distribution, their roots shall be protected from drying out by means of wet canvas, burlap, or straw, except as specified in Sec 808.3.6.6. The trunks and branches of all trees shall be carefully protected from injury of any kind during all operations. Any injured tree may be rejected.

808.3.4 Location and Spacing of Plants. The general location of each individual tree or shrub and the areas for ground cover plants will be shown on the plans. To facilitate the staking operations, the contractor shall notify the engineer in writing at least 2 weeks in advance of the date on which he intends to begin planting. Stakes indicating plant locations shall be set for the contractor by representatives of the Department within 48 hours from the time the contractor requests such stakes. Stakes for indicating plant locations shall be furnished by the contractor.

808.3.5 Pruning Roots. A maximum of root growth shall be preserved and no root pruning will be permitted except as noted herein. Any large or fleshy roots that have been broken, crushed, or badly bruised shall be cleanly cut back to sound wood. Interfering roots shall be pruned if directed by the engineer.

808.3.6 Planting.

808.3.6.1 The planting of all plants shall be subject to the inspection of the engineer. Any rock, rubble, or other underground obstructions shall be removed to the required depth. If underground obstructions, not feasible to move are encountered in the planting areas, then other locations may be selected by the engineer. The contractor shall notify the County Engineer at least 24 hours before proceeding with planting operations.

808.3.6.2 Preparation of Holes. Holes for trees shall be not less than 450 mm (18 in.) larger in diameter than the ball diameter, container, or root spread. Holes for shrubs shall not be less than 300 mm (12 in.) larger than the ball diameter, container, or root spread. Holes for vines and seedlings shall be not less than 225 mm (9 in.) in diameter. The holes shall be of such depth to set the plants at the same height at which they grew in the nursery. If the holes are dug too deep, it shall be necessary to add enough backfill material to the bottom of the hole to allow for settling. Depth of holes for vines and seedlings shall be sufficient to allow for proper spreading of roots.

808.3.6.3 Backfill Material. In general, backfill material for planting shall consist of the existing excavated soil broken into less than one inch clods and thoroughly mixed with peat moss as required. Plants with a ball diameter, container, or root spread of 375 mm (15 in.) or less require 0.04 m$^3$ (one bushel) of peat moss. Plants with a ball diameter, container, or root spread of over 375 mm (15 in.) require 0.10 m$^3$ (2 bushels) of peat moss. Peat moss will not be required for vines or seedlings.

808.3.6.4 Bare Root Trees and Shrubs. Plants with bare roots shall be held firmly in the proper position with the roots spread out during backfilling. Backfill material shall be worked and puddled around the roots and thoroughly firmed during backfilling. Sufficient water shall be used to insure thorough saturation of the backfill material around the plant roots.
**808.3.6.5 Balled and Burlapped and Container Grown Stock.** Plants which are balled and burlapped or container grown shall be set to proper position and grade. The backfill material shall be carefully worked and puddled around the ball. Sufficient water shall be used to insure thorough saturation of the backfill material.

**808.3.6.6 Vines and Seedlings.** Vines and seedlings shall be planted on 1.0 m (3 ft.) centers and 1.0 m (3 ft.) staggered rows within designated areas. When a bundle of plants is opened, all plants in that bundle shall immediately be placed in a container of water and each plant planted from the container. Plants placed in the holes shall be backfilled immediately. Backfill material shall be thoroughly firmed, and all plants shall be watered the same day of planting.

**808.3.6.7 Preparation of Plant Beds.** Prior to planting in areas designated on the plans as plant beds, the existing sod shall be removed by stripping with a sod cutter set for a 25 mm (1 in.) depth of cut. The sod so removed shall be disposed of by the contractor outside the limits of the right-of-way or as directed by the engineer.

**808.3.6.8 Mulching.** Individual plants except for vines and seedlings shall be mulched with a 100 mm (4 in.) layer of wood chips over the backfill or as shown on the plans. All areas shown on the plans as plant beds shall be mulched with a 100 mm (4 in.) thick layer of wood chips in a continuous bed over the entire area. Mulch will not be required for vines or seedlings.

**808.3.6.9 Fertilizing.** A 10-8-6 inorganic commercial fertilizer shall be applied to all plant materials at the time of planting. The fertilizer shall be delivered to the site in unopened containers bearing the manufacturer’s statement of analysis. Apply fertilizer at the rate of 4 g/mm to 9 g/mm (1/4 lb./in. to 1/2 lb./in.) of caliber for trees, and 100 g/m² (2 lb./100 sq. ft.) of planting bed.

**808.3.7 Pruning Branches or Stems.**

**808.3.7.1 Deciduous trees shall be pruned to balance the loss of roots.** Pruning shall retain the natural form of the plant type. Only thinning cuts will be permitted on trees. A single trunk shall be preserved on all shade trees. All dead, broken, and interfering branches shall be removed. When branches are removed, they shall be cut off flush with the parent branch. All cut surfaces over 25 mm (1 in.) in diameter shall be painted with tree paint or tar.

**808.3.7.2 Deciduous shrubs shall be pruned by removing all dead wood and broken branches and by removing or heading approximately 1/3 to 1/2 of the branches.**

**808.3.7.3 Evergreens shall be pruned only to the extent of removing dead or damaged portions of the branches, except as permitted by the engineer.**

**808.3.7.4 Vines shall be pruned to the extent necessary to retain approximately 150 mm (6 in.) of runner above the ground surface.**
808.3.8 Wrapping Trees. The trunks of all deciduous trees, and the lower part of the largest branches of trees more than 125 mm (5 in.) caliber, shall be carefully wrapped with tree wrapping paper immediately after planting. The wrapping shall begin at the ground line and extend upward in a spiral to the lowest major branch. The spiral paper shall overlap not less than 25 mm (1 in.). Multiple stemmed trees shall have each stem separately wrapped to the lowest major branch. Suckers and small twigs shall be removed to permit proper wrapping. The wrapping paper shall be held in place with binder twine.

808.3.9 Supporting Methods for Trees. Trees 50 mm (2 in.) or more in caliber, or as determined by the County Engineer shall be properly supported using 3 guy wires securely anchored to approved stakes not less than 1.5 m (5 ft) from the trunk and at a height as indicated on the plans. The trunk shall be adequately protected from the guy wires. The guy wires are to be No. 12 gage wire. The supports shall be installed within 2 days of planting.

808.3.10 Finishing. Waste material, including sod, subsoil, rock, branches, twigs, packing material, and other debris shall be disposed of by the contractor outside the limits of the right-of-way or as directed by the engineer. All roadway shoulders and other areas damaged by the contractor’s operations shall be restored to a satisfactory condition as directed by the engineer. Finishing in accordance with this section shall be performed following the completion of each planting phase when fall and spring planting phases are required.

808.4 Care and Replacement.

808.4.1 Starting with the first day of planting for each phase and continuing through a period of 45 days following the last day of planting within the respective phase, the contractor shall keep all plants watered sufficiently to maintain moist soil in the root zone. The engineer may direct watering as necessary to maintain moist soil and may halt further planting within the respective phases until sufficient water is applied to those plants in place. In addition to watering, the contractor shall perform such weeding, adjusting tree supporting posts, pruning, chemical spraying for insect and disease control, and keep all bedded areas substantially clear of weeds and grass to insure healthy plants. The contractor, at no cost to the county, will be permitted to apply commercial wilt-proofing compound or liquid fertilizer on plants during the planting or the watering period of the contract.

808.4.1.1 In addition to the 10 percent retained percentage specified in Sec 808.6, there will be withheld an amount equal to 15 percent of the price bid for plants until satisfactory completion of the watering requirements specified for each phase of planting, at which time the 15 percent will be released.

808.4.2 The contractor shall be responsible for the proper care of all plants until final inspection and acceptance of the plants has been made by the engineer.

808.4.2.1 Any plant, which in the judgment of the engineer, is not in a healthy growing condition at the time of final plant inspection shall be replaced by the contractor in accordance with the original specifications except that additional peat moss will not be required for the
backfill material, and except that the specified 45-day watering period will not be required. No maintenance will be required for those plants replaced under this replacement specification.

808.4.3 Final Plant Inspection. For those contracts requiring fall phase planting only, the final inspection of plants will be made as soon as practicable after May 15. For those contracts requiring spring phase planting only, or requiring both fall and spring phase planting, the final plant inspection will be made as soon as practicable following either the specified spring watering period or May 15 whichever comes last. Plants not accepted at the time of final plant inspection will be marked and shall be replaced in the fall in accordance with the dates established in the contract. The contractor will be relieved of all further responsibility for plants that are accepted at the time of final plant inspection.

808.5 Liquidated Damages Liquidated damages will be charged against the contractor only for those days which would qualify as working days. The designated amount will be charged separately for each phase of planting and for the plant replacement period. Liquidated damages will not be charged during required watering periods.

808.6 Method of Payment Trees will be planted and, upon planting, the contractor shall be paid 90 percent of the bid price within 30 days of receipt of invoice for the planting. The contractor will receive the final 10 percent payment following the first successful leafing out of the trees, within 60 days of the first following growing season when leafing out occurs. The replacement of unsuccessful planting material shall be the responsibility of the contractor at no cost to the County. Replacement shall be made at the direction of the County Engineer or his authorized representative.

808.7 Basis of Payment. The accepted quantities of plants will be paid for at the contract unit bid price for each plant of the types, species, and sizes required, complete in place. No direct payment will be made for any incidental items such as supporting posts, mulch, edging, and water necessary for this work.
SECTION 809
CROWN VETCH SEEDING
(DISTURBED AREAS)

809.1 Description. This work shall consist of preparing, fertilizing, and mulching seedbed, and the furnishing and sowing of seeds as specified in the contract.

All disturbed areas shall be seeded except: (1) sodded areas, (2) surfaced areas, (3) solid rock, and (4) slopes consisting primarily of broken rock. Disturbed areas outside of authorized construction limits shall be seeded at the contractor’s expense.

809.2 Materials.

809.2.1 Seed. Seed labeled in accordance with U.S. Department of Agriculture Rules and Regulations under the Federal Seed Act (March 1940 with 1970 Amendments) shall be furnished: Seed shall be furnished in sealed, standard containers unless written exception is granted. Seed that is wet or moldy or that has been otherwise damaged in transit or storage will not be acceptable. All seed samples shall be furnished by contractor.

<table>
<thead>
<tr>
<th>Type of Seed</th>
<th>Percentage by Weight of Each Type of Seed in Mixture</th>
<th>Purity</th>
<th>Germination</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crown Vetch (Lespedeza Stipulacea, Lespedeza Striata)</td>
<td>100%</td>
<td>98%</td>
<td>80%</td>
</tr>
</tbody>
</table>

809.2.2 Mulch. A soil stabilizer shall be applied at a rate of 500 L/hectare (60 gal./acre) along with 1675 kg/hectare (1,500 lb./acre) green wood cellulose fiber mulch, applied in accordance with the manufacturer’s directions.

809.2.3 Wood Cellulose Fiber Mulch. Wood cellulose fiber mulch, for use with the hydraulic application of grass seed and fertilizer, shall consist of specially prepared wood cellulose fiber, processed to contain no growth or germination-inhibiting factors, and dyed green to facilitate visual metering of application of the materials. The mulch material shall be supplied in packages having a gross weight not in excess of 50 kg (100 lb.). The wood cellulose fiber shall contain not in excess of 10 percent moisture, air dry weight basis. The wood cellulose fiber shall be manufactured so that after addition and agitation in slurry tanks with fertilizers, grass seeds, water, and any other approved additives, the fibers in the material will become uniformly suspended to form a homogeneous slurry; and that when hydraulically sprayed on the ground,
the material will form a blotter-like ground cover impregnated uniformly with grass seed; and which, after application, will allow the absorption of moisture and allow rainfall or mechanical watering to percolate to the underlying soil. Suppliers shall be prepared to certify that laboratory and field testing of their product has been accomplished, and that their product meets all the foregoing requirements based upon such testing.

809.2.4 Fertilizer. Fertilizer shall be uniform in composition, free flowing and suitable for properly applying as specified. Application rate of 900 kg (800 lb.) of 10 percent nitrogen, 6 percent phosphorus and 4 percent potash per hectare (per acre) or equivalent shall be tilled into soil to a depth of 75 mm (3 in.).

809.2.4.1 Fertilizer shall be delivered to the site in bags or other convenient containers, each fully labeled, and shall comply with applicable State of Missouri standards, and shall bear the name, tradename or trademark, and warranty of the producer.

809.2.5 Water. Water used for any part of this operation shall be free from oil, acid, alkali, salt, and other substances harmful to growth.

809.3 Inspection and Tests.

809.3.1 Fertilizer. Duplicate copies of invoices shall be furnished. Invoices shall show quantities and grade of fertilizer. Sampling of bulk fertilizer shall be with an approved sampling tube. Samples of each lot of fertilizer shall be with an approved sampling tube. Samples of each lot of fertilizer shall be furnished for testing. Samples will be tested at contractor expense, in accordance with Official Methods of Analysis of the Association of Official Analytical Chemists, at the direction of the engineer. Prior to commencing seeding operations, a check of total quantities of fertilizer used will be made against the total area treated, and if minimum rates of application have not been met, additional quantities of this material to make up minimum application specified shall be distributed as directed.

809.3.2 Mulch. Within 30 days prior to commencing seeding operations, the engineer shall be notified of sources from which mulch materials are available and the quantities thereof, and representative samples of the materials proposed for use shall be submitted for approval if requested.

809.3.3 Seed. The engineer shall be furnished duplicate signed copies of statement from vendor, certifying that each container of seed delivered is labeled in accordance with the Federal Seed Act and is at least equal to requirements previously specified. This certification shall be obtained from vendor and shall be furnished on or with all copies of seed invoices. Each lot of seed will be sampled and tested, in accordance with the latest Rules and Regulations under the Federal Seed Act, at the direction of the engineer.

809.4 Equipment.

809.4.1 Seeder. Equipment to be used for applying a seed-fertilizer mix over prepared slopes shall be a hydraulic seeder designed to pump and discharge a water-borne homogeneous
slurry of seed and fertilizer at the desired specified rate. The seeder shall be equipped with a power-driven agitator, and shall be capable of discharging up to 750 L (200 gal.) per minute at 450 N (100 psi) from a nozzle with clearance for 13 mm (1/2 in.) solids.

809.4.2 Wood Cellulose Fiber Mulch Spreader. Hydraulic equipment used for the application of fertilizer, seed, and slurry of prepared wood pulp shall have a built-in agitation system with an operating capacity sufficient to agitate, suspend, and homogeneously mix a slurry containing up to 18 kg (40 lb.) of fiber plus a combined total of 32 kg (70 lb.) of fertilizer solids for each 375 L (100 gal.) of water. The slurry distribution lines shall be large enough to prevent stoppage. The discharge line shall be equipped with a set of hydraulic spray nozzles that will provide even distribution of the slurry on the various slopes to be mulched. The slurry tank shall have a minimum capacity of 3.75 m$^3$ (1,000 gal.) and shall be mounted on a traveling unit which may be either self-propelled or drawn by a separate unit that will place the slurry tank and spray nozzles near the areas to be mulched so as to provide uniform distribution without waste. The engineer may authorize equipment with smaller tank capacity provided that the equipment has the necessary agitation system and sufficient pump capacity to spray the slurry in a uniform coat over the surface of the area to be mulched.

809.5 Construction Requirements.

809.5.1 General. Equipment, in good condition, shall be provided for the proper preparation of the ground and for handling and placing all materials. Equipment shall be approved before work is started.

809.5.2 Clearing. Prior to tilling, vegetation that may interfere with operations shall be mowed, grubbed, and raked; the collected material shall be buried or removed from the site, or when suitable, the material shall be used for mulch as directed. The surface shall be cleared of stumps, stones larger than 50 mm (2 in.) in diameter, roots, cable, wire, and other materials that might hinder the work or subsequent maintenance.

809.5.3 Preparation of Areas for Seeding. After the areas required to be treated have been leveled, the soil shall be fine tilled to a depth of at least 75 mm (3 in.) by plowing, diskng, harrowing, or other approved operations until the condition of the soil is acceptable. The work shall be performed only during periods when, in the opinion of the engineer, beneficial results are likely to be obtained. When drought, excessive moisture, or other unsatisfactory conditions prevail, the work shall be stopped when directed. Undulations or irregularities in the surface shall be leveled before the next specified operation.

809.5.4 Preplanting Fertilization of Areas to be Seeded. Fertilizer shall be distributed uniformly at the rate prescribed over areas to be seeded and shall be incorporated into the soil to a depth of at least 75 mm (3 in.) by diskng, harrowing, or other acceptable methods. Incorporation of fertilizer may be part of the operation specified in Sec 809.5.3.

809.5.5 Leveling. Surface irregularities resulting from tillage, fertilizing, or other operations before seeding shall be leveled.
809.5.6 Application of Seed. Seed shall be sown with approved seeding equipment, as specified hereinbefore, in combination with soil stabilizer wood cellulose fiber mulch and fertilizer and a minimum of 16 800 L (1,800 gal.) of water per hectare (acre). Seed shall be the last constituent to be added and shall not be in the slurry over 15 minutes.

809.6 Maintenance.

809.6.1 Seeded areas shall be maintained until all work or designated portions thereof have been completed and accepted. Any damage shall be repaired, and mulch material that has been removed by wind or other causes shall be replaced and secured by the contractor.

809.6.2 When any portion of the surface becomes gullied or otherwise damaged or treatment is destroyed prior to acceptance by the engineer, the affected portion shall be repaired to reestablish condition and grade of soil and treatment prior to injury, as directed. Repair work required because of faulty operations or negligence on the part of the contractor shall be performed without cost to the County.

809.6.3 The contractor shall assume full responsibility for proper care of seeded areas while grass is becoming established on the entire project until there is a show of green vegetation over not less than 80 percent of the area. Reseeding by the contractor shall be performed in those areas not meeting the above criteria, without additional cost to the County.

809.7 Quality Control Requirements. The contractor shall establish and maintain quality control for all operations to assure compliance with contract requirements and maintain records of his quality control for all construction operations, including but not limited to the following:

1) Preparation of seedbed.
2) Material.
3) Seeding and mulching operations.
4) Maintenance.

809.8 Method of Measurement. Measurement of seeded areas will be made to the nearest 0.10 hectare (nearest 1/10 acre) of surface area seeded.

809.9 Basis of Payment. The accepted quantity of seeded areas will be paid for at the unit bid price. No direct payment will be made for water, fertilizing, or mulching seeded areas.
SECTION 810
CROWN VETCH SEEDING
(UNDISTURBED AREAS)

810.1 Description. This work shall consist of preparing, fertilizing, and furnishing and sowing of seeds as specified in the contract. All undisturbed areas shall be seeded except: (1) surfaced areas, (2) solid rock, and (3) slopes consisting primarily of broken rock. Undisturbed areas outside of authorized construction limits shall be seeded at the contractor’s expense.

810.2 Materials.

810.2.1 Seed. Seed labeled in accordance with U.S. Department of Agriculture Rules and Regulations under the Federal Seed Act (March 1940 with 1970 Amendments) shall be furnished. Seed shall be furnished in sealed standard containers unless written exception is granted. Seed that is wet or moldy or that has been otherwise damaged in transit or storage will not be acceptable. All seed samples shall be furnished by contractor.

<table>
<thead>
<tr>
<th>Type of Seed</th>
<th>Percentage by Weight of Each Type of Seed in Mixture</th>
<th>Purity</th>
<th>Germination</th>
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<td>100%</td>
<td>98%</td>
<td>80%</td>
</tr>
</tbody>
</table>

810.2.2 Fertilizer. Fertilizer shall be uniform in composition, free flowing and suitable for properly applying as specified. Application rate of 900 kg (800 lb.) of 10 percent nitrogen, 6 percent phosphorus and 4 percent potash per hectare (acre) or equivalent shall be tilled into soil to a depth of 75 mm (3 in.).

810.2.2.1 Fertilizer shall be delivered to the site in bags or other convenient containers, each fully labeled, and shall comply with applicable State of Missouri standards, and shall bear the name, tradename or trademark, and warranty of the producer.

810.2.3 Water. Water used for any part of this operation shall be free from oil, acid, alkali, salt, and other substances harmful to growth.

810.3 Inspection and Tests.

810.3.1 Fertilizer. Duplicate copies of invoices shall be furnished. Invoices shall show quantities and grade of fertilizer. Sampling of bulk fertilizer shall be with an approved sampling tube. Samples of each lot of fertilizer shall be with an approved sampling tube. Samples of each...
lot of fertilizer shall be furnished for testing. Samples will be tested at contractor expense, in accordance with Official Methods of Analysis of the Association of Official Analytical Chemists, at the direction of the engineer. Prior to commencing seeding operations, a check of total quantities of fertilizer used will be made against the total area treated, and if minimum rates of application have not been met, additional quantities of this material to make up minimum application specified shall be distributed as directed.

810.3.2 Seed. The engineer shall be furnished duplicate signed copies of statement from vendor, certifying that each container of seed delivered is labeled in accordance with Federal Seed Act and is at least equal to requirements previously specified. This certification shall be obtained from vendor and shall be furnished on or with all copies of seed invoices. Each lot of seed will be sampled and tested, in accordance with the latest Rules and Regulations under the Federal Seed Act, at the direction of the engineer.

810.4 Equipment.

810.4.1 Seeder. Equipment to be used for applying a seed-fertilizer mix over prepared slopes shall be a hydraulic seeder designed to pump and discharge a water-borne homogeneous slurry of seed and fertilizer at the desired specified rate. The seeder shall be equipped with a power-driven agitator, and shall be capable of discharging up to 750 L (200 gal.) per minute at 690 kPa (100 psi) from a nozzle with clearance for 13 mm (1/2 in.) solids.

810.5 Construction Requirements.

810.5.1 General. Equipment, in good condition, shall be provided for the proper preparation of the ground and for handling and placing all materials. Equipment shall be approved before work is started.

810.5.2 Prior to seeding, vegetation that may interfere with operations shall be mowed, grubbed, and raked; the collected material shall be buried or removed from the site. The surface shall be cleared of stumps, stones larger than 50 mm (2 in.) in diameter, roots, cable, wire, and other materials that might hinder the work or subsequent maintenance.

810.5.3 Application of Seed. Seed shall be sown with approved seeding equipment, as specified hereinbefore, in combination with fertilizer and a minimum of 18 700 L (2,000 gal.) of water per hectare (acre). Seed shall be the last constituent to be added and shall not be in the slurry over 15 minutes.

810.6 Maintenance.

810.6.1 Seeded areas shall be maintained until all work or designated portions thereof have been completed and accepted. Any damage shall be repaired.

810.6.2 When any portion of the surface becomes gullied or otherwise damaged or treatment is destroyed prior to acceptance by the engineer, the affected portion shall be repaired to reestablish condition and grade of soil and treatment prior to injury, as directed. Repair work
required because of faulty operations or negligence on the part of the contractor shall be performed without cost to the County.

810.6.3 The contractor shall assume full responsibility for proper care of reseeded areas while grass is becoming established on the entire project. Reseeding by the contractor shall be performed in those areas not meeting the above criteria without additional cost to the County.

810.7 Quality Control Requirements. The contractor shall establish and maintain quality control for all operations to assure compliance with contract requirements and maintain records of his quality control for all construction operations, including but not limited to the following:

(1) Preparation of seedbed.
(2) Material.
(3) Seeding.
(4) Maintenance.

810.8 Method of Measurement. Measurement of seeded areas will be made to the nearest 0.1 hectare (nearest 1/10 acre) of surface area seeded.

810.9 Basis of Payment. The accepted quantity of seeded areas will be paid for at the unit bid price. No direct payment will be made for water or fertilizing seeded areas.
Division 900

TRAFFIC CONTROL FACILITIES
SECTION 901
HIGHWAY LIGHTING

When applicable, Section 901, "Highway Lighting", from the most current edition of the Missouri Standard Specifications for Highway Construction shall be included as part of the contract.
SECTION 902
TRAFFIC SIGNALS

When applicable, Section 902, "Traffic Signals", from the most current edition of the Missouri Standard Specifications for Highway Construction shall be included as part of the contract.
SECTION 903
HIGHWAY SIGNING

903.1 All permanent regulatory, warning, and guide signs along County roads will be furnished and installed by the Department, unless otherwise indicated.

903.2 All existing regulatory, warning, and guide signs along County roads will be removed or relocated by the Department as required, unless otherwise indicated.

903.3 For all temporary construction signing see Sec 612, Traffic Control Devices.

903.4 The contractor shall notify the engineer one day in advance of any required signing modifications.
SECTION 904
HIGHWAY STRIPING

904.1 All striping materials shall be manufactured in accordance with Sec 1048.

904.2 All striping for temporary striping or permanent striping shall be installed in accordance with the Manual on Uniform Traffic Control Devices published by the Federal Highway Administration.

904.2.1 Striping installations and removals shall be performed in accordance with Sec 620.
Division 1000

MATERIALS DETAILS
SECTION 1001
GENERAL REQUIREMENTS FOR MATERIALS

1001.1 All packaged material shall be plainly marked showing the quantity and nature of contents and shall be delivered intact.

1001.2 A description of the visual characteristics of deleterious rock types most likely to be encountered at any specific aggregate source may be obtained by the supplier upon written request to the engineer.

1001.3 At local plants installed for production of any sand or gravel required for highway work, the oversize shall not be returned to the deposit or to the stream.

1001.4 Chat is defined as aggregate tailings from mills in which metallic minerals have been recovered.

1001.5 Crushed stone is defined as the product obtained by the artificial reduction in the size of rock which has been mined or excavated from ledge formation. Chat as defined in Sec. 1001.4 is not included.

1001.6 Gravel is defined as the coarse granular material (generally considered as material retained on the 4.75 mm (No. 4) or 2.0 mm (No. 10) sieve, but may include finer sizes) resulting from the natural disintegration and abrasion of rock or from processing of weakly bound conglomerate. It may include such material that has been further reduced in size by artificial means.

1001.7 Porphyry is defined as a fine grained, dense, igneous rock generally occurring in the Missouri counties of Iron, Madison, St. Francois, and their adjacent counties.

1001.8 Wet bottom boiler slag is defined as a hard, angular by-product of the combustion of coal in wet bottom boilers.

1001.9 Sieves specified for gradation requirements shall have openings as prescribed in AASHTO M 92.

1001.10 Storage and Handling of Aggregates.

1001.10.1 When coarse aggregate for concrete, bituminous mixtures, or Type 4 base is stockpiled, it shall be handled, placed in horizontal layers, ramped, and matted, or stockpiled by conveyor belts, as specified below:

Equipment used in stockpiling and in reclaiming from stockpile, both at the source and the batching plant setup, shall be so operated as to minimize segregation, degradation, and
1001.10.1.1 Horizontal Stockpiling. Equipment which moves the material by pushing will be permitted on the stockpile only as necessary for ramp and runway construction and for leveling of the top of a completed lift. When stockpiling, the aggregates shall be deposited in place in successive increments over the length and width of the stockpile. Material in the layer being placed shall not be allowed to flow down over the edges of the adjacent underlayer. The thickness of each layer shall be not more than the thickness of a single deposit from a hauling unit. If trucks or other types of hauling equipment are used, all ramps and runways on the stockpile shall be covered by mats, boards, or other approved materials. For unloading purposes, hauling equipment will be permitted off the runway a distance of approximately two hauling unit lengths. Clam shells or drag lines when permitted by the engineer for use in stockpiling aggregates specified to be placed in horizontal layers and ramped, shall have areas of travel upon the stockpile covered by mats, boards, or other approved materials.

1001.10.1.2 Conveyor Belt Stockpiling. All conveyor belts, whether mobile or stationary shall have a device fitted to the discharge end of the conveyor to stop the forward movement of the aggregate and mix and discharge the material vertically downward. Only those devices meeting the approval of the engineer will be permitted.

(a) When a mobile conveyor belt is used to stockpile the aggregate with specified stockpile requirements and no further handling is done for stockpiling purposes, the maximum height from the head pulley centerline to the ground surface shall not exceed 4.5 m (15 ft.) when stockpiling is started. After the initial conical pile is built, the vertical free fall of the aggregate shall not exceed 1.5 m (5 ft.). The conveyor belt shall be automated to travel laterally or vertically only the distance needed to comply with the free fall requirements. Manual operation of the conveyor will only be allowed for the time necessary to make repairs.

(b) When a stationary conveyor belt is used, the maximum height from the head pulley centerline to the ground surface shall not exceed 9.0 m (30 ft.). Aggregates initially deposited in a conical pile by a stationary conveyor shall be moved at least one more time for stockpiling purposes. The aggregates shall ultimately be stockpiled in horizontal layers and shall comply with Sec. 1001.10.2.

1001.10.2 Regardless of the method of storage and handling, all aggregates that are segregated, degraded, or contaminated to the extent that they do not meet specifications, will be considered unacceptable. However, they may be reconditioned by any method that produces satisfactory material. Disposal of unacceptable material shall be the responsibility of the contractor.

1001.11 Plant Laboratory. A plant laboratory meeting the minimum requirements of Sec. 404.4 shall be provided by the contractor. In addition, the following shall apply: a minimum of two outside doors and four windows shall be provided. The outside doors shall be located so as to permit ingress and egress from opposite ends of the building. A desk, lighting facilities of an approved type, three grounded electrical outlets with 110-120 volt, 60 Hz current shall be
provided inside the laboratory. Lighting facilities shall be located so as to adequately light all work areas in the interior of the building. The laboratory shall be equipped with two work tables, each of which meet the requirements of Sec. 404.4, and equipped with a sink with faucet and running water. A two burner stove with an adequate fuel supply shall be furnished. A thermostatically controlled air conditioning system, capable of maintaining an interior ambient temperature of 22°C (72°F) and connected to an adequate power supply, shall be furnished. An exhaust fan, capable of moving a volume of air each hour equal to at least ten times the cubic volume of the laboratory shall be provided. A sieve shaker with time controls, meeting AASHTO T 27 requirements, capable of handling ten 300 mm (12 in.) diameter sieves having a stacking height of 54 mm (2 1/8 in.) each, and 200 mm (8 in.) platform adapter to accommodate 200 mm (8 in.) sieves, and a sample splitter, complete with pans, meeting AASHTO T 248 requirements, having a minimum length of 500 mm (20 in.) with 50 mm (2 in.) maximum opening size, shall be provided. The location of the plant laboratory, with respect to other plant operations, will be as directed by the engineer.
SECTION 1002
AGGREGATE FOR ASPHALTIC CONCRETE

1002.1 Coarse Aggregate.

1002.1.1 All coarse aggregate shall consist of sound, durable rock, free from objectionable coatings. When the coarse aggregate is tested in accordance with AASHTO T 96 (Los Angeles Abrasion), the percentage of wear shall not exceed 45. The percentage of deleterious substances shall not exceed the following values and the sum of percentages of all deleterious substances shall not exceed 8 percent. At least 60 percent of the particles, retained on a 4.75 mm (No. 4) sieve, for use in asphaltic concrete shall have two or more mechanically induced faces.

<table>
<thead>
<tr>
<th>Item</th>
<th>Percent by Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deleterious rock</td>
<td>8.0</td>
</tr>
<tr>
<td>Shale</td>
<td>1.0</td>
</tr>
<tr>
<td>Other foreign material</td>
<td>0.5</td>
</tr>
</tbody>
</table>

The requirements of this section apply to each size or fraction of aggregate produced.

1002.1.2 Coarse aggregate for Type B asphaltic concrete mixtures shall be furnished and stockpiled in two or more separate sizes or fractions. One fraction shall consist of material retained on the 12.5 mm (1/2 in.) sieve, and the other fractions shall consist of material passing the 12.5 mm (1/2 in.) sieve. A tolerance not to exceed 25 percent may be permitted on the 12.5 mm (1/2 in.) sieve for each fraction.

1002.1.3 Crushed porphyry aggregate meeting the approval of the engineer shall be a uniform product, furnished in one or more fractions. The total crushed porphyry aggregate shall be uniformly graded and shall have material passing each sieve from the maximum size aggregate through the 75 μm (No. 200) sieve. Total aggregate gradations consisting of essentially one size aggregate will not be permitted.

1002.1.4 Steel slag aggregate meeting the approval of the engineer shall be a uniform product, furnished in one or more fractions. Steel slag consisting principally of a fused mixture of oxides and silicates is a synthetic aggregate produced as a byproduct of basic oxygen, electric or open hearth steel making furnaces. The steel slag shall be aged at least 3 months after crushing and screening. Material that is screened after it has been crushed, initially screened, and aged 3 months will not be required to receive additional aging. Steel slag from one source shall not be mixed with or used with steel slag from a different source. The total steel slag aggregate shall be uniformly graded and shall have material passing each sieve from the maximum size aggregate through the 75 μm (No. 200) sieve. Total aggregate gradations consisting of essentially one size aggregate will not be permitted.
1002.1.5 When a density requirement is specified for asphaltic concrete, the total quantity of chert in each size or fraction of produced crushed stone aggregate, including that permitted as deleterious, shall not vary more than 10 percentage points from the quantity present in the aggregates used in the approved laboratory job mixtures.

1002.1.6 Gravel aggregate shall be washed sufficiently to remove any objectionable coating. Gravel aggregate for Type B mixtures shall be crushed from gravel that has a maximum of 10 percent passing a 25 mm (1 in.) sieve. Gravel aggregate for Type C (BP-1) mixtures shall be crushed from gravel that has a maximum of 10 percent passing a 19 mm (3/4 in.) sieve. Crushed gravel shall comply with the requirements for mechanically induced faces in Sec. 1002.1.

1002.1.7 Pile-run chat will not be approved for use in asphaltic concrete unless the chat has been conditioned to meet a specific gradation. A tolerance of 7 percent plus or minus, on each sieve fraction will be permitted providing the aggregate complies with other provisions of this specification.

1002.1.8 The gradation of coarse aggregate shall be such that the combinations of coarse aggregate fractions, when combined with fine aggregate, will meet the gradation requirements for the type of asphaltic concrete specified. All fractions of coarse aggregate shall comply with the following requirements, with the exception of crushed porphyry and steel slag. The maximum size of each fraction is defined by the smallest sieve through which 100 percent will pass:

<table>
<thead>
<tr>
<th>Maximum Size of Fraction</th>
<th>2.36 mm (No. 8)</th>
<th>75 μm (No. 200)</th>
</tr>
</thead>
<tbody>
<tr>
<td>25 mm (1 in.)</td>
<td>---</td>
<td>2.0</td>
</tr>
<tr>
<td>19 mm (3/4 in.)</td>
<td>12.0</td>
<td>3.5</td>
</tr>
<tr>
<td>12.5 mm (1/2 in.)</td>
<td>12.0</td>
<td>3.5</td>
</tr>
<tr>
<td>9.5 mm (3/8 in.) or smaller</td>
<td>14.0</td>
<td>4.0</td>
</tr>
</tbody>
</table>

1002.1.9 Absorption. The absorption value of the aggregate used shall not exceed 4.0 percent measured by weight.

1002.2 Fine Aggregate.

1002.2.1 Fine aggregate for asphaltic concrete shall be a fine, granular material naturally produced by the disintegration of rock of a siliceous nature and/or manufactured by the mechanical reduction of sound durable rock with a percentage of wear not exceeding 45 when tested in accordance with AASHTO T 96. With written approval of the engineer and compliance with this specification, chat sand produced from flint chat in the Joplin area, dolomite chat sand as produced in the southeast lead belt area, or fines manufactured from igneous rock and chert.
gravel, or wet bottom boiler slag may be used as fine aggregate for asphaltic concrete. Fine aggregate shall be free from cemented or conglomerated lumps and shall not have any coating or injurious material. The fraction passing a 475 μm (No. 40) sieve shall be non-plastic. The percentage of deleterious substances shall not exceed the following values:

<table>
<thead>
<tr>
<th>Item</th>
<th>Percent By Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clay lumps and shale</td>
<td>1.0</td>
</tr>
<tr>
<td>Total lightweight particles,</td>
<td></td>
</tr>
<tr>
<td>including coal and lignite</td>
<td>0.5</td>
</tr>
<tr>
<td>Other deleterious substances</td>
<td>0.1</td>
</tr>
</tbody>
</table>

Lightweight sand particles are not considered deleterious lightweight particles. The total lightweight particles requirement shall not apply to wet bottom boiler slag, angular chert sand or manufactured sand.

1002.2.2 Natural aggregate delivered to the cold bin shall be furnished in one fraction and shall meet the following gradation requirements. If the material is produced by use of two or more fractions, they shall be thoroughly blended at the site of original mixing to form a single material of uniform gradation. Further, if the blending is performed at the job site, it shall be done a sufficient distance from the cold feed bins so that the blended stockpile of fine aggregate will be moved at least once before being fed into the cold bin.

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Percent Passing by Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>9.5 mm (3/8 in.)</td>
<td>100</td>
</tr>
<tr>
<td>75 μm (No. 200)</td>
<td>0-6</td>
</tr>
</tbody>
</table>

1002.2.3 Fine aggregate manufactured by the mechanical reduction of sound durable rock shall be delivered to the cold feed in one fraction, separate from any natural fine aggregate and shall meet the following gradation requirements.

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Percent Passing by Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>9.5 mm (3/8 in.)</td>
<td>100</td>
</tr>
<tr>
<td>4.75 mm (No. 4)</td>
<td>85-100</td>
</tr>
<tr>
<td>75 μm (No. 200)</td>
<td>0-8</td>
</tr>
</tbody>
</table>

1002.3 Mineral Filler. Mineral filler shall consist of limestone: dust, portland cement, or other suitable mineral matter. It shall be thoroughly dry and free of lumps consisting of aggregations of fine particles. When tested by means of laboratory sieves in accordance with AASHTO T 37, the mineral filler shall conform to the following requirements:
<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Percent Passing by Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>600 µm (No. 30)</td>
<td>.................................................. 100</td>
</tr>
<tr>
<td>300 µm (No. 50)</td>
<td>.................................................. 95-100</td>
</tr>
<tr>
<td>150 µm (No. 100)</td>
<td>.................................................. 90-100</td>
</tr>
<tr>
<td>75 µm (No. 200)</td>
<td>.................................................. 70-100</td>
</tr>
</tbody>
</table>

1002.4 **Salvaged Bituminous Materials.** Salvaged bituminous materials shall be processed or crushed to a maximum size of 38 mm (1 1/2 in.) and stockpiled in accordance with Sec. 1001.9.2. Stockpiles shall consist of salvaged bituminous materials from one source only, or materials from multiple sources may be blended into one stockpile to provide a uniform mixture. Such blending will be done under the observation of a representative of St. Charles County. No stockpiled material will be incorporated into asphaltic concrete prior to testing and approval by St. Charles County.

1002.5 **Soundness.** When testing in accordance with AASHTO T 104 the loss of coarse aggregate in 5 cycles of the accelerated soundness test shall not be greater than 12% when sodium sulfate is used. Aggregates to be tested shall be made available for testing a minimum of ten calendar days prior to the intended time of use. It shall be the responsibility of the contractor to notify St. Charles County when samples are available.

A soundness test taken on aggregate sampled from a well defined quarry ledge or gravel pit may be considered to represent that entire ledge or pit, and any fine or coarse aggregate fractions from that ledge or pit. Should any change in ledge or pit characteristics be observed, retesting may be required at the discretion of the engineer.

If approval of a stock pile is requested, the stock pile shall contain material for 5 days of the intended usage or 500 metric tons (tons), whichever is greater. No material shall be removed from or added to the stock pile during the testing period. Unapproved material shall be segregated from approved materials in stockpiles at all times.

This specification shall not apply to siliceous sands from the Missouri, Mississippi or Meramec Rivers.

1002.6 **Hydrated Lime.** Hydrated lime shall be thoroughly dry and free of lumps. Hydrated lime produced from limestone shall comply with ASTM C 206 Type N or S. Hydrated lime produced from dolomite shall comply with ASTM C 206 Type S. The plasticity requirements of ASTM shall not apply to either Type N or S, and the gradation shall be determined in accordance with AASHTO T 37.
SECTION 1003
AGGREGATE FOR SEAL COATS

1003.1 Aggregate for seal coats shall consist of sound durable rock particles, free from objectionable coatings.

<table>
<thead>
<tr>
<th>Item</th>
<th>Percent by Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deleterious rock</td>
<td>8.0</td>
</tr>
<tr>
<td>Shale</td>
<td>1.0</td>
</tr>
<tr>
<td>Other foreign material</td>
<td>0.5</td>
</tr>
</tbody>
</table>

1003.2 The aggregate shall comply with the following requirements as specified in the contract:

<table>
<thead>
<tr>
<th>Sieve Sizes</th>
<th>Percent Passing by Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>25 mm (1 in.)</td>
<td>100</td>
</tr>
<tr>
<td>19 mm (3/4 in.)</td>
<td>—</td>
</tr>
<tr>
<td>12.5 mm (1/2 in.)</td>
<td>—</td>
</tr>
<tr>
<td>9.5 mm (3/8 in.)</td>
<td>—</td>
</tr>
<tr>
<td>4.75 mm (No. 4)</td>
<td>—</td>
</tr>
<tr>
<td>2.00 mm (No. 10)</td>
<td>—</td>
</tr>
<tr>
<td>75 μm (No. 200)</td>
<td>—</td>
</tr>
<tr>
<td>45-85</td>
<td>0-10</td>
</tr>
<tr>
<td>80-100</td>
<td>0-5</td>
</tr>
</tbody>
</table>

1003.3 Precoating. Should the material, as crushed and screened, have an amount passing the 75 μm (No. 200) sieve greater than 1% by weight, the supplier will have the option of washing the material to reduce the amount of aggregate passing through the 75 μm (No. 200) sieve.
sieve to 1% or less of the total sample. If the material passing through the 75 µm (No. 200) sieve is greater than 1%, but less than or equal to 2.5% the material can be rendered acceptable if precoated with emulsified or liquid asphalt, only in accordance with the following paragraph. Material which has an amount passing a 75 µm (No. 200) sieve greater than 2.5% is not acceptable to this Department, even by precoating, and such material shall be rejected until washing or some other means is found and approved by the County Engineer, which will reduce the amount of material passing through the 75 µm (No. 200) sieve to less than 2.5%.

1003.3.1 If precoating material is used, such material shall be precoated through a pug-mill with quick setting or emulsified asphalt in such proportion as to leave residual asphalt coating of not less than 0.75% or greater than 1.25% of the total aggregate weight on the surface of the aggregate particles.
SECTION 1004
AGGREGATE FOR BITUMINOUS CONCRETE

1004.1 Coarse Aggregate.

1004.1.1 All coarse aggregate shall consist of sound, durable rock, free from objectionable coatings. When the coarse aggregate is tested in accordance with AASHTO T 96 (Los Angeles Abrasion), the percentage of wear shall not exceed 45. The percentage of deleterious substances shall not exceed the following values and the sum of percentages of all deleterious substances shall not exceed 8 percent.

At least 60 percent of the particles, retained on a 4.75 mm (No. 4) sieve, for use in bituminous concrete shall have two or more mechanically induced faces.

<table>
<thead>
<tr>
<th>Item</th>
<th>Percent by Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deleterious rock</td>
<td>8.0</td>
</tr>
<tr>
<td>Shale</td>
<td>1.0</td>
</tr>
<tr>
<td>Other foreign material</td>
<td>0.5</td>
</tr>
</tbody>
</table>

The requirements of this section apply to each size or fraction of aggregate produced.

1004.1.2 When a density requirement is specified for bituminous concrete, the total quantity of chert in each size or fraction of produced crushed stone aggregate, including that permitted as deleterious, shall not vary more than 10 percentage points from the quantity present in the aggregates used in the approved laboratory job mixtures.

1004.1.3 Gravel aggregate shall be washed sufficiently to remove any objectionable coating. Gravel aggregate for Type X mixtures will not be permitted. Gravel aggregate for Type C BP-1) mixtures shall be crushed from gravel that has a maximum of 10 percent passing a 19 mm (3/4 in.) sieve. Crushed gravel shall comply with the requirements for mechanically induced faces in Sec. 1002.1.

1004.1.4 Pile-run chat will not be approved for use in bituminous concrete unless the chat has been conditioned to meet a specific gradation. A tolerance of 7 percent plus or minus, on each sieve fraction will be permitted providing the aggregate complies with other provisions of this specification.

1004.1.5 The gradation of coarse aggregate shall be such that the combinations of coarse aggregate fractions, when combined with fine aggregate, will meet the gradation requirements for the type of bituminous concrete specified for Type C (BP-1) and Type X bituminous concrete mixtures. At least one fraction of coarse aggregate that comprises not less than 20 percent of the total mixture shall comply with the following requirements. The maximum size of each fraction is defined by the smallest sieve through which 100 percent will pass:
Maximum Size of Fraction | 2.36 mm (No. 8) 75 μm (No. 200)
---|---
25 mm (1 in.) | ---- | 2.0
19 mm (3/4 in.) | 12.0 | 3.5
12.5 mm (1/2 in.) | 12.0 | 3.5
9.5 mm (3/8 in.) or smaller | 14.0 | 4.0

1004.1.6 Absorption. The absorption value of the aggregate used shall not exceed 4.0 percent measured by weight.

1004.2 Fine Aggregate.

1004.2.1 Fine aggregate for bituminous concrete shall be a fine, granular material naturally produced by the disintegration of rock of a siliceous nature and/or manufactured by the mechanical reduction of sound durable rock with a percentage of wear exceeding 45 when tested in accordance with AASHTO T 96. With written approval of the engineer and compliance with this specification, chat sand produced from flint chat in the Joplin area, dolomite chat sand as produced in the southeast lead belt area, or fines manufactured from igneous rock and chert gravel, or wet bottom boiler slag may be used as fine aggregate for asphaltic concrete. Fine aggregate shall be free from cemented or conglomerated lumps and shall not have any coating or injurious material. The fraction passing a 475 μm (No. 40) sieve shall be non-plastic. The percentage of deleterious substances shall not exceed the following values:

<table>
<thead>
<tr>
<th>Item</th>
<th>Percent By Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clay lumps and shale</td>
<td>1.0</td>
</tr>
<tr>
<td>Total lightweight particles, including coal and lignite</td>
<td>0.5</td>
</tr>
<tr>
<td>Other deleterious substances</td>
<td>0.1</td>
</tr>
</tbody>
</table>

Lightweight sand particles are not considered deleterious lightweight particles. The total lightweight particles requirement shall not apply to wet bottom boiler slag, angular chert sand, or manufactured sand.

1004.3 Material designated as Limestone Screenings shall not be used in bituminous concrete unless the material can meet the following gradation and quality requirements:

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Percent Passing by Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>9.5 mm (3/8 in.)</td>
<td>95% minimum</td>
</tr>
<tr>
<td>2.36 mm (No. 8)</td>
<td>±10% of approved design material</td>
</tr>
<tr>
<td>75 μm (No. 200)</td>
<td>± 5% of approved design material*</td>
</tr>
</tbody>
</table>

* Material not meeting the passing 75 μm (No. 200) sieve minimum may be supplemented by
mineral filler meeting the requirements of 1002.3 in order to produce the final mix composition.

The fraction passing the 4.75 μm (No. 40) sieve shall exhibit a maximum plasticity index of six (6) when tested in accordance with AASHTO T 90.

Fine aggregate manufactured in accordance to Sec. 1002.2.3 may be used in lieu of or in combination with Limestone Screenings, provided that the approved mix design is structured to accommodate the blending of these two materials.

**1004.4 Mineral Filler.** Mineral filler shall consist of limestone dust, portland cement, or other suitable mineral matter. It shall be thoroughly dry and free of lumps consisting of aggregations of fine particles. When tested by means of laboratory sieves in accordance with AASHTO T 37 the mineral filler shall conform to the following requirements:

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Percent Passing by Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>600 μm (No. 30)</td>
<td>.......................................................... 100</td>
</tr>
<tr>
<td>300 μm (No. 50)</td>
<td>.......................................................... 95-100</td>
</tr>
<tr>
<td>150 μm (No. 100)</td>
<td>......................................................... 90-100</td>
</tr>
<tr>
<td>75 μm (No. 200)</td>
<td>.......................................................... 70-100</td>
</tr>
</tbody>
</table>

**1004.5 Salvaged Bituminous Materials.** Salvaged bituminous materials shall be processed or crushed to a maximum size of 38 mm (1 1/2 in.) and stockpiled in accordance with Sec. 1001.9.2. Stockpiles shall consist of salvaged bituminous materials from one source only, or materials from multiple sources may be blended into one stockpile to provide a uniform mixture. Such blending will be done under the observation of a representative of St. Charles County. No stockpiled material will be incorporated into asphaltic concrete prior to testing and approval by St. Charles County.

**1004.6 Soundness.** When testing in accordance with AASHTO T 104 the loss of coarse aggregate in 5 cycles of the accelerated soundness test shall not be greater than 12% when sodium sulfate is used. Aggregates to be tested shall be made available for testing a minimum of ten calendar days prior to the intended time of use. It shall be the responsibility of the contractor to notify St. Charles County when samples are available.

A soundness test taken on aggregate sampled from a well defined quarry ledge or gravel pit may be considered to represent that entire ledge or pit, and any fine or coarse aggregate fractions from that ledge or pit. Should any change in ledge or pit characteristics be observed, retesting may be required at the discretion of the engineer.

If approval of a stockpile is requested, the stockpile shall contain material for 5 days of the intended usage or 500 metric tons (tons), whichever is greater. No material shall be removed from or added to the stockpile during the testing period. Unapproved material shall be segregated from approved materials in stockpiles at all times.

This specification shall not apply to siliceous sands from the Missouri, Mississippi or Meramec
1004.7 Hydrated Lime. Hydrated lime shall be thoroughly dry and free of lumps. Hydrated lime produced from limestone shall comply with ASTM C 206 Type N or S. Hydrated lime produced from dolomite shall comply with ASTM C 206 Type S. The plasticity requirements of ASTM shall not apply to either Type N or S, and the gradation shall be determined in accordance with AASHTO T 37.
SECTION 1005
AGGREGATE FOR
PORTLAND CEMENT CONCRETE

1005.1 Coarse Aggregate.

1005.1.1 All coarse aggregate for concrete shall consist of sound, durable rock particles, free from objectionable coatings and frozen and cemented lumps. The percentage of deleterious substances shall not exceed the following values and the sum of percentages of all deleterious substances, exclusive of Items 5 and 6, shall not exceed 6 percent.

<table>
<thead>
<tr>
<th>Item</th>
<th>Percent by Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Deleterious rock                                           6.0</td>
</tr>
<tr>
<td>2.</td>
<td>Shale                                                        1.0</td>
</tr>
<tr>
<td>3.</td>
<td>Chert in limestone                                          4.0</td>
</tr>
<tr>
<td>4.</td>
<td>Other foreign material                                      0.5</td>
</tr>
<tr>
<td>5.</td>
<td>Material passing 75 µm (No. 200) sieve:</td>
</tr>
<tr>
<td>a.</td>
<td>Coarse fraction, Limestone, Gradation A                      1.5</td>
</tr>
<tr>
<td>b.</td>
<td>Fine fraction, Limestone, Gradation A                        2.5</td>
</tr>
<tr>
<td>c.</td>
<td>Limestone, Gradations B, D, &amp; E                             2.0</td>
</tr>
<tr>
<td>d.</td>
<td>Other aggregates                                             1.0</td>
</tr>
<tr>
<td>6.</td>
<td>Thin or elongated pieces                                     5.0</td>
</tr>
</tbody>
</table>

The above requirements apply to each size or fraction of aggregate produced.

1005.1.2 Crushed stone shall be obtained from rock of uniform quality and when tested in accordance with AASHTO T 96 (Los Angeles Abrasion), the percentage of wear shall not exceed 50.

1005.1.3 Gravel shall be washed and when tested in accordance with AASHTO T 96 (Los Angeles Abrasion), the percentage of wear shall not exceed 45.

1005.1.4 Coarse aggregate for concrete pavement or base course shall be divided into three classifications as follows:

Aggregate No. 1 Any aggregate containing more than 30 percent of any one, or a combination of two or more, of the following materials: Chert gravel, crushed flint, or any other essentially siliceous material.
Aggregate No. 2 Any gravel of essentially glacial origin similar in character to that found in deposits in Missouri at LaGrange and Sampsel.

Aggregate No. 3 Crushed limestone or any other accepted aggregate not falling under the designations for Aggregate No. 1 or Aggregate No. 2.

Aggregate No. 3 shall be used unless otherwise specified.

1005.1.4.1 If coarse aggregate for concrete pavement or base is furnished, handled, and batched in two separate sizes or fractions, one fraction shall consist of material retained on the 19 mm (3/4 in.) sieve, and the other fraction shall consist of material passing the 19 mm (3/4 in.) sieve. A tolerance not to exceed 15 percent may be permitted on the 19 mm (3/4 in.) sieve for each fraction. The two fractions will be combined in a ratio as near as possible to the proportions in which the two fractions are furnished by the contractor to make a uniformly well-graded coarse aggregate graded within the following limits:

**Gradation A**

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Percent Passing by Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>50 mm (2 in.)</td>
<td>.............................................................. 100</td>
</tr>
<tr>
<td>38 mm (1 1/2 in.)</td>
<td>.............................................................. 95-100</td>
</tr>
<tr>
<td>19 mm (3/4 in.)</td>
<td>.............................................................. 35-70</td>
</tr>
<tr>
<td>9.5 mm (3/8 in.)</td>
<td>.............................................................. 10-30</td>
</tr>
<tr>
<td>4.75 mm (No. 4)</td>
<td>.............................................................. 0-5</td>
</tr>
</tbody>
</table>

Coarse aggregate may be divided into more than two fractions if approved by the engineer.

1005.1.4.2 If crushed flint is used as coarse aggregate, it shall meet the above requirements, and in addition 100 percent shall pass the 38 mm (1 1/2 in.) sieve.

1005.1.4.3 The contractor shall be responsible for maintaining the proper balance in the quantities of each fraction and for securing the final quantities of each fraction in such proportions as to minimize wastage.

1005.1.4.4 If coarse aggregate for concrete pavement or base is furnished, handled, and batched in one size or fraction, it shall be graded to meet Gradation B, or Gradation D, Sec. 1005.1.5.
Gradation B

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Percent Passing by Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>38 mm (1 1/2 in.)</td>
<td>................................................................. 100</td>
</tr>
<tr>
<td>25 mm (1 in.)</td>
<td>................................................................. 95-100</td>
</tr>
<tr>
<td>12.5 mm (1/2 in.)</td>
<td>................................................................. 25-60</td>
</tr>
<tr>
<td>4.75 mm (No. 4)</td>
<td>................................................................. 0-8</td>
</tr>
<tr>
<td>2.00 mm (No. 10)</td>
<td>................................................................. 0-3</td>
</tr>
</tbody>
</table>

1005.1.5 Coarse aggregate for Class B, B-1, B-2, or Seal concrete for structures except as specified in Sec. 1005.1.7, may be gravel or crushed stone and shall meet the following gradation requirements:

Gradation D

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Percent Passing by Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>25 mm (1 in.)</td>
<td>................................................................. 100</td>
</tr>
<tr>
<td>19 mm (3/4 in.)</td>
<td>................................................................. 90-100</td>
</tr>
<tr>
<td>9.5 mm (3/8 in.)</td>
<td>................................................................. 15-45</td>
</tr>
<tr>
<td>4.75 mm (No. 4)</td>
<td>................................................................. 0-8</td>
</tr>
</tbody>
</table>

1005.1.6 Coarse aggregate for Class A-1 concrete may be gravel or crushed stone and shall meet the following gradation requirements:

Gradation E

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Percent Passing by Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>19 mm (3/4 in.)</td>
<td>................................................................. 100</td>
</tr>
<tr>
<td>12.5 mm (1/2 in.)</td>
<td>................................................................. 80-100</td>
</tr>
<tr>
<td>9.5 mm (3/8 in.)</td>
<td>................................................................. 40-70</td>
</tr>
<tr>
<td>4.75 mm (No. 4)</td>
<td>................................................................. 0-10</td>
</tr>
<tr>
<td>2.00 mm (No. 10)</td>
<td>................................................................. 0-3</td>
</tr>
</tbody>
</table>

1005.1.7 Coarse aggregate for ornamental concrete, when such concrete, is designated on the plans, shall be crushed stone meeting the requirements of Sec. 1005.1.6. However, the use of coarse aggregate containing more than 2 percent chert will not be permitted.

1005.1.8 Soundness. When testing in accordance with AASHTO T 104 the loss of coarse aggregate in 5 cycles of the accelerated soundness test shall not be greater than 12% when sodium sulfate is used. Aggregates to be tested shall be made available for testing a minimum of ten calendar days prior to the intended time of use. It shall be the responsibility of the contractor to notify St. Charles County when samples are available.
A soundness test taken on aggregate sampled from a well defined quarry ledge or gravel pit may be considered to represent that entire ledge or pit, and any fine or coarse aggregate fractions from that ledge or pit. Should any change in ledge or pit characteristics be observed, retesting may be required at the discretion of the engineer.

If approval of a stockpile is requested, the stockpile shall contain material for 5 days of the intended usage or 500 metric tons (tons), whichever is greater. No material shall be removed from or added to the stockpile during the testing period. Unapproved material shall be segregated from approved materials in stockpiles at all times.

This specification shall not apply to siliceous sands from the Missouri, Mississippi or Meramec Rivers.

**1005.1.9 Absorption.** The absorption value of the aggregate used in pavement concrete shall not exceed 2.0 percent measured by weight. The absorption value of the aggregate used for all other concrete shall not exceed 3.0 percent measured by weight.

**1005.2 Fine Aggregate.**

**1005.2.1** Fine aggregate for portland cement concrete shall be a fine granular material naturally produced by the disintegration of rock of a siliceous nature, except that by specific approval of the engineer, fines manufactured from igneous rock or chert gravel may be used. Fine aggregate shall be free from cemented or conglomerated lumps and shall not have any coating or injurious material. The quantity of deleterious substances shall not exceed the following limits:

<table>
<thead>
<tr>
<th>Item</th>
<th>Percent by Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clay lumps</td>
<td>0.25</td>
</tr>
<tr>
<td>Coal and lignite</td>
<td>0.25</td>
</tr>
<tr>
<td>Total lightweight particles,</td>
<td>0.50</td>
</tr>
<tr>
<td>including coal and lignite</td>
<td></td>
</tr>
</tbody>
</table>

Material passing 75 μm (No. 200) sieve:

- a. Natural sand .................................. 2.0
- b. Manufactured sand ................................ 4.0

Other deleterious substances .......................... 0.10

Lightweight sand particles are not considered deleterious lightweight particles.

The total lightweight particle requirement shall not apply to angular chert sand or manufactured sand.
1005.2.2 Fine aggregate subjected to the mortar strength test shall produce a mortar having a tensile strength at the age of 7 days of at least 90 percent of that developed at the same age by mortar of the same proportions and consistency made of the same cement and Standard Ottawa sand. Tests shall be made in accordance with procedures set out in AASHTO T 132. Cement used in the tests shall be Type 1 meeting the requirements of Sec. 1019.

1005.2.2.1 Fine aggregate subjected to the colormetric test for organic impurities and producing a color darker than the standard will be rejected unless it passes the mortar strength test specified above.

1005.2.3 Fine aggregate for ornamental concrete, when such concrete is designated on the plans, and for concrete to be used in sidewalks and drive approaches shall in addition to meeting the requirements of this section, be free from coal and lignite materials as determined by AASHTO T 113.

1005.2.4 Gradation.

1005.2.4.1 All fine aggregate, except manufactured sand, shall meet the following gradation requirements:

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Percent Passing by Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>9.5 mm (3/8 in.)</td>
<td>........................................</td>
</tr>
<tr>
<td>4.75 mm (No. 4)</td>
<td>........................................</td>
</tr>
<tr>
<td>850 (\mu)m (No. 20)</td>
<td>........................................</td>
</tr>
<tr>
<td>300 (\mu)m (No. 50)</td>
<td>........................................</td>
</tr>
<tr>
<td>150 (\mu)m (No. 100)</td>
<td>.........................................</td>
</tr>
</tbody>
</table>

1005.2.4.2 Manufactured sand shall be the product of grinding flint chat, igneous rock, or chert gravel and shall meet the following gradation requirements:

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Percent Passing by Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.75 mm (No. 4)</td>
<td>........................................</td>
</tr>
<tr>
<td>200 mm (No. 10)</td>
<td>........................................</td>
</tr>
<tr>
<td>850 (\mu)m (No. 20)</td>
<td>........................................</td>
</tr>
<tr>
<td>300 (\mu)m (No. 50)</td>
<td>........................................</td>
</tr>
<tr>
<td>150 (\mu)m (No. 100)</td>
<td>.........................................</td>
</tr>
</tbody>
</table>

1005.3 Lightweight Aggregates.

1005.3.1 Lightweight aggregates shall be prepared by expanding, calcining, or sintering argillaceous materials such as clay, shales, and slates.

1005.3.2 Grading. The grading shall be uniform and conform to the requirements given in Table I.
1005.3.3 **Unit Weight.** The unit weight of lightweight aggregates shall not exceed the following:

<table>
<thead>
<tr>
<th>Size</th>
<th>Max, Dry, Loose Weight, kg/m$^3$ (lb/cu. ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fine aggregate</td>
<td>1120 (70)</td>
</tr>
<tr>
<td>Coarse aggregate</td>
<td>880 (55)</td>
</tr>
</tbody>
</table>

1005.3.3.1 **Uniformity of Weight.** If the unit weight of any shipment of lightweight aggregate tested in accordance with AASHTO T 19 is found to differ by more than 10 percent from that of the sample submitted for source approval, the aggregate in the shipment may be rejected.

1005.3.4 **Soundness.** When testing in accordance with AASHTO T 104 the loss of coarse aggregate in 5 cycles of the accelerated soundness test shall not be greater than 8% when sodium sulfate is used. Aggregates to be tested shall be made available for testing a minimum of 20 calendar days prior to the intended time of use. It shall be the responsibility of the contractor to notify St. Charles County when samples are available.

A soundness test taken on aggregate sampled from a well defined quarry ledge or gravel pit may be considered to represent that entire ledge or pit, and any fine or coarse aggregate fractions from that ledge or pit. Should any change in ledge or pit characteristics be observed, retesting may be required at the discretion of the engineer.

If approval of a stockpile is requested, the stockpile shall contain material for 5 days of the intended usage or 500 metric tons (tons), whichever is greater. No material shall be removed from or added to the stockpile during the testing period. Unapproved material shall be segregated from approved materials in stockpiles at all times.

This specification shall not apply to siliceous sands from the Missouri, Mississippi or Meramec Rivers.

1005.3.5 **Drying Shrinkage.** The drying shrinkage of concrete specimens prepared and tested in accordance with the provisions of Sec. 8.1.4 of AASHTO M 195 shall not exceed 0.07 percent.

1005.3.6 **Sampling.** Samples of fine and coarse aggregate shall be furnished by the contractor for source approval. Other samples shall be taken from shipments at intervals stipulated by the engineer.
<table>
<thead>
<tr>
<th>Grade</th>
<th>Size</th>
<th>38 mm (1-1/2 in.)</th>
<th>25 mm (1 in.)</th>
<th>19 mm (3/4 in.)</th>
<th>12.5 mm (1/2 in.)</th>
<th>9.5 mm (3/8 in.)</th>
<th>4.75 mm (No. 4)</th>
<th>2.36 mm (No. 8)</th>
<th>1.18 mm (No. 16)</th>
<th>300 µm (No. 50)</th>
<th>150 µm (No.100)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Fine Aggregate 4.74 mm (No. 4) to 0</td>
<td>----</td>
<td>----</td>
<td>----</td>
<td>----</td>
<td>100</td>
<td>85 - 100</td>
<td>----</td>
<td>40 - 80</td>
<td>10 - 35</td>
<td>5 - 20</td>
</tr>
<tr>
<td>2</td>
<td>Coarse Aggregate 25 mm (1 in.) to 12.5 mm (1/2 in.)</td>
<td>100</td>
<td>90 - 100</td>
<td>20 - 55</td>
<td>0 - 10</td>
<td>0 - 5</td>
<td>----</td>
<td>----</td>
<td>----</td>
<td>----</td>
<td>----</td>
</tr>
<tr>
<td>3</td>
<td>25 mm (1 in.) to 4.75 mm (No. 4)</td>
<td>100</td>
<td>95 - 100</td>
<td>----</td>
<td>25 - 60</td>
<td>----</td>
<td>0 - 10</td>
<td>0 - 5</td>
<td>----</td>
<td>----</td>
<td>----</td>
</tr>
<tr>
<td>4</td>
<td>19 mm (3/4 in.) to 4.75 mm (No.4)</td>
<td>----</td>
<td>100</td>
<td>90 - 100</td>
<td>----</td>
<td>20 - 55</td>
<td>0 - 10</td>
<td>0 - 5</td>
<td>----</td>
<td>----</td>
<td>----</td>
</tr>
<tr>
<td>5</td>
<td>12.5 mm (1/2 in.) to 4.75 mm (No. 4)</td>
<td>----</td>
<td>----</td>
<td>100</td>
<td>90 - 100</td>
<td>40 - 75</td>
<td>0 - 15</td>
<td>0 - 5</td>
<td>----</td>
<td>----</td>
<td>----</td>
</tr>
<tr>
<td>5</td>
<td>9.5 mm (3/8 in.) to 2.36 mm (No. 4)</td>
<td>----</td>
<td>----</td>
<td>----</td>
<td>100</td>
<td>85 - 100</td>
<td>10 - 30</td>
<td>0 - 10</td>
<td>0 - 5</td>
<td>----</td>
<td>----</td>
</tr>
</tbody>
</table>
SECTION 1006
AGGREGATE SURFACING MATERIAL

1006.1 Aggregate for surfacing material shall be composed of durable particles of rock. When the aggregate is tested in accordance with AASHTO T 96 (Los Angeles Abrasion), the percentage of wear shall not exceed 60. The percentage of deleterious substances shall not exceed the following values and the sum of percentages of all deleterious substances shall not exceed 12 percent.

<table>
<thead>
<tr>
<th>Item</th>
<th>Percent by Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deleterious rock and shale</td>
<td>12.0</td>
</tr>
<tr>
<td>Mud balls</td>
<td></td>
</tr>
<tr>
<td>Other foreign material</td>
<td>2.0</td>
</tr>
</tbody>
</table>

1006.2 The aggregate shall comply with the following requirements as specified in the contract:

<table>
<thead>
<tr>
<th>Grade</th>
<th>Kind of Material</th>
<th>Sieve Sizes</th>
<th>Percent Passing by Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>25 mm (1 in.)</td>
<td>19 mm (3/4 in.)</td>
</tr>
<tr>
<td>A</td>
<td>Gravel</td>
<td>100</td>
<td>80-100</td>
</tr>
<tr>
<td>B</td>
<td>Crushed Stone</td>
<td>100</td>
<td>—</td>
</tr>
<tr>
<td>C</td>
<td>Chat</td>
<td>100</td>
<td>—</td>
</tr>
<tr>
<td>D</td>
<td>Gravel</td>
<td>—</td>
<td>100</td>
</tr>
<tr>
<td>E</td>
<td>Gravel</td>
<td>—</td>
<td>100</td>
</tr>
<tr>
<td>F</td>
<td>Crushed Stone</td>
<td>—</td>
<td>100</td>
</tr>
<tr>
<td>G</td>
<td>Crushed Stone or Gravel</td>
<td>—</td>
<td>100</td>
</tr>
<tr>
<td>H</td>
<td>Porphyry**</td>
<td>—</td>
<td>80-100</td>
</tr>
</tbody>
</table>

NOTE: *Indicates maximum permitted.
**100% must pass 12.5 mm (1/2”) sieve.
SECTION 1007
AGGREGATE BASE MATERIAL

1007.1 Type 1 Aggregate.

1007.1.1 Type 1 aggregate for base shall be essentially limestone or dolomite. The crushed stone shall contain not more than 15 percent deleterious rock and shale. Sand may be added to the crushed stone only for the purpose of reducing the plasticity index of the fraction passing the 475 μm (No. 40) sieve in the finished product. Any sand, silt, and clay, and any deleterious rock and shale shall be uniformly distributed throughout the weight. The aggregates shall conform to the following gradation requirements:

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Percent Passing by Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>25 mm (1 in.)</td>
<td>.......................................................... 100</td>
</tr>
<tr>
<td>12.5 mm (1/2 in.)</td>
<td>.......................................................... 60-90</td>
</tr>
<tr>
<td>4.75 mm (No. 4)</td>
<td>.......................................................... 40-60</td>
</tr>
<tr>
<td>475 μm (No. 40)</td>
<td>.......................................................... 15-35</td>
</tr>
</tbody>
</table>

The fraction passing the 475 μm (No. 40) sieve shall have a plasticity index not greater than 6.

1007.2 Type 2 Aggregate.

1007.2.1 Type 2 aggregate for base shall consist of crushed stone, sand and gravel, or chat, with or without soil binder as may be required to conform to the requirements of these specifications. If crushed stone is used, sand may be added only for the purpose of reducing the plasticity index of the fraction passing the 475 μm (No. 40) sieve in the finished product. It shall not contain more than 15 percent deleterious rock and shale. Deleterious rock, shale, sand, or binder if required, shall be uniformly distributed throughout the weight. The aggregate, combined with binder if required, shall conform to one of the following gradation requirements:

<table>
<thead>
<tr>
<th>Percent Passing by Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gradation A</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Gradation A</th>
<th>Gradation B</th>
</tr>
</thead>
<tbody>
<tr>
<td>25 mm (1 in.)</td>
<td>100</td>
<td>---</td>
</tr>
<tr>
<td>19 mm (3/4 in.)</td>
<td>---</td>
<td>100</td>
</tr>
<tr>
<td>12.5 mm (1/2 in.)</td>
<td>60-90</td>
<td>---</td>
</tr>
<tr>
<td>4.75 mm (No. 4)</td>
<td>40-60</td>
<td>55-85</td>
</tr>
<tr>
<td>2.00 mm (No. 10)</td>
<td>---</td>
<td>40-65</td>
</tr>
<tr>
<td>475 μm(No. 40)</td>
<td>15-35</td>
<td>20-45</td>
</tr>
</tbody>
</table>

The fraction passing the 75 μm (No. 200) sieve shall, when sand and gravel aggregate is used, be less than 2/3 of the fraction passing the 475 μm (No. 40) sieve. The fraction passing the 475 μm(No. 40) sieve shall have plasticity indices as follows:
Minimum | Maximum
--- | ---
 Crushed stone or chat | 0 | 6
 Sand and gravel | 2 | 6

1007.2.2 Binder shall consist of soil or similar fine material with such cohesive properties as to impart the desired plasticity to the finished base course. The binder shall be obtained from a deposit approved by the engineer.

1007.3 Type 3 Aggregate.

1007.3.1 Type 3 aggregate for base shall consist of crushed stone, limestone screenings, sand and gravel, sand, chat, or sandstone, or combinations of these materials, with or without soil binder as may be required. It shall contain not more than 15 percent deleterious rock and shale. The material shall conform to the following gradation requirements and in addition shall be so graded that it will readily compact to the specified density and withstand construction traffic without distortion and displacement.

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Percent Passing by Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>38 mm (1-1/2 in.)</td>
<td>100</td>
</tr>
<tr>
<td>475 μm (No. 40)</td>
<td>15-50</td>
</tr>
<tr>
<td>75 μm (No. 200)</td>
<td>not more than 35</td>
</tr>
</tbody>
</table>

The fraction passing the 475 μm (No. 40) sieve for Type 3 aggregate shall have a plasticity index not greater than eight. If chat is used, it shall meet the requirements of this section and in addition shall have at least 20 percent passing the 475 μm(No. 40) sieve. If soft sandstone, sand, or sand-gravel mixtures are used, they shall meet the requirements of this section and in addition the fraction passing the 475 μm(No. 40) sieve shall have a plasticity index not less than two nor greater than eight.

1007.3.2 Binder shall consist of soil or similar fine material with such cohesive properties as to impart the desired plasticity to the finished product. The binder shall be obtained from a deposit approved by the engineer.

1007.4 Type 4 Aggregate.

1007.4.1 Type 4 aggregate for base shall consist of a uniform mixture of washed sand and gravel, crushed stone, or chat. Aggregates shall consist of sound durable particles. When the aggregate is tested in accordance with AASHTO T 96 (Los Angeles Abrasion), the percentage of wear shall not exceed 55. The percentage of deleterious substances shall not exceed the following values and the sum of these percentages shall not exceed 8 percent.
The material shall at all times during loading, hauling, and placing, contain sufficient moisture to prevent segregation and to aid in obtaining compaction.

1007.4.2 Washed sand and gravel mixtures shall meet the following gradation requirements:

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Percent Passing by Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>25 mm (1 in.)</td>
<td>100</td>
</tr>
<tr>
<td>12.5 mm (1/2 in.)</td>
<td>55-90</td>
</tr>
<tr>
<td>2.00 mm (No. 10)</td>
<td>25-50</td>
</tr>
<tr>
<td>475 µm (No. 40)</td>
<td>10-30</td>
</tr>
<tr>
<td>150 µm (No. 100)</td>
<td>0-10</td>
</tr>
<tr>
<td>75 µm (No. 200)</td>
<td>0-3</td>
</tr>
</tbody>
</table>

1007.4.3 Crushed stone shall consist of limestone or dolomite and shall be graded to meet the following gradation requirements:

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Percent Passing by Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>25 mm (1 in.)</td>
<td>100</td>
</tr>
<tr>
<td>12.5 mm (1/2 in.)</td>
<td>55-90</td>
</tr>
<tr>
<td>4.75 mm (No. 4)</td>
<td>8-40</td>
</tr>
<tr>
<td>2.00 mm (No. 10)</td>
<td>0-15</td>
</tr>
<tr>
<td>75 µm (No. 200)</td>
<td>0-4</td>
</tr>
</tbody>
</table>

A tolerance not to exceed 2 percent passing the 75 µm (No. 200) sieve will be permitted for samples taken at the point of delivery on the roadway.

1007.4.4 Chat shall be graded to meet the following requirements:

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Percent Passing by Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>19 mm (3/4 in.)</td>
<td>100</td>
</tr>
<tr>
<td>12.5 mm (1/2 in.)</td>
<td>90-100</td>
</tr>
<tr>
<td>2.00 mm (No. 10)</td>
<td>20-50</td>
</tr>
<tr>
<td>475 µm (No. 40)</td>
<td>5-30</td>
</tr>
<tr>
<td>75 µm (No. 200)</td>
<td>0-5</td>
</tr>
</tbody>
</table>
1007.5 Type 5 Aggregate.

1007.5.1 Type 5 aggregate for base shall consist of crushed stone or sand and gravel. It shall not contain more than 15 percent deleterious rock and shale. If crushed stone is used, sand may be added only for the purpose of reducing the plasticity index of the fraction passing the 475 μm (No. 40) sieve in the finished product. The fraction passing the 475 μm (No. 40) sieve shall have a plasticity index not to exceed six. Any sand, silt, and clay, and any deleterious rock and shale shall be uniformly distributed throughout the mass. When sand and gravel aggregate is used, the fraction passing the 75 μm (No. 200) sieve shall be less than 1/2 that of the fraction passing the 600 μm (No. 30) sieve.

1007.5.2 Type 5 aggregate shall conform to the following gradation requirements and in addition shall be so graded that it will readily compact to the specified density and withstand construction traffic without distortion and displacement.

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Percent Passing by Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>25 mm (1 in.)</td>
<td>................................................................. 100</td>
</tr>
<tr>
<td>12.5 mm (1/2 in.)</td>
<td>................................................................. 60-90</td>
</tr>
<tr>
<td>4.75 mm (No. 4)</td>
<td>................................................................. 40-60</td>
</tr>
<tr>
<td>600 μm (No. 30)</td>
<td>................................................................. 15-35</td>
</tr>
<tr>
<td>75 μm (No. 200)</td>
<td>................................................................. 0-15</td>
</tr>
</tbody>
</table>
SECTION 1009
POROUS BACKFILL MATERIAL

1009.1 Class A Drains. Porous backfill material adjacent to and for a height of 0.6 m (2 ft.) above the top of the perforated pipe shall be gravel, crushed stone, or other material of approved quality, and shall meet the gradation requirements of Sec. 1003.2 (Gradation 3).

The remainder of the porous backfill material shall conform to the requirements of this section or to those of Sec. 1009.2.

1009.2 Class B and Class C Drains. Porous backfill material used in constructing pipe or French underdrains shall be of approved quality, and shall meet the gradation requirements of Sec. 1005.1.5 (Gradation D).
SECTION 1015
BITUMINOUS MATERIALS

1015.1 General.

1015.1.1 Approval of Source. The contractor shall obtain approval of the source of bituminous materials from the engineer before any shipments to the work are made.

1015.1.2 Sampling, Testing, and Acceptance Procedures. It shall be the responsibility of the supplier to guarantee by certification that the material fully complies with the specification requirements after being loaded and delivered to the point of acceptance.

1015.1.2.1 The supplier shall furnish the truck driver a copy of the bill of lading, manifest, or truck ticket that is to be available to the St. Charles County personnel at destination prior to unloading. The engineer at the source is also to be furnished a copy. The bill of lading, manifest, or truck ticket shall show the following information regarding the shipment: type and grade of material, purchase and confirmation order numbers or project number, consignee, truck number, identification number, the weight of truck before and after loading, destination, date loaded, name and location of the source and a certification statement. The certification statement shall be substantially as follows:

“This certifies that the asphaltic material in this shipment was loaded from tank(s) number(s) _____, and complies with St. Charles County specifications for the grade specified.”

The certification statement shall be signed by an authorized representative of the supplier.

1015.1.2.2 The County may, at the discretion of the County Engineer, observe the sampling and testing at the source of truck shipments and tanks, and will select representative samples of the material being supplied. These samples will be tested by the engineer in the field or in the Central Laboratory. When test results certified by the supplier are not representative of the material being shipped, the source approval will be withdrawn. A source may be reinstated when proof is furnished that the deficiency has been corrected and adequate controls are in effect to guarantee delivery of materials meeting specifications.

1015.1.2.3 The supplier shall furnish the required sampling equipment and shall be responsible for keeping all sampling equipment clean and in good condition. Sampling devices on truck transports will be approved provided an adequately insulated valve is used with a pipe or nipple inserted a suitable distance into the truck.

1015.1.2.4 Each truck transport shall carry a log showing the types of materials and dates hauled, with respect to recent shipments, or the supplier shall sample the truck under the direction of the engineer. The supplier shall furnish the engineer such information with respect to
the previous load.

1015.1.2.5 At sources from which material is being accepted by certification, the applicable requirements of the foregoing sections shall be followed for shipments of material in transportation units other than trucks. The certification and all information regarding each shipment shall be furnished to the engineer at the source.

1015.1.2.6 For railroad shipments from refineries where inspection is not being maintained by the County, the supplier shall sample and seal each car load at the source and submit the sample promptly to the Central Laboratory. A bill of lading or identification sheet shall accompany each sample and contain the following information: car number, type and grade of material, quantity represented including gross liters (gallons), temperature, and net liters (gallons) at 15°C (60°F), destination of shipment, purchase order or project number, and consignee. An approved certification statement similar to that in Sec. 1015.1.2.2 shall accompany each sample. Approval of the source will be withdrawn when samples submitted are not representative of the material shipped in the car.

1015.1.3 Measurement of Bituminous Materials. Field weight or field volumetric determinations of the material actually incorporated into the work will be used for measurement of the quantity of bituminous material for payment. The volume of material supplied from intermediate storage tanks will be determined by measuring the weight before and after loading the truck transports which deliver the material to the project. The following volume correction methods, where applicable, shall be used for determining the volume of bituminous materials:

1015.1.3.1 Liquid Asphalt and Asphalt Cement - Volumetric Determination. Measurement of the material will be based on the volume at 15°C (60°F). The volume correction factors of ASTM D 1250 Vol. 9: Table 54C (Vol. 3: Table 6C) will be used for converting the material from the volume at the observed temperature to the volume at 15°C (60°F). The volume of uncalibrated distributors and tank trucks will be determined from the net weight of the material by measuring before and after loading. For computing the volume in liters (gallons) from weight, either the conversion factors of ASTM D 1250 Vol. 8: Table 54B (Vol. 2: Table 6B) or the following formula will be used:

$$V = \frac{W}{\text{S.G.} \times 998}$$

where:

- $V$ = Volume in Liters at 15°C.
- $W$ = Weight of material in kilograms.
- S.G. = Specific Gravity of material at 15/15°C.
English Units

\[ G = \frac{W}{\text{S.G.} \times 8.328} \]

where:
- \( G \) = Volume in gallons at 60\(^0\) F
- \( W \) = Weight of material in pounds
- \( \text{S.G.} \) = Specific Gravity of material at 60/60 \( ^0\) F

1015.1.3.2 Emulsified Asphalt. Measurement of the material will be based on the volume at 15\(^0\) C (60\(^0\) F) using a coefficient of expansion of 0.00054 per degree C (0.0003 per degree F) for converting the material from the volume at the observed temperature to the volume at 15\(^0\) C (60\(^0\) F).

1015.1.4 Proportioning and Blending Bituminous Material Constituents. All materials shall be properly proportioned and thoroughly blended in suitable tanks prior to delivery to transportation equipment, or may be proportioned and blended by use of automatic proportioning equipment. All automatic proportioning blenders shall meet the approval of the engineer and shall be equipped with precision instruments, including electrically interlocked motors, and automatic meters. Blending in tanks in quantities of less than 30000 L (8000 gallons), or in tank trucks, will not be permitted.

1015.1.5 Application Temperatures for Bituminous Materials. Application temperatures of other grades of emulsions and of refined tars will be specified in the contract.

When material to be applied by pressure distributor is, due to refining or blending procedures, delivered at a temperature above the specified limits, it may be applied at the higher temperature provided a satisfactory application can be obtained at the specified rate and provided sufficient precaution is exercised with respect to the fire hazard.
### Bituminous Material

#### Temperature-Degrees Celsius (Fahrenheit)

<table>
<thead>
<tr>
<th>Bituminous Material</th>
<th>Spraying</th>
<th>Plant Mixing</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Minimum</td>
<td>Maximum</td>
</tr>
<tr>
<td>Asphalt Cement 200-300 Penetration All Other Grades</td>
<td>127 (260)</td>
<td>163 (325)</td>
</tr>
<tr>
<td></td>
<td>140 (285)</td>
<td>175 (350)</td>
</tr>
<tr>
<td>Liquid Asphalt RC-MC-SC Grade</td>
<td></td>
<td></td>
</tr>
<tr>
<td>30</td>
<td>21(70)</td>
<td>65 (150)</td>
</tr>
<tr>
<td>70</td>
<td>38 (100)</td>
<td>82 (180)</td>
</tr>
<tr>
<td>250</td>
<td>65 (150)</td>
<td>104 (220)</td>
</tr>
<tr>
<td>800</td>
<td>82 (180)</td>
<td>127 (260)</td>
</tr>
<tr>
<td>3000</td>
<td>99 (210)</td>
<td>143 (290)</td>
</tr>
<tr>
<td>Asphalt Emulsions</td>
<td></td>
<td></td>
</tr>
<tr>
<td>RS-1</td>
<td>24 (75)</td>
<td>54 (130)</td>
</tr>
<tr>
<td>RS-2</td>
<td>43 (110)</td>
<td>79 (175)</td>
</tr>
<tr>
<td>SS-1</td>
<td>24 (75)</td>
<td>54 (130)</td>
</tr>
<tr>
<td>SS-1h</td>
<td>24 (75)</td>
<td>54 (130)</td>
</tr>
<tr>
<td>CRS-1</td>
<td>24 (75)</td>
<td>54 (130)</td>
</tr>
<tr>
<td>CRS-2</td>
<td>43 (110)</td>
<td>79 (175)</td>
</tr>
<tr>
<td>CSS-1</td>
<td>24 (75)</td>
<td>54 (130)</td>
</tr>
<tr>
<td>CSS-1h</td>
<td>24 (75)</td>
<td>54 (130)</td>
</tr>
</tbody>
</table>

**1015.2 Type RC Liquid Asphalt.** This material shall be produced by fluxing an asphaltic base with suitable petroleum distillates. It shall show no separation or curdling prior to use and shall not foam when heated to the application temperature. The material shall conform to the requirements of Table I for the grade specified in the contract.

**1015.3 Type MC Liquid Asphalt.** This material shall be produced by fluxing an asphaltic base with suitable petroleum distillates. It shall show no separation or curdling prior to use and shall not foam when heated to the application temperature. The material shall conform to the requirements of Table II for the grade specified in the contract.

**1015.4 Type SC Liquid Asphalt.** This material shall be uniform in appearance and consistency and shall show no sign of foaming when heated to the application temperature. The residue of specified penetration shall be smooth and homogeneous in appearance. It shall conform to the requirements of Table III for the grade specified in the contract.

**1015.5 Asphalt Cement.** This material shall be homogenous and free from water, and shall not, on heating, foam below the specified minimum flash point. It shall be prepared by refining crude petroleum by suitable methods. It shall conform to the requirements of Table IV or Table V for the penetration or viscosity grade specified in the contract. Material from any one source for any one contract shall not vary more than 0.02 in specific gravity.
<table>
<thead>
<tr>
<th>Grade</th>
<th>RC-70</th>
<th>RC-250</th>
<th>RC-800</th>
<th>RC-3000</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Min</td>
<td>Max</td>
<td>Min</td>
<td>Max</td>
</tr>
<tr>
<td>Min</td>
<td>Max</td>
<td>Min</td>
<td>Max</td>
<td>Min</td>
</tr>
<tr>
<td>Water, Percent</td>
<td>—</td>
<td>0.2</td>
<td>—</td>
<td>0.2</td>
</tr>
<tr>
<td>Flash point (tag, open cup), degrees C (degrees F)</td>
<td>—</td>
<td>—</td>
<td>27 (80)</td>
<td>—</td>
</tr>
<tr>
<td>Kinematic Viscosity at 60 °C (140 °F), centistokes</td>
<td>70</td>
<td>140</td>
<td>250</td>
<td>500</td>
</tr>
<tr>
<td>Distillation Test: Distillate, percentage by volume of total distillate to 360 °C (680 °F):</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>to 190 °C (374 °F)</td>
<td>10</td>
<td>—</td>
<td>3</td>
<td>—</td>
</tr>
<tr>
<td>to 225 °C (437 °F)</td>
<td>50</td>
<td>—</td>
<td>35</td>
<td>—</td>
</tr>
<tr>
<td>to 260 °C (500 °F)</td>
<td>70</td>
<td>—</td>
<td>60</td>
<td>—</td>
</tr>
<tr>
<td>to 315 °C (600 °F)</td>
<td>85</td>
<td>—</td>
<td>80</td>
<td>—</td>
</tr>
<tr>
<td>Residue from distillation to 360 °C (680 °F), volume percentage of sample by difference</td>
<td></td>
<td></td>
<td>55</td>
<td>—</td>
</tr>
<tr>
<td>Tests on residue from distillation: Penetration, 100g, 5 sec., at 25 °C (77 °F)</td>
<td>80</td>
<td>120</td>
<td>80</td>
<td>120</td>
</tr>
<tr>
<td>Ductility, 5 cm/min, 25 °C (77 °F), cm</td>
<td>100</td>
<td>—</td>
<td>100</td>
<td>—</td>
</tr>
<tr>
<td>Solubility in 1,1,1-Trichloroethane, percent</td>
<td>99.0</td>
<td>—</td>
<td>99.0</td>
<td>—</td>
</tr>
</tbody>
</table>
TABLE II - Type MC Liquid Asphalt

<table>
<thead>
<tr>
<th>Grade</th>
<th>MC-30</th>
<th>MC-70</th>
<th>MC-250</th>
<th>MC-800</th>
<th>MC-3000</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Min</td>
<td>Max</td>
<td>Min</td>
<td>Max</td>
<td>Min</td>
</tr>
<tr>
<td>Water, Percent</td>
<td>—</td>
<td>0.2</td>
<td>—</td>
<td>0.2</td>
<td>—</td>
</tr>
<tr>
<td>Flash point (tag, open cup). degrees C (degrees F)</td>
<td>38 (100)</td>
<td>—</td>
<td>38 (100)</td>
<td>—</td>
<td>66 (150)</td>
</tr>
<tr>
<td>Kinematic Viscosity at 60[^0]C (140[^0]F), centistokes</td>
<td>30</td>
<td>60</td>
<td>70</td>
<td>140</td>
<td>250</td>
</tr>
<tr>
<td>Distillation Test:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Distillate, percentage by volume of total distillate to</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>360[^0]C (680[^0]F):</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>to 225[^0]C (437[^0]F)</td>
<td></td>
<td>25</td>
<td>0</td>
<td>20</td>
<td>0</td>
</tr>
<tr>
<td>to 260[^0]C (500[^0]F)</td>
<td></td>
<td>40</td>
<td>70</td>
<td>20</td>
<td>60</td>
</tr>
<tr>
<td>to 315[^0]C (600[^0]F)</td>
<td></td>
<td>75</td>
<td>93</td>
<td>65</td>
<td>90</td>
</tr>
<tr>
<td>Residue from distillation to 360[^0]C (680[^0]F), volume percentage of sample by difference</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tests on residue from distillation: Penetration, 100 g. 5 sec., at 25[^0]C (77[^0]F)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ductility, 5 cm/min. cm (NOTE 1)</td>
<td>100</td>
<td>—</td>
<td>100</td>
<td>—</td>
<td>100</td>
</tr>
<tr>
<td>Solubility in 1,1,1—Trichloroethane, percent</td>
<td>99.0</td>
<td>—</td>
<td>99.0</td>
<td>—</td>
<td>99.0</td>
</tr>
</tbody>
</table>

Note 1 - If the ductility at 25[^0]C (77[^0]F) is less than 100 cm., the material will be acceptable if its ductility at 15[^0]C (60[^0]F) is more than 100 cm.
<table>
<thead>
<tr>
<th>Grade</th>
<th>SC-70 Min</th>
<th>SC-70 Max</th>
<th>SC-250 Min</th>
<th>SC-250 Max</th>
<th>SC-800 Min</th>
<th>SC-800 Max</th>
<th>SC-3000 Min</th>
<th>SC-3000 Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water, Percent</td>
<td>—</td>
<td>0.5</td>
<td>—</td>
<td>0.5</td>
<td>—</td>
<td>0.5</td>
<td>—</td>
<td>0.5</td>
</tr>
<tr>
<td>Flash point (Cleveland, open cup), degrees C (degrees F)</td>
<td>65 (150)</td>
<td>—</td>
<td>80 (175)</td>
<td>—</td>
<td>93 (200)</td>
<td>—</td>
<td>107 (225)</td>
<td>—</td>
</tr>
<tr>
<td>Kinematic Viscosity at 60 °C (140°F), centistokes</td>
<td>70</td>
<td>140</td>
<td>250</td>
<td>500</td>
<td>800</td>
<td>1600</td>
<td>3000</td>
<td>6000</td>
</tr>
<tr>
<td>Asphalt residue of 100 pen., percent by weight</td>
<td>50</td>
<td>—</td>
<td>60</td>
<td>—</td>
<td>70</td>
<td>—</td>
<td>80</td>
<td>—</td>
</tr>
<tr>
<td>Ductility of 100 pen. residue 5 cm/min. 25 °C (77°F), cm</td>
<td>100</td>
<td>—</td>
<td>100</td>
<td>—</td>
<td>100</td>
<td>—</td>
<td>100</td>
<td>—</td>
</tr>
<tr>
<td>Solubility in 1,1,1-Trichloroethane, percent</td>
<td>99.0</td>
<td>—</td>
<td>99.0</td>
<td>—</td>
<td>99.0</td>
<td>—</td>
<td>99.0</td>
<td>—</td>
</tr>
<tr>
<td>Total distillate to 360 °C (680°F) percent by volume</td>
<td>10</td>
<td>30</td>
<td>4</td>
<td>20</td>
<td>2</td>
<td>12</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>Kinematic Viscosity on distillation residue 60 °C (140°F), centistokes</td>
<td>4</td>
<td>70</td>
<td>8</td>
<td>100</td>
<td>20</td>
<td>160</td>
<td>40</td>
<td>350</td>
</tr>
</tbody>
</table>
TABLE IV

Asphalt Cement (Penetration Graded)

<table>
<thead>
<tr>
<th>Penetration Grade</th>
<th>40-50</th>
<th>60-70</th>
<th>85-100</th>
<th>120-150</th>
<th>200-300</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Min</td>
<td>Max</td>
<td>Min</td>
<td>Max</td>
<td>Min</td>
</tr>
<tr>
<td>Penetration at 25(^0) C (77(^\circ) F), 100 g., 5 sec</td>
<td>40</td>
<td>50</td>
<td>60</td>
<td>70</td>
<td>85</td>
</tr>
<tr>
<td>Flash point (Cleveland, open cup), degrees C, (degrees F)</td>
<td>232 (450)</td>
<td>—</td>
<td>232 (450)</td>
<td>—</td>
<td>232 (450)</td>
</tr>
<tr>
<td>Ductility, 5 cm/min., 25(^0) C (77(^\circ) F), cm</td>
<td>100</td>
<td>—</td>
<td>100</td>
<td>—</td>
<td>100</td>
</tr>
<tr>
<td>Thin-film oven test. 3 mm (1/8 in.), 163(^0) C (325(^\circ) F), 5 hour: Loss on Heating, percent</td>
<td>—</td>
<td>.80</td>
<td>—</td>
<td>.80</td>
<td>—</td>
</tr>
<tr>
<td>Penetration of residue percent of original</td>
<td>58</td>
<td>—</td>
<td>54</td>
<td>—</td>
<td>50</td>
</tr>
<tr>
<td>Ductility of residue 5 cm/min., 25(^0) C (77(^\circ) F), cm</td>
<td>—</td>
<td>—</td>
<td>50</td>
<td>—</td>
<td>7S</td>
</tr>
<tr>
<td>Solubility in 1,1,1 - Trichloroethane, percent</td>
<td>99.0</td>
<td>—</td>
<td>99.0</td>
<td>—</td>
<td>99.0</td>
</tr>
</tbody>
</table>
### TABLE V

**Asphalt Cement (Viscosity Graded)**

<table>
<thead>
<tr>
<th>Viscosity Grade</th>
<th>AC-2.5</th>
<th>AC-5</th>
<th>AC-10</th>
<th>AC-20</th>
<th>AC-30</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Min</td>
<td>Max</td>
<td>Min</td>
<td>Max</td>
<td>Min</td>
</tr>
<tr>
<td><strong>Absolute Viscosity, 60°C (140°F), poises</strong></td>
<td>200</td>
<td>300</td>
<td>400</td>
<td>600</td>
<td>800</td>
</tr>
<tr>
<td><strong>Kinematic Viscosity, 135°C (275°F), centistokes</strong></td>
<td>125</td>
<td>—</td>
<td>150</td>
<td>—</td>
<td>200</td>
</tr>
<tr>
<td><strong>Penetration, 20°C (77°F), 100g, 5 sec</strong></td>
<td>200</td>
<td>—</td>
<td>100</td>
<td>—</td>
<td>70</td>
</tr>
<tr>
<td><strong>Flash Point (Cleveland open cup) degrees C (degrees F)</strong></td>
<td>163</td>
<td>—</td>
<td>177 (350)</td>
<td>—</td>
<td>219 (425)</td>
</tr>
<tr>
<td><strong>Solubility is 1,1,1-Trichloroethane, percent</strong></td>
<td>99.0</td>
<td>—</td>
<td>99.0</td>
<td>—</td>
<td>99.0</td>
</tr>
<tr>
<td><strong>Tests on residue from Thin—film Oven Test: Loss on heating, percent</strong></td>
<td>—</td>
<td>1.5</td>
<td>—</td>
<td>1.0</td>
<td>—</td>
</tr>
<tr>
<td><strong>Absolute Viscosity 60°C (140°F), poises</strong></td>
<td>—</td>
<td>1000</td>
<td>—</td>
<td>2000</td>
<td>—</td>
</tr>
<tr>
<td><strong>Ductility, 25°C (77°F) 5 cm/min, cm</strong></td>
<td>100*</td>
<td>—</td>
<td>100</td>
<td>—</td>
<td>75</td>
</tr>
<tr>
<td><strong>Ductility, 4°C (39.2°F) 1 cm/min, cm</strong></td>
<td>50</td>
<td>—</td>
<td>25</td>
<td>—</td>
<td>15</td>
</tr>
</tbody>
</table>

*If ductility is less than 100, material will be acceptable if ductility at 15°C (60°F) is 100 minimum.
1015.6 Asphalt Filler for Undersealing Pavements. This material shall be free from water and shall not, on heating, foam below the specified minimum flash point. It shall conform to the following requirements:

Flash point (Cleveland open cup), degrees C (F), mm........................230 (445)
Softening point, degrees C (F).........................................................70-85 (158-185)
Penetration, $0^\circ$ C ($32^\circ$ F), 200 g, 60 sec, min........................9
Penetration, $25^\circ$ C ($77^\circ$ F), 100 g, 5 sec.................................20-45
Penetration, $45^\circ$ C ($115^\circ$ F), 50 g, 5 sec, max.......................90
Solubility in 1,1,1-trichloroethane, percent, min..........................99.0

1015.7 Emulsified Asphalt. This material shall meet the requirements prescribed in AASHTO M 140 or AASHTO M 208, for the type and grade specified in the contract except that Polymer Modified Emulsions (CRS-2P) shall conform to the following specifications:

<table>
<thead>
<tr>
<th></th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Viscosity, SSF @ $50^\circ$ C ($122^\circ$ F)</td>
<td>100</td>
<td>400</td>
</tr>
<tr>
<td>Storage Stability Test</td>
<td></td>
<td></td>
</tr>
<tr>
<td>24 hour, percent</td>
<td>(NA)</td>
<td>1</td>
</tr>
<tr>
<td>Classification Test</td>
<td></td>
<td>(NA)</td>
</tr>
<tr>
<td>Particle Charge Test</td>
<td></td>
<td>(NA)</td>
</tr>
<tr>
<td>Sieve Test, 20 mesh, percent</td>
<td>(NA)</td>
<td>0.3</td>
</tr>
<tr>
<td>Distillation:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oil distillation by volume of emulsion, percent</td>
<td>(NA)</td>
<td>3</td>
</tr>
<tr>
<td>Residue from distillation, percent</td>
<td>65</td>
<td>(NA)</td>
</tr>
<tr>
<td>Tests on residue from distillation:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Penetration, $25^\circ$ C ($77^\circ$ F), 100 g, 5 sec</td>
<td>100</td>
<td>200</td>
</tr>
<tr>
<td>Ductility, $4^\circ$ C ($39.2^\circ$ F), 5 cm/minute, cm</td>
<td>30</td>
<td>(NA)</td>
</tr>
<tr>
<td>Ash percent</td>
<td></td>
<td>(NA)</td>
</tr>
</tbody>
</table>

NOTE: All tests are to be performed in accordance with AASHTO T 59 except as follows:

Storage Stability Test: In addition to AASHTO T 59, upon examination of the test cylinder, after standing undisturbed for 24 hours, the surface shall show no appreciable white, milky colored substance and shall be a homogeneous brown color throughout.

Residue from Distillation Test: AASHTO T 59 modified to maintain a $240^\circ$ C $\pm$ $5^\circ$ C ($400^\circ$ F $\pm$ $10^\circ$ F) temperature for 15 minutes,

Ash in Bituminous Material Test: AASHTO T 111.

1015.8 Refined Tar. This material shall be produced from suitable gashouse, coke-oven, or water-gas tars, or combinations thereof, and shall conform to the requirements prescribed in AASHTO M 52 for the grade specified in the contract.

1015.9 Paving Fabric. This material shall be non-woven mat of a type approved by the
engineer. The fabric shall meet the following Minimum Average Roll Values:

Grab tensile strength (weakest principal direction)
   ASTM D 4632 ................................................................. 350 N (80 lbs.)
Grab elongation (weakest principal direction)
   ASTM D 4632 ................................................................. 50%
Weight (fused two sides) .................................................. 100-170 g/m² (3-5 oz./yd²)
Asphalt retention ............................................................... 900 ml/m² (0.2 gal./yd²)
Melting point, ASTM D 276 ............................................... 163⁰ C (325⁰ F)
SECTION 1018
FLY ASH FOR CONCRETE

1018.1 Description. The contractor may use fly ash only in the production of flowable backfill in accordance with the following specifications.

1018.2 General. All fly ash shall conform to the requirements of AASHTO M 295, Class C, except as herein specified.

1018.2.1 Only fly ash from sources prequalified in accordance with these specifications will be permitted.

1018.2.1.1 The loss on ignition shall be 3.0 percent, maximum.

1018.2.1.2 The percent each of Silicon Dioxide (SiO₂), Aluminum Oxide (Al₂O₃) and Iron Oxide (Fe₂O₃) shall be reported in addition to the total of the three.

1018.2.1.3 The physical requirement for fineness by air permeability shall be deleted.

1018.2.2 Fly ash may only be used with the type of cement used in the prequalification tests. The type and source of cement used by the manufacturer shall be shown on all test reports. Cement used by the manufacturer for testing fly ash shall meet the requirements of Sec 1019.

1018.2.3 Prequalified or finally approved fly ash shall not be mixed with other fly ash.

1018.2.4 The term manufacturer as used in this specification will be considered to be the actual manufacturer of the fly ash, the supplier or broker. The entity marketing the fly ash to the contractors or suppliers shall be responsible for complying with these specifications.

1018.2.5 All tests by the manufacturer shall be performed in an approved laboratory.

1018.3 Prequalification and Acceptance Procedures.

1018.3.1 Prequalification. Prior to approval and use of fly ash, the manufacturer shall submit to the County Engineer all information, test reports, and prequalifications samples herein specified.

1018.3.1.1 The manufacturer shall submit the following information, in writing:

(a) Complete name and address of the fly ash source and owner. If located in an area without precise address identification, a complete map description shall be furnished.
(b) Complete name and address or map location of the coal mine. If more than one source of coal is used, list all sources.

(c) Type of coal used.

(d) Class of fly ash produced.

(e) A description of production procedures, including but not limited to pulverization techniques, any additives mixed with the coal during production, any additive or dust suppressant used to collect the fly ash, ash collection methods, production capacity in metric tons (tons) per day, and the proportions and proportioning procedures of any blended coals.

(f) Description of storage facilities, including capacities and set-aside capabilities.

(g) Description of quality control program.

(h) Copies of test results to document a satisfactory history of quality control, including but not limited to a record of ten tests for Fineness, Moisture Content, Specific Gravity, Loss on Ignition, and Soundness and two complete chemicals and physical tests complying with AASHTO M 295-I. Samples shall have been taken in a manner and frequency in accordance with ASTM C 311.

1018.3.1.2 The manufacturer’s testing laboratory and the Department’s laboratory shall split a sample and perform all tests required in AASHTO M 295-I. The sample shall be obtained in accordance with ASTM C 311. Each one-half of the sample shall have a weight of at least 3.5 kg (8 lbs.). The sample shall be packaged in a plastic lined bag or box and the plastic liner shall be securely tied or fastened. Both sets of test results shall comply with AASHTO M 295-I and the two sets of results shall be within interlaboratory reproducibility of each other, for each test.

1018.3.1.3 Fly ash from each coal source at each point will be prequalified separately except coals from different sources may be blended prior to burning.

1018.3.1.4 Upon completion of evaluation of all information submitted by the manufacturer, the engineer will notify the manufacturer in writing whether the source is given preliminary approval. After preliminary approval is given, no further prequalification tests will be required except when the production procedure of fuel source is changed or when any change is made by the manufacturer that alters the properties or characteristics of the prequalified fly ash, in which case, prequalification will again be required.

1018.3.1.5 The engineer may inspect and approve or disapprove the production and storage facilities.

1018.3.2 Final Acceptance Procedures. All fly ash intended for use shall be sampled, tested, and placed in a designated silo or bin.
1018.3.2.1 All fly ash shall be subject to inspection and sampling at the source of manufacture, at an intermediate shipping terminal, or at destination, as determined by the engineer. The engineer shall have free access to plant records and required plant facilities to conduct inspection and sampling. The manufacturer shall conduct sufficient tests to insure that adequate quality control is maintained and that fly ash furnished conforms to all the specification requirements. The manufacturer shall maintain a record of all test results for a period of not less than five years, for review by the engineer.

1018.3.2.2 Samples shall be taken by the manufacturer from the conveyor delivering fly ash to the designated storage silo or where designated by the engineer. Each sample shall represent no more than 200 metric tons (tons). Samples shall be taken in a manner in accordance with ASTM C 311.

1018.3.2.2.1 A portion of each of the samples representing 200 metric tons (tons) shall be tested, by the manufacturer, for Fineness using 45 \( \mu \text{m} \) (No. 325) sieve analysis, Moisture Content, Specific Gravity, Loss on Ignition and Soundness. The Soundness test requiring cement shall be run with the type and source of cement to be used on the project.

1018.3.2.2.2 The manufacturer shall perform complete chemical and physical tests on a composite of the samples representing each silo or for each 1000 metric tons (tons), whichever is smaller.

1018.3.2.3 Before shipment of fly ash from a designated silo, the engineer shall be furnished, by the manufacturing plant or terminal personnel, three copies of the manufacturer’s certification. The certification shall include or have attached, results of the tests required in Sec 1018.3.2.2.1 for each sample.

1018.3.2.4 The bill of lading or delivery receipt for each shipment from the certified silo shall carry the following statement:

“This is to certify that this fly ash meets St. Charles County specifications and was loaded from tested and certified silo number ____________.”

________________________
Name of Manufacturer

________________________
Shipping Facility

By ______________________
Signature

1018.3.2.5 Upon completion of the complete chemical and physical tests required in Sec 1018.3.2.2.2, the manufacturer shall submit to the engineer, a copy of the test results.
1018.3.2.6 If any test submitted by the manufacturer deviates from the specification requirements, the engineer may require fly ash to only be accepted in accordance with Sec 1018.3.2.7.

1018.3.2.7 The engineer will obtain random samples at the point of use. If fly ash certified by the manufacturer does not conform to the specification requirements, as determined by random sampling and testing, the engineer may require that all fly ash furnished, be sampled and tested by the manufacturer and certifications furnished to the engineer for approval prior to shipment. In which case, approval will only be given based on complete chemical and physical tests. Shipment shall only be made from tested and sealed silos or bins. This procedure shall continue until the engineer determines that adequate quality control has been reestablished. Samples for tests of any fly ash offered for use may be taken at any time deemed necessary by the engineer.
SECTION 1019
PORTLAND CEMENT

1019.1 Scope. These specifications cover portland cement.

1019.1.1 All portland cement shall conform to the requirements of AASHTO M 85/ASTM C 150 with the following modifications: Sec. 12, Acceptance Procedures, shall not apply, and sampling shall be in accordance with AASHTO T 127. The sum of tricalcium silicate and tricalcium aluminate shall not exceed 58 percent in Type II cement, Optional Chemical Requirements, AASHTO M 85.

1019.1.2 Type I cement shall be used for all general concrete construction. Type II cement shall be used only when specified in the contract. Type I or Type III cement shall be used in high early strength concrete. White portland cement shall meet the requirements for Type I. Type IA, air entraining cement, shall be used only when specified in the contract.

1019.2 General Requirements.

1019.2.1 All portland cement shall conform to the requirements of AASHTO M 85/ASTM C 150 with the following modifications:

(a) Section 12, Acceptance Procedures of AASHTO M 87 shall not apply.

(b) The sum of tricalcium silicate and tricalcium aluminate shall not exceed 58 percent in Type II portland cement, Optional Requirements, AASHTO M 85.

1019.2.2 In English units of measure, a one cubic foot sack or bag of portland cement shall contain 94 pounds net and a barrel of portland cement shall consist of 376 pounds net.

1019.3 Basis of Acceptance.

1019.3.1 All cement shall be subject to inspection and sampling at the source of manufacture, at an intermediate shipping terminal, or at destination, as determined by the engineer. The engineer or a representative of same shall have free access to plant records and required plant facilities to conduct inspection and sampling.

1019.3.2 Upon approval by the engineer, cement will be accepted by certification from qualified manufacturers. A manufacturer shall become qualified by establishing a history of satisfactory quality control of cement produced as evidenced by results of tests performed by the Laboratory and the manufacturer’s testing laboratory and upon approval of production and storage facilities by the engineer. The manufacturer shall conduct sufficient tests to insure that adequate quality control is maintained and that cement furnished conforms to the specification requirements. The manufacturer shall maintain a record of all test results for review by the
engineer. In the event cement certified by the manufacturer does not conform to the specification requirements, as determined by random sampling and testing, all cement furnished by that manufacturer will be sampled, tested, and approved by the engineer prior to shipment. This procedure will continue until the engineer determines that adequate quality control has been reestablished. Samples for tests of any cement offered for use may be taken at any time deemed necessary by the engineer.

1019.3.3 Before shipment of cement from a designated silo or bin, the inspector shall be furnished, at the manufacturing plant or terminal, three copies of the manufacturer’s certification. Actual test results for each silo or bin of cement proposed for use shall be reported under a “Plant Analysis” log. Typical plant analysis shall be reported on finished cement produced during the past 30 days. All information to be shown on the certification shall be supplied by the manufacturer.

1019.3.4 The bill of lading or delivery receipt for each shipment from the certified silo or bin shall carry the following statement

“This is to certify that this cement meets St. Charles County specifications and was loaded and tested from certified silo number _____.“

______________________________
Name of Manufacturer

______________________________
Shipping Facility

by ________________________________
Signature

In case a manufacturer is shipping cement for another cement manufacturer, the bill of lading or delivery receipt may be from either company, however, all certifications and the above certification statement shall be supplied by the actual manufacturer of the cement. The certification statement shall be prominently placed on the bill of lading or delivery receipt. The engineer shall be furnished, at destination, a copy of the bill of lading or delivery receipt for each shipment. The bill of lading or delivery receipt shall accompany each truck shipment and shall be supplied to the engineer by the contractor for each rail shipment.
SECTION 1020
CORRUGATED METALLIC-COATED STEEL
CULVERT PIPE, PIPE ARCHES AND END
SECTIONS

1020.1 Scope. This specification covers corrugated steel pipe, pipe-arches and flared end sections intended for use in the construction of culverts and similar uses. The steel used in fabrication shall have a protective metal coating of zinc (galvanizing) or aluminum.

1020.2 Basis of Acceptance. Unless otherwise specified, the basis of acceptance will be in accordance with AASHTO M 36. Pipe shall be from an approved qualified plant and will be accepted based on certification, manufacturer quality control documentation and tests and tests on samples as required by the engineer.

1020.3 Material.

1020.3.1 Steel Sheet. Steel sheet shall be certifiable in accordance with AASHTO M 218 or AASHTO M 274. Finished steel sheet shall be free from injurious defects such as blisters, flux and uncoated spots.

1020.3.2 Zinc Coating. Zinc for coating or galvanizing shall be prime western grade or better. Zinc-coated steel shall have a weight of zinc coating no less than 2.00 ounces psf of double exposed surface. If the average weight of zinc coating, as determined from the required samples, is less than 2.00 ounces psf, or if any one specimen has less than 1.80 ounces of zinc psf of double exposed surface, the lot sampled will be rejected or resampled, as determined by the engineer. If a retest is conducted, the weight of zinc coating of all of the original samples and the samples for retest shall average at least 2.00 ounces psf of double exposed surface, and no specimen shall have less than 1.80 ounces psf, or the entire lot sampled will be rejected. Adherence of coating shall be such that no peeling occurs while the material is being corrugated or formed into pipe.

1020.3.3 Aluminum Coating. Aluminum for coating shall be commercially pure aluminum. The bath analysis shall be in accordance with the Aluminum Bath Analysis table shown on the plans. Aluminum-coated steel shall have a weight of aluminum coating no less than 1.00 ounce psf of double exposed surface. If the average weight of aluminum coating, as determined from the required samples, is less than 1.00 ounce psf or if any one specimen has less than 0.90 ounce of aluminum psf of double exposed surface, the lot sampled will be rejected or resampled, as determined by the engineer. If a retest is conducted, the weight of aluminum coating of all of the original samples and the samples for retest shall average at least 1.00 ounce psf of double exposed surface, and no specimen shall have less than 0.90 ounce psf, or the entire lot sampled will be rejected.
1020.3.4 Documentation.

1020.3.4.1 Sheet Manufacturer’s Certified Analysis. The manufacturer of each brand shall file with the St. Charles County Highway Department a certificate setting forth the name or brand of metal to be furnished, the specified chemical composition and a typical or average analysis showing the percent of carbon, phosphorus, manganese, sulfur and silicon. The certificate shall be sworn to, for the manufacturer, by a person having legal authority to bind the company.

1020.3.4.2 Sheet Manufacturer’s Guarantee. The manufacturer of the steel sheet shall submit with the certified analysis a guarantee providing that all metal furnished is in accordance with the specification requirements, shall bear a suitable identification brand or mark and shall be replaced without cost to the county when not in accordance with the specified analysis, sheet thickness or coating. The guarantee shall be so worded as to remain in effect as long as the manufacturer continues to furnish material. The manufacturer shall conduct such tests and measurements as necessary to ensure the material produced is in accordance with all specification requirements. These tests and measurements shall be identified by the identification symbols or code used on the sheet in a manner that will permit the manufacturer to produce specific reports showing test results representative of specific lots of steel sheet. Copies of reports of these tests shall be kept on file and shall be submitted to the engineer upon request. The brand shall be removed or obliterated by the manufacturer on all material where control tests, as outlined herein, do not conformance to this specification.

1020.4 Fabrication.

1020.4.1 Riveted Seams. A longitudinal seam shall not be permitted on the corner radius or invert of pipe arch.

1020.4.2 Resistance Spot welded Seams. A longitudinal seam shall not be permitted on the corner radius or invert of pipe arch.

1020.4.3 Shop Elongation. If round pipe is required to be shop elongated, the vertical axis shall be five percent greater than the nominal diameter. A tolerance of one percentage point in elongation will be permitted. Approximately two feet at each end of an installation may be left round to accommodate connecting end treatments or extensions. A paint mark to indicate the top of pipe shall be placed on each piece of shop elongated pipe, and round ends on an elongated pipe shall be clearly marked “Outside End-Round.”

1020.4.4 Beveled Ends. Corrugated metal pipe requiring beveled ends to conform to the adjacent roadway slope shall be cut in such a manner as to leave smooth edges without damage to the coating away from the cut edge. Cut edges shall be completely covered with two coats of single component inorganic zinc or organic zinc-rich paint meeting the approval of the engineer. No other end finish will be required for pipe with beveled ends.

1020.4.5 End Sections. Metal end sections shall be in accordance with the requirements for base metal, coating, fabrication, sampling, accepted brands of metal, sheet manufacturer’s
certified analysis, sheet manufacturer’s guarantee, sheet thickness, workmanship and repair of coating. The sections shall conform to the shape, dimensions and sheet thicknesses shown on the plans, and shall be manufactured as integral units or so the sections may be readily assembled in place.

1020.4.6 Bands. Formed bands may be used on pipe with annular corrugations and helically corrugated pipe with reformed ends. Bands shall be formed with a minimum of two corrugations matching the profile of the pipes being joined together. The corrugations shall be spaced to provide seating in the second corrugation of each pipe and without creating more than 1/2-inch annular space between the pipe ends when joined together.

1020.4.6.1 Circumferentially corrugated bands, bands with projections and helically corrugated bands shall be so constructed as to lap on an equal portion of each of the culvert sections and shall be connected at the ends by galvanized angles having minimum dimensions of 2 x 2 x 3/16 inch, fastened with galvanized bolts of 1/2-inch minimum diameter. Formed bands shall be fastened together by two 1/2-inch bolts through a bar, and strap welded to the band. Angles shall be secured to the coupling band by riveting, welding, resistance spot welding or a method approved by the engineer at each corrugation. Rivets shall be placed such that the head of the rivet will be on the inside of the band. Welds, except for resistance spot welds, shall be painted with one coat of zinc dust-zinc oxide or zinc-rich paint meeting the approval of the engineer. The 7-inch and 10 1/2-inch bands shall have at least two fastening bolts, the 12-inch and 14-inch bands shall have at least three fastening bolts and the 16 1/4-inch or greater bands shall have at least four fastening bolts. Alternate methods of fastening the ends of coupling bands may be used if approved by the engineer. Coupling bands for pipe-arch and shop elongated pipe shall be shaped to fit the structure.

1020.4.6.2 As an alternate to coupling bands, a bell and spigot joint system may be used as approved by the engineer.

1020.4.7 Special Fittings. Special fittings, angles and tees shown on the plans shall be fabricated by welding in such a manner as to avoid excessive damage to the coating away from the welded area. The welded area and adjacent damaged coating shall be repaired in accordance with Sec 1020.6.

1020.5 Sampling, Testing and Acceptance Procedures. All fabrication plants furnishing pipe for shall be qualified as herein described. A pipe distributor, who does not fabricate pipe, may attain qualification as set forth for a pipe manufacturer or may furnish pipe for county projects that is marked and certified from an approved plant. All pipe will be subject to inspection by the engineer at the source of manufacture, at an intermediate shipping terminal or at destination. The engineer shall be allowed unlimited access to all facilities and records, as required, to conduct inspection and sampling.

1020.5.1 Blank

1020.5.2 Blank
1020.5.3 Blank

1020.5.4 Disqualification of a Manufacturer or Plant. A manufacturer or plant may be disqualified to provide pipe based on the discretion of the engineer, for reasons including, but not limited to, failure to consistently meet specifications, falsification of documentation, unsatisfactory performance in the field or for other reasons indicating lack of consistent material or workmanship quality.

1020.5.5 Reinstatement of a Manufacturer or Plant. Consideration of reinstatement of a manufacturer or a plant once disqualified will be no sooner than one year from the date of disqualification, will require a written document from the manufacturer or plant stating the reasons for disqualification and the action taken to correct those deficiencies and written concurrence from the engineer that the problem has been suitably addressed.

1020.5.6 Sampling of Material. Random sampling of the pipe or material used in the production of pipe will be conducted by the engineer to verify if the pipe and material are in accordance with the applicable specifications. Sampling size and frequency will be at the discretion of the engineer. In the event pipe materials certified by the manufacturer are not in accordance with Sec 1020 as determined by random sampling, testing and inspection, all pipe incorporating that material will be rejected.

1020.5.7 Mill and Factory Inspection. The engineer may have the material inspected and sampled in the rolling mill or in the shop where fabricated. The engineer may require from the mill the chemical analysis of any heat number. The inspection, either in the mill or in the shop, shall be under the direction of the engineer. The engineer shall have unlimited access to the mill or shop for inspection, and every facility shall be extended for the purpose of inspection. Any material or pipe that has been previously rejected at the mill or shop and included in a later lot will be considered sufficient cause for rejection of the entire lot.

1020.5.8 Inspection. Inspection by the engineer will include an examination of the pipe for deficiency in specified diameter, net length of finished pipe and any evidence of poor workmanship. The inspection may include taking samples for chemical analysis, mechanical properties and determination of weight (mass) of coating. The pipe making up the shipment shall meet all requirements of these specifications. If 10 percent of the pipe in any lot fails to meet these requirements, the entire lot may be rejected.

1020.5.9 Sampling of Coated Steel. Samples of coated steel sheet may be obtained from coils, flat or corrugated cut lengths or fabricated culverts. Samples shall be taken at a frequency as required by the engineer.

1020.5.9.1 For testing weight of coating of flat or corrugated cut lengths before fabrication, three specimens, each no less than 2 1/4 inches square or of an equivalent area, shall be taken from each test sheet selected to represent the lot. The specimens shall be taken such that no part includes metal closer than 2 inches from an edge or 4 inches from an end of the cut length. These specimens shall be obtained in any one of the following patterns:
(a) One specimen shall be obtained from the center of the cut length and the other two in a straight line diagonally at the opposite corners.

(b) Specimens shall be taken in a straight line from one end of the cut length, one from the middle portion and one from near each edge.

1020.5.9.2 For testing weight of coating of coils before fabrication, three specimens, each no less than 2 1/4 inches square or of an equivalent area, shall be taken, one from the middle of the width and one from each side. No specimen shall be taken closer than 2 inches from an edge or 4 inches from an end of the coil.

1020.5.9.3 For testing weight of coating of fabricated pipe or pipe-arch, at least one specimen 2 1/4 inches square or of equivalent area, shall be selected for each 20 pieces of pipe within a given lot selected to be tested, provided that no less than three specimens, each from a different piece, shall represent any one lot. The three specimens shall constitute one sample and shall be in accordance with 1020.3.

1020.5.9.4 For chemical analysis of the base metal of flat or corrugated cut lengths before fabrication, a specimen, no less than 2 1/4 inches square or of an equivalent area, shall be taken from each of three different cut lengths for lots weighing 5 tons or less, from four cut lengths for lots weighing more than 5 tons and less than 10 tons and from five cut lengths for lots weighing 10 tons or more. Drillings or chips from the specimens shall be thoroughly mixed for analysis.

1020.5.9.5 For chemical analysis of the base metal of coils, three specimens, each no less than 2 1/4 inches square or of an equivalent area, shall be taken from across the width of the coil, or if more than one mill lift or coil is involved, three specimens shall be selected from each of at least two different coils. Drillings or chips from the specimens shall be thoroughly mixed for analysis.

1020.5.9.6 When chemical analysis of base metal of fabricated pipe or pipe-arch is required, the analysis shall be performed on the same specimens taken for determination of weight (mass) of coating.

1020.5.9.7 For testing mechanical properties of the base metal, two specimens, each 4 x 14 inches, shall be taken from one end of a cut length or coil. The 14-inch dimension shall be in the longitudinal direction of the steel sheet. No specimen shall be taken closer than 2 inches from an edge or 4 inches from an end of a sheet.

1020.5.9.8 Samples for retest of weight of coating on cut lengths shall be taken in accordance with pattern (a) of Sec 1020.5.9.1. Samples for retest of mechanical properties or chemical composition of any base metal or retest of weight of coating on coils or fabricated pipe or pipe-arch shall be taken in taken in the same manner as for the original test.

1020.5.10 Testing of Metallic-Coated Steel. Tests for weight of coating, chemical composition and mechanical properties of metallic-coated steel sheets shall be as herein specified.
1020.5.10.1 Test specimen size and method of test for determining weight of coating shall be in accordance with AASHTO T 65 for zinc coatings and AASHTO T 213 for aluminum coatings. At the option of the engineer, material may be accepted on the basis of magnetic gauge determinations made in accordance with ASTM E 376.

1020.5.10.2 The method of test for chemical analysis shall be in accordance with ASTM E 30-68, exclusive of any later revisions or additions.

1020.5.10.3 Test specimen size and method of test for determining tensile strength, yield strength and elongation shall be in accordance with ASTM A 370 for sheet steel.

1020.5.11 Acceptance of Metallic-Coated Steel Sheet. Acceptance of metallic-coated steel sheet will be based on a satisfactory sheet manufacturer’s certified analysis and guarantee and sheet identification markings, upon tests on samples of the material, or upon both. The frequency of sampling will be determined by the engineer. The fabricator shall provide the equipment and personnel required to obtain the samples as directed by the engineer.

1020.5.12 Accepted Brands of Metal. No metal will be accepted under these specifications until the sheet manufacturer’s certified analysis and manufacturer’s guarantee have been approved by the engineer. Misbranding or other misrepresentation and non-uniformity of product, will each be considered sufficient reason to discontinue the acceptance of any brand under these specifications, and notice sent to the sheet manufacturer of the discontinuance of acceptance of any brand will be considered to be notice to all culvert companies that handle that particular brand.

1020.5.13 Sampling and Testing of Continuous Lock Seam. Sampling and testing of continuous lock seam quality control shall be in accordance with AASHTO T 249.

1020.5.13.1 The pipe manufacturer or plant shall cut, log and retain quality control samples, which shall be retained for two years. Visual examination samples for quality control shall be cut during production. The manufacturer or plant shall sample a minimum of one lock per coil when the same diameter of pipe is being produced. The samples shall be taken from the beginning of the coil. If diameters are changed within a coil, at least one lock per diameter shall be taken. Quality control tension test specimens shall be taken from pipe representing each sheet thickness and diameter the first time that sheet thickness and diameter is produced. In addition, each sheet thickness thereafter shall be sampled on a monthly basis during production for tension testing of the seam. The manufacturer or plant shall record all tension test results and retain those records for two years.

1020.5.13.2 Inspection by the engineer will include random visual examination samples and tension test samples taken in the presence of the engineer. If visual examination samples indicate nonconformance, that length of pipe will be rejected, and a resample will be taken from a different length of pipe of the same sheet thickness of the same diameter. If the resample fails, each shipment of that sheet thickness thereafter shall be sampled for visual examination and tension testing until the engineer determines that satisfactory quality control is established. Pipe from which tension test specimens have been taken may be cut and the undamaged portion
accepted for use.

1020.6 Repair of Damaged Coating. Damaged coating on pipe shall be repaired in accordance with AASHTO M 36, except as follows. Coating damaged in the field shall be repaired by recoating by the hot-dip process or by the metallizing process, except that in instances of minor damage to areas in the upper two-thirds of the perimeter as installed, the engineer may permit repair in the same manner as specified for repair during fabrication. The fabricated unit shall be thoroughly cleaned prior to recoating. The hot-dip process shall be in accordance with Sec 1020.3.

1020.7 Marking. Each section of pipe to be used shall be marked with an approved manufacturer’s identification marking prior to shipment. The marking shall be permanent and located within 12 inches of the downstream end of the pipe.

1020.8 Handling. All pipe shall be handled with care to avoid damage. Pipe having damaged coating, localized bends in excess of 5 percent of the specified pipe diameter or any dent in excess of 1/2 inch will be rejected at the site of the work regardless of previous approvals. Rejected damaged pipe may be used if repaired to the satisfaction of the engineer.

1020.9 County Identification Number. The manufacturer shall contact the engineer and the engineer will assign a specific county identification number for each size of pipe in the shipment.

1020.10 Bill of Lading. A bill of lading or delivery receipt for each shipment of pipe shall be furnished to the engineer at the shipping and destination points. The bill of lading shall contain an itemized statement of the sizes and lengths of pipe with the corresponding designated county identification number provided to the manufacturer for each size of pipe for that shipment. The bill of lading shall contain a certified statement. The certified statement shall be signed by an authorized representative of the manufacturer and shall state the following:

“This certifies that the pipe, bands and end sections in this shipment are in accordance with St. Charles County specifications, were fabricated at an approved plant and were fabricated from the following brand names:”
SECTION 1024
CORRUGATED ALUMINUM ALLOY CULVERT PIPE AND CORRUGATED ALUMINUM ALLOY STRUCTURAL PLATE

1024.1 Scope. This specification covers corrugated aluminum alloy culvert pipe and corrugated aluminum alloy structural plate intended for use in construction of pipe and pipe arches.

1024.2 Basis of Acceptance. The basis of acceptance will be in accordance with Sec 1020.2, Sec 1020.5 and as specified herein.

1024.3 Material.

1024.3.1 Corrugated Aluminum Alloy Culvert Pipe. This pipe shall be in accordance with AASHTO M 196, Type I.

1024.3.2 Corrugated Aluminum Alloy Structural Plate. Plates, shapes and fasteners for aluminum alloy field bolted pipe and arch pipe shall be in accordance with AASHTO M 219.
SECTION 1036
REINFORCING STEEL FOR CONCRETE

1036.1 Reinforcing Steel for Concrete Structures.

1036.1.1 Unless otherwise specified, reinforcement shall be deformed bars meeting the requirements of one of the following:

(a) AASHTO M 31 M/M 31 (ASTM A 615M/A 615), Deformed Billet-Sled Bars for Concrete Reinforcement, Grade 40 or Grade 60.

(b) AASHTO M 42M/M 42 (ASTM A 616M/A 616), Rail-Steel Deformed Bars for Concrete Reinforcement. Bars conforming to AASHTO M 42 (ASTM A 615) shall be in straight lengths only.

(c) AASHTO M 53M/M 53 (ASTM A 617M/A 617), Axle-Steel Deformed Bars for Concrete Reinforcement. Bars conforming to AASHTO M 53 (ASTM A 617) shall be in straight lengths only.

1036.1.2 Spiral reinforcement shall conform to the requirement for reinforcing steel bars, except that it may be plain or deformed, or shall be cold drawn steel wire conforming to the requirements of AASHTO M 32 (ASTM A 82).

1036.1.3 Welded steel wire fabric shall conform to requirements of AASHTO M 55 (ASTM A 185) or AASHTO M 221 (ASTM A 497).

1036.2 Steel Wire Fabric for Concrete Pavement. Welded steel wire fabric reinforcement for concrete pavement shall meet the requirement of AASHTO M 55 (ASTM A 185). It shall be in mats of the size and design shown on the plans. It will be permissible to furnish longitudinally hinged wire fabric for sheets of a required width of 2.4 m (8 ft.) or greater. The hinge shall be made by looping the transverse wires around a longitudinal wire, and shall be capable of developing the full strength of the transverse wire. The hinge shall be located within 0.3 m (1 ft.) of the center of the width of the sheet. All steel wire fabric shall be free from dirt, paint, oil, grease, thick rust, and other foreign substances. Thin powdery rust need not be removed.

1036.3 Epoxy Coated Reinforcing Steel.

1036.3.1 The steel shall be deformed billet-steel reinforcing bars meeting the requirements of AASHTO M 31M/M 31 (ASTM A 615M/A 615); rail and axle steel bars
conforming to AASHTO M 42 and M 53 shall be in straight lengths only.

1036.3.1.1 The reinforcing bars in top of the slab as designated on the plans shall be furnished with a protective coating applied by the electrostatic spray or electrostatic fluidized-bed method. The contractor and the coating applicator shall determine the actual lengths of bars to be shipped for coating. The coated bar lengths delivered to the construction site shall be as shown on the plans. Additional bars as indicated in the bar bill for each bridge shall be furnished and coated for testing purposes. These additional bars shall not be used by the coating applicator for tests, but are to be furnished to the project as an integral part of the total shipment of coated reinforcing steel. No separate payment will be made for coating additional bars for testing.

1036.3.2 Inspection of Uncoated Steel.

1036.3.2.1 If the contractor obtains the uncoated steel from a source where the St. Charles County Highway Department normally performs inspection of reinforcing steel, the engineer shall be notified when the steel is ready for inspection, and the steel will be inspected and approved prior to shipment to the coating applicator.

1036.3.2.2 If the contractor obtains the uncoated steel from a source where the St. Charles County Highway Department does not normally have arrangements for inspection, the steel may be inspected and sampled at the coating applicator’s plant, prior to coating, by the engineer or a representative, if the engineer so elects. In such cases, the engineer or a representative shall sample each heat and each bar size for testing. Each heat is to be properly identified by the steel manufacturer by a means such as tagging bundles or bars of each heat with the heat number. Steel that cannot be identified by heat number and source will not be inspected or accepted.

1036.3.2.3 The engineer will inspect and sample the steel at the project site if inspection was not performed at the steel mill or at the coating applicator’s plant. Samples taken at the project site for testing of steel properties will be taken at the same time as samples of the coated steel, and will be from the bar size and shape listed on the bar bill that includes additional bars for testing. If any bar fails to meet all requirements for reinforcing steel, all bars of that size in the total quantity will be rejected. No additional bars will be taken for destructive testing unless requested by the contractor, and no additional payment will be made for bars taken for retest. If the shipment is retested, double the number of bars taken for the original tests will be selected. All samples taken for retest shall meet all requirements, or all bars of that size in the total quantity will be rejected.

1036.3.2.4 Regardless of where the steel is sampled, the contractor shall furnish in triplicate a copy of the steel manufacturer’s certified mill test report showing complete chemical and physical test results for each heat.

1036.3.3 Coating Process. The epoxy powder may be applied by the electrostatic spray or electrostatic fluidized-bed method to either a hot or cold bar. The coated bar shall be given a thermal treatment specified by the manufacturer of the epoxy resin which will provide a fully cured finished coating.
1036.3.4 Coating Material.

1036.3.4.1 The coating material shall be a powdered epoxy resin that has been approved by the engineer. The powdered resin shall be of the same material, quality, and formulation as that approved by the engineer.

1036.4.2 The contractor shall furnish the engineer three copies of the manufacturer’s certification that the materials supplied to the coating applicator conform to these specifications. The contractor shall also furnish the engineer a 250 g (8 oz.) sample of the resin powder from each lot provided by the manufacturer of material actually used in coating these bars.

Each sample shall be packaged in an individual air-tight container identified by the manufacturer’s lot number. The manufacturer of the epoxy resin shall supply to the coating applicator information on the resin that the manufacturer considers essential to the proper use and performance of the resin as a coating. Acceptance of the coating material will be based on the manufacturer’s certification and results of any tests deemed necessary.

1036.3.5 Patching Material. Patching or repair materials, compatible with the coating and inert in concrete, shall be as recommended and made available by the epoxy resin manufacturer. The material shall be epoxy and must be suitable for application at the plant or in the field to uncoated and damaged areas.

1036.3.6 Surface Preparation. The surface of bars to be coated shall be clean and free from rust, scale, oil, grease, and similar surface contaminants. The surface shall be blasted to a near white metal in accordance with the Steel Structure Painting Council Surface Preparation Specification SSPC-SP10. All traces of grit and dust from the blasting shall be removed. The coating shall be applied to the cleaned surface as soon as possible after cleaning, before visible oxidation of the surface occurs and not more than 8 hours after cleaning unless otherwise approved by the engineer.

1036.3.7 Coating Thickness.

1036.3.7.1 A film thickness, after curing, of 125 to 300 μm (5 to 12 mils) shall be applied in a uniform, smooth coat as outlined in ASTM G 12. Thickness of the film shall be measured, by the applicator, on a representative number of bars from each production lot, in accordance with ASTM G 12.

1036.3.7.2 The coating film shall be fully cured. A representative portion of each production lot shall be checked by the coating applicator, using the method found most effective for measuring cure, to insure that the entire production lot of coating is supplied in a fully cured condition.
1036.3.8 Continuity of Coating.

1036.3.8.1 The coating shall be checked visually after cure for continuity of coating and shall be free from holes, voids, contamination, cracks, and damaged areas. In addition, there shall be no more than six holidays (pinholes, not visually discernible) per linear meter (no more than two holidays per linear ft.) of the coated bar.

1036.3.8.2 The coating applicator shall use an in-line holiday detector with automatic marking capacity in accordance with the manufacturer’s instructions to check the coating for holidays. A 67 1/2-volt detector such as the Tinker and Rasor Model M-1 or its equivalent shall be used. If approved by the engineer, a portable holiday detector will be permitted.

1036.3.9 Flexibility of Coating. The coating applicator shall perform the flexibility of coating test on a representative number of bars selected from each production lot. The coated reinforcing bars shall be capable of being bent 120 degrees (after rebound) around a mandrel without any visible evidence of cracking of the coating, except that very minute hairline cracks, with no evidence of disbonding, at the base of the deformation will be permitted. The mandrel shall have a diameter equal to eight times the size of the bar being tested, e.g., 90 mm for No. 10 bars (4 in. for No. 4 bars). The bend shall be made at a uniform rate of speed and may take up to one minute to complete. The two longitudinal deformations may be placed in a plane perpendicular to the mandrel radius. The bending test shall be conducted at room temperature after the specimen has been exposed to room temperature for a sufficient time to insure that it has reached thermal equilibrium. A temperature in the range of 20°C to 30°C (68°F to 85°F) shall be considered room temperature.

The fracture or partial failure of the steel reinforcing bar in the bend test for flexibility of coating shall not be considered as a failure of flexibility of coating. Additional bars may, however, be required for testing and evaluation of flexibility of coating.

1036.3.10 Inspection and Testing.

1036.3.10.1 The coating applicator shall inform the engineer, in writing, at least 10 days prior to performing any of the cleaning or coating operations.

1036.3.10.2 If the engineer so elects, the preparation, coating, and curing of the bars, and testing for coating thickness, continuity, and flexibility shall be done in his or her presence. The engineer or a representative shall have free access to the shop for inspection, and every facility shall be extended for this purpose. On a random basis, lengths of coated bars, other than the additional test bars, may be taken by the engineer from the production run at the point of coating application, for non-destructive test, evaluation, and check purposes.

1036.3.10.3 In lieu of shop inspection, the engineer may elect to perform all sampling and testing at the project site. On a random basis, lengths of coated bars will be taken by the engineer from the total quantity at the project site for test, evaluation, and check purposes. The engineer will perform testing for holiday detection on bars selected at random, and the contractor shall provide personnel for such items as handling steel. Destructive sampling and testing will be limited to the number of bars furnished as additional bars for testing in accordance with Sec.
1036.3.1.1 If any bar fails to meet all the above specified tests, all coated bars of that size will be rejected. No additional bars will be taken for destructive testing unless requested by the contractor, and no additional payment will be made for bars taken for retest. If the shipment is retested, double the number of bars taken for the original tests will be selected. All samples taken for retest shall meet all requirements, or all bars of that size in the total quantity will be rejected.

1036.3.10.4 Regardless of where inspection and testing is performed, the contractor shall furnish to the engineer the coating applicator’s certification in triplicate, certifying that all materials used, the preparation of the bars, coating, and curing conform to the requirements of these specifications, and that no bar contains more than six holidays per linear meter (no more than two holidays per linear ft.). The certification shall include or have attached specific results of test of coating thickness and flexibility of coating.

1036.3.11 Shipping. All systems for handling epoxy coated bars shall have padded contact areas. Coated bars shall be prepared for shipment by use of excelsior or equivalent padded metal bands, or other methods that will prevent damage during shipment. If bundled together for shipment, the bundles shall be small and tightly banded with padded bands. Bundles shall be lifted in a manner to prevent bar abrasion in the bar bundle, and shall be stored on padded supports.
SECTION 1037
SHEAR CONNECTORS

1037.1 Scope. This specification covers the requirements for stud-type shear connectors and weldability qualification.

1037.2 Materials. Studs shall meet the requirements of AASHTO M 169 (ASTM A 108) for cold drawn carbon steel bars, Grades 1015, 1017, or 1020, either semi or fully-killed. If flux retaining caps are used, the steel for the caps shall be of a low carbon grade suitable for welding and shall comply with the requirements of ASTM A 109. The flux for welding shall be self-contained either in the base of the stud or in the ferrule, and automatically applied in the welding operation. A ferrule of heat resistant ceramic or other suitable material shall be used with each stud, and the ferrule shall be composed of material which is not detrimental to the welds, does not cause excessive slag, and which has sufficient strength to withstand thermal or structural shock.

1037.3 Qualification Procedure. This procedure prescribes weldability tests to qualify shear connector studs for welding under shop or field conditions. Such tests may be performed by a university, independent laboratory, or by other approved testing agencies. The tests shall be made on each type and size of stud. The agency performing the tests shall submit to the manufacturer of the stud a certified report giving procedures and results for all tests including the information listed under Sec. 1037.9.

1037.4 Duration of Qualification. Qualifications are considered valid until the manufacturer makes a change in the base of the stud, the flux, or the arc shield, which affects the welding characteristics.

1037.5 Preparation of Specimens.

1037.5.1 Test specimens shall be prepared by welding representative studs to the center of square specimen plates, 13 to 19 mm (1/2 to 3/4 in.) thick, meeting the requirements of AASHTO M 183 (ASTM A 36). At the option of the manufacturer, several studs may be welded to a large plate and the specimen plates cut of a size suitable for test equipment used. Studs shall be welded with power source, welding gun, and control equipment as recommended by the manufacturer. Welding voltage, current, and time shall be measured by suitable instrumentation and recorded for each specimen. Lift and plunge shall be at the optimum setting as recommended by the manufacturer.

1037.5.2 Studs shall be of uniform quality and condition, free from laps, fins, seams, cracks, twists, bends, or other injurious defects. The finish shall be as produced by cold drawing, cold rolling, or machining. The size of studs with allowable tolerance shall be as shown in Table 1. The overall height after welding will be shown on the plans.
**TABLE 1**

Stud-Size - mm (in.)

<table>
<thead>
<tr>
<th>Shank Diameter</th>
<th>Overall Height (Tolerance After Welding)</th>
<th>Head Diameter</th>
<th>Head Thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td>+.000</td>
<td>+1.6 mm (+.062 in.)</td>
<td>32 mm (1 1/4 in.)</td>
<td>9.5 mm (3/8 in.)</td>
</tr>
<tr>
<td>19 mm (3/4 in.)</td>
<td>-3.2 mm (-.125 in.)</td>
<td>±0.40 mm (1/64 in.)</td>
<td>Min</td>
</tr>
<tr>
<td>-2.5 mm (-.010 in.)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>+.000</td>
<td>+1.6 mm (+.062 in.)</td>
<td>35 mm (1 3/8 in.)</td>
<td>9.5 mm (3/8 in.)</td>
</tr>
<tr>
<td>22 mm (7/8 in.)</td>
<td>-3.2 mm (-.125 in.)</td>
<td>±0.40 mm (1/64 in.)</td>
<td>Min</td>
</tr>
<tr>
<td>-2.5 mm (-.010 in.)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**1037.5.3** Thirty test specimens shall be welded consecutively with optimum current and time. Optimum current and time shall be the mid-point of the range normally recommended by the manufacturer for production welding.

**1037.5.4** Thirty test specimens shall be welded consecutively with time held constant at optimum, but with current 10 percent below optimum.

**1037.5.5** Thirty test specimens shall be welded consecutively with time held constant at optimum, but with current 10 percent above optimum.

**1037.6 Qualification Tests.**

**1037.6.1 Tensile Test.** Ten of the specimens welded in accordance with Sec. 1037.5.3, ten in accordance with Sec. 1037.5.4, and ten in accordance with Sec. 1037.5.5, shall be subjected to a tensile test. A stud will be considered as qualified if all test specimens meet the following requirements:

- Tensile strength, min ................................. 414 MPa (60,000 psi)
- Yield Strength*, min ................................. 345 MPa (50,000 psi)
- Elongation, min ........................................ 20% in 50 mm (2 in.)
- Reduction of area, min .............................. 50%

*As determined by a 0.2% offset method.

Tensile properties shall be determined in accordance with the applicable sections of AASHTO T 244 (ASTM A 370), Mechanical Testing of Steel Products. If a fracture occurs outside the middle half of the gage length, the test shall be repeated.

**1037.6.2 Bend Test.** Twenty of the specimens welded in accordance with Sec. 1037.5.3, twenty in accordance with Sec. 1037.5.4, and twenty in accordance with Sec. 1037.5.5 shall be bent alternately 30 degrees in opposite directions until failure occurs. A stud will be considered as qualified if, on all rest specimens, fracture occurs in the shank of the stud and nor in the weld.
1037.7 Retests. If a weld failure occurs in any of the tensile or bend test groups, another test group may be prepared and tested. If weld failure repeats, the stud shall fail to qualify.

1037.8 Qualification. For a manufacturer’s studs and arc shields to be qualified, each group of thirty studs shall, by test and retest, meet the requirements specified in Sec. 1037.6.

1037.9 Report of Tests. The report of the testing laboratory to the manufacturer shall include the following:

(a) Drawings that show shapes and dimensions with tolerances of studs, arc shields, and flux.

(b) A complete description of materials used in the studs and arc shields, including the quantity and analysis of the flux.

(c) A certification that the studs and arc shields described in the report are qualified in accordance with Sec. 1037.8.

1037.10 Certification. Prior to inspection, the contractor shall submit to the engineer the following information:

(a) The name of the manufacturer.

(b) A detailed description of the studs to be furnished.

(c) A certification from the manufacturer that the studs delivered are qualified in accordance with Sec. 1037.8.

(d) A copy of the qualification test results as certified by the testing laboratory unless the source and manufacturing process for these studs has been previously approved.

(e) Certified copies of in-plant quality control test results.
SECTION 1038
BEARING PADS FOR STRUCTURES

1038.1 Scope. These specifications cover elastomeric bearing pads of neoprene, of rubber and fabric, and of rubber and fiber. Elastomeric bearing pads as herein specified shall include plain bearings (consisting of elastomer only) and laminated bearings (consisting of layers of elastomer restrained at their interfaces by bonded laminates.)

1038.2 Elastomeric Bearing Pads.

1038.2.1 Materials. The elastomer shall be 100 percent virgin chloroprene (neoprene) compound meeting the requirements listed in Table I. The pads shall be of the Durometer Grade specified on the plans. When test specimens are cut from the finished product a 10 percent variation in “Physical Properties” will be allowed.
<table>
<thead>
<tr>
<th>ASTM Standard</th>
<th>Physical Properties</th>
<th>Durometer</th>
<th>50±5</th>
<th>60±5</th>
<th>70±5</th>
</tr>
</thead>
<tbody>
<tr>
<td>D2240-75</td>
<td>Hardness</td>
<td></td>
<td>50±5</td>
<td>60±5</td>
<td>70±5</td>
</tr>
<tr>
<td>D 412.75</td>
<td>Tensile strength, min. kPa (psi)</td>
<td></td>
<td>17 250 (2500)</td>
<td>17 250 (2500)</td>
<td>17 250 (2500)</td>
</tr>
<tr>
<td>D 412.75</td>
<td>Ultimate elongation min. kPa (psi)</td>
<td></td>
<td>2800 (400)</td>
<td>2450 (350)</td>
<td>2100 (300)</td>
</tr>
<tr>
<td><strong>Heat Resistance</strong></td>
<td></td>
<td></td>
<td>+15</td>
<td>+15</td>
<td>+15</td>
</tr>
<tr>
<td>D 573-67 (1972) 70 hours @100°F (212°F)</td>
<td>Change in durometer hardness, max. points</td>
<td></td>
<td>-15</td>
<td>-15</td>
<td>-15</td>
</tr>
<tr>
<td>D 573-67 (1972) 70 hours @100°F (212°F)</td>
<td>Change in tensile strength, max. percent</td>
<td></td>
<td>-40</td>
<td>-40</td>
<td>-40</td>
</tr>
<tr>
<td>D 573-67 (1972) 70 hours @100°F (212°F)</td>
<td>Change in ultimate elongation max. percent</td>
<td></td>
<td>-40</td>
<td>-40</td>
<td>-40</td>
</tr>
<tr>
<td><strong>Compressive Set</strong></td>
<td></td>
<td></td>
<td>35</td>
<td>35</td>
<td>35</td>
</tr>
<tr>
<td>D 395-69 Method B</td>
<td>22 hours at 100°C (212°F), max. percent</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Ozone</strong></td>
<td></td>
<td></td>
<td>No Cracks</td>
<td>No Cracks</td>
<td>No Cracks</td>
</tr>
<tr>
<td>D 1149-64 (1970)</td>
<td>100 pphm ozone in air by volume, 20 percent strain 38°C ±1°C (100°F ±2°F), 100 hours, mounting procedure ASTM D 518 Procedure A</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Adhesion</strong></td>
<td></td>
<td></td>
<td>No Cracks</td>
<td>No Cracks</td>
<td>No Cracks</td>
</tr>
<tr>
<td>D 429-73 Method B</td>
<td>Bond made during vulcanization kN/m (lb./in.)</td>
<td></td>
<td>7 (40)</td>
<td>7 (40)</td>
<td>7 (40)</td>
</tr>
<tr>
<td><strong>Low Temperature Test</strong></td>
<td></td>
<td></td>
<td>No Failure</td>
<td>No Failure</td>
<td>No Failure</td>
</tr>
<tr>
<td>D 746-73 Procedure B</td>
<td>Britteness at -10°C (-40°F)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Laminates shall be rolled mild steel sheets conforming to AASHTO M 251. 618

### 1038.2.2 Manufacturing Requirements

Plain bearings may be molded individually, cut from previously molded strips or slabs, or extruded and cut to length. Cut edges shall be at least as smooth as ANSI 250 finish. Unless otherwise shown on the plans, all components of a laminated bearing shall be molded together into an integral unit, and all edges of the laminations shall be covered by a minimum of 3 mm (1/8 in.) of elastomer except at laminate restraining devices and around holes that will be entirely closed on the finished structure. The following values shall be met under laboratory testing conditions of full size bearings.

(a) Compressive strain of any layer of an elastomeric bearing shall not exceed 7 percent at 5520 kPa (800 psi) average unit pressure, or at the design dead load plus live load
(b) Shear resistance of the bearing shall not exceed 345 kPa (50 psi) for 50 durometer, 518 kPa (75 psi) for 60 durometer, or 759 kPa (110 psi) for 70 durometer compounds at 25 percent strain of the total effective elastomer thickness after an extended 4-day ambient temperature of -29°C (-20°F).

1038.2.3 Tolerances. For both plain and laminated bearings, the permissible variation from the dimensions and configuration shown on the plans shall be as follows:

<table>
<thead>
<tr>
<th></th>
<th>mm</th>
<th>(in.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Overall vertical dimensions:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Design thickness 32 mm (1 1/4 in.) or less</td>
<td>-0, +3</td>
<td>(-0, +1/8)</td>
</tr>
<tr>
<td>Design thickness over 32 mm (1 1/4 in)</td>
<td>-0, +6</td>
<td>(-0, +1/4)</td>
</tr>
<tr>
<td>2. Overall horizontal dimensions:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>914 mm (36 in.) or less</td>
<td>-0, +6</td>
<td>(-0, +1/4)</td>
</tr>
<tr>
<td>Over 914 mm (36 in)</td>
<td>-0, +12</td>
<td>(-0, +1/2)</td>
</tr>
<tr>
<td>3. Thickness of individual layers of elastomer (laminated bearings only) at any point within the bearing.</td>
<td>±20 percent of design value, but no more than ± 3 mm (1/8”)</td>
<td></td>
</tr>
<tr>
<td>4. Variations from a plane parallel to the theoretical surface (as determined by measurements at the edge of the bearings):</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Top</td>
<td>Slope relative to the bottom of no more than 0.005 radians</td>
<td></td>
</tr>
<tr>
<td>Sides</td>
<td>6</td>
<td>(1/4)</td>
</tr>
<tr>
<td>Individual non-elastic laminates</td>
<td>3</td>
<td>(1/8)</td>
</tr>
<tr>
<td>5. Position of exposed connection members</td>
<td>3</td>
<td>(1/8)</td>
</tr>
<tr>
<td>6. Edge cover of embedded laminates of connection members</td>
<td>0, +3</td>
<td>(-0, +1/8)</td>
</tr>
<tr>
<td>7. Size of holes, slots, or inserts</td>
<td>± 3</td>
<td>(± 1/8)</td>
</tr>
<tr>
<td>8. Position of holes, slots, or inserts</td>
<td>± 3</td>
<td>(± 1/8)</td>
</tr>
</tbody>
</table>

1038.3 Rubber and Fabric Pads.

1038.3.1 Rubber and fabric bearing pads shall be manufactured of new materials and be
composed of multiple layers of prestressed cotton duck having a weight of not less than 275 g/m² (8.1 oz./sq. yd). The duck warp count shall be 20 threads plus or minus 1 thread per centimeter (50 threads plus or minus one thread per inch), and filling count 16 threads plus or minus one thread per centimeter (40 threads plus or minus 2 threads per inch), each with 2 yarns per thread. The finished pads shall have 25 plies per centimeter of thickness (64 plies per inch). The duck material shall be impregnated and bound with a high quality rubber compound containing rot and mildew inhibitors and anti-oxidants, compounded into resilient pads of uniform thickness.

1038.3.2 The pads shall withstand compressive loads perpendicular to the plane of laminations of not less than 6900 kPa (1000 psi) without separation of bond or detrimental deformation. Load deflection properties, determined in accordance with procedures of Military Specifications MIL-C-882B, shall not exceed the following percentages of total pad thickness: 10 percent at 6900 kPa (1000 psi), 15 percent at 13,800 kPa (2000 psi). When loaded to 10,350 kPa (1500 psi), permanent set as load is removed in accordance with procedures of MIL-C-882B, shall not be more than 2.5 percent of the original “zero point” thickness. Type A Durometer hardness shall be 87 to 95. The ratio of lateral expansion to vertical deflection shall not exceed 0.25 when loaded to 10,350 kPa (1500 psi). The material shall not lose effectiveness throughout a temperature range of -54°C to 66°C (-65°F to 150°F). The thickness shall not vary more than 5 percent from that shown on the plans. There shall be no visible evidence of damage or deterioration resulting from environmental effects of sunshine, humidity, salt spray, fungus, or dust in accordance with MIL-E-5272.

1038.4 Rubber and Fiber Pads.

1038.4.1 Rubber and fiber bearing pads shall consist of a rubber body and fabric fibers for insulation under aluminum rail posts. They shall be made from new unvulcanized rubber and unused fabric fibers. Fibers and rubbers shall be in proper proportion to maintain specified strength and stability.

1038.4.2 Type A durometer surface hardness of the pads shall be 70 to 90. Pads of the specified thickness shall be capable of withstanding compressive loads of not less than 48,300 kPa (7000 psi) without excessive extrusion or detrimental reduction in thickness.

1038.5 Dimensions. Bearing pads shall be furnished to the specified dimensions with all anchor bolt holes accurately located.

1038.6 Certification. The contractor shall furnish a manufacturer’s certification in triplicate, showing typical test results representative of the material, and certifying that the material supplied conforms to all of the requirements specified.
SECTION 1039

EPOXY RESIN MATERIALS

1039.1 Scope. This specification covers two-component, epoxy-resin bonding systems for application to portland cement concrete.

1039.2 General Requirements. Epoxy resin materials shall be sampled and tested in accordance with AASHTO M 235 and shall meet the requirements for type, grade, class, and color as specified in the contract.

1039.3 Certification. The manufacturer shall certify the type, grade, class, and color of the epoxy bonding system furnished. Technical data sheets shall be submitted which clearly define instructions for mixing the epoxy components.

1039.4 Packaging and Marking. The two components furnished shall be supplied in separate containers that are nonreactive with the contents. Each container shall be clearly identified according to the requirements of AASHTO M 235.
SECTION 1040
GUARD RAIL, GUARD CABLE, AND
GUARD FENCE MATERIALS

1040.1 Wood Posts. Wood posts for guard rail and guard cable shall conform to the requirements of Sec. 1050.

1040.2 Steel Posts. Posts shall be structural steel, meeting the requirements of AASHTO M 183 (ASTM A 36). Posts shall be of the dimensions and weights shown on the plans and shall be galvanized by the hot-dip process in accordance with the requirements of AASHTO M III (ASTM A 123). Anchor bolts, nuts, and washers shall conform to the dimensions shown on the plans and shall be galvanized in accordance with requirements of AASHTO M 232 (ASTM A 153).

1040.3 Steel Beam Guard Rail.

1040.3.1 General. This specification covers two classes and two types of guard rail beams.

Class A - 12 Gage - base metal nominal thickness, 2.67 mm (0.105 in.)

Class B - 10 Gage - base metal nominal thickness, 3.43 mm (0.135 in.)

Type I - Zinc coated, 650 g/m\(^2\) (1.80 oz./sq. ft.), minimum single-spot.

Type 2 - Zinc coated, 1100 g/m\(^2\) (3.60 oz./sq. ft.), minimum single-spot.

Guard rail beams shall be of the class (gage) shown on the plans. They shall be galvanized in accordance with the requirements for Type I except that, at the option of the contractor, beams coated in accordance with the requirements for Type 2 may be supplied.

1040.3.2 Base Metal. The beam elements shall consist of sheet made of open hearth, electric furnace, or basic oxygen steel.

1040.3.2.1 The mechanical properties of the base metal for beams shall conform to the following tensile requirements:

Yield Point, minimum, 345 MPa (50000 psi).

Tensile Strength, minimum, 483 MPa (70000 psi).

Elongation, 50 mm (2 in.), minimum, 12 percent.
1040.3.2 Test specimens for mechanical properties shall be prepared and tested as specified in ASTM A 525, except that correction for thickness of zinc coated specimens shall be 75 μm (0.003 in.) for Type 1 beams and 150 μm (0.006 in.) for Type 2 beams.

1040.3.3 Sheet or Beam Thickness.

1040.3.3.1 The thickness for the finished beam or sheet shall conform to the requirements prescribed in Table I.

<table>
<thead>
<tr>
<th>Class of Beam</th>
<th>Type of Thickness</th>
<th>Thickness mm (in.)</th>
<th>Tolerance under specified thickness mm (in.). No limit for over thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1</td>
<td>2.74 (0.108)</td>
<td>0.23 (0.009)</td>
</tr>
<tr>
<td>A</td>
<td>2</td>
<td>2.82 (0.111)</td>
<td>0.23 (0.009)</td>
</tr>
<tr>
<td>B</td>
<td>1</td>
<td>3.51 (0.138)</td>
<td>0.25 (0.010)</td>
</tr>
<tr>
<td>B</td>
<td>2</td>
<td>3.58 (0.141)</td>
<td>0.25 (0.010)</td>
</tr>
</tbody>
</table>

1040.3.3.2 For fabricated beams, thickness measurements will be made on tangent portions of the cross-section.

1040.3.4 Sheet Width. The beam elements shall be formed from sheets having a nominal width of 483 mm (19 in). A tolerance of minus 3 mm (1/8 in.) from the nominal width will be permissible.

1040.3.5 Galvanized Beams.

1040.3.5.1 The beams may be galvanized before or after fabrication. The zinc used for the coating shall be as prescribed in AASHTO M 120 (ASTM B 6), and shall be at least equal to the grade designated as “Prime Western”.

1040.3.5.2 The weight of coating shall conform to the requirements prescribed in Table II for the type specified. The weight of coating is the total amount of galvanizing on both sides of a sheet or beam, expressed as grams per square meter (ounces per square foot) of sheet.
TABLE II

<table>
<thead>
<tr>
<th>Type</th>
<th>Check Limit, Single-Spot Test, g/m² (oz/sq. ft.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>550 (1.80)</td>
</tr>
<tr>
<td>2</td>
<td>1100 (3.60)</td>
</tr>
</tbody>
</table>

1040.3.5.3 The sheets or beams shall be of prime finish; that is, free from injurious defects such as blisters, flux, and uncoated spots. Uncoated edges resulting from shearing or punching will not be considered objectionable.

1040.3.5.4 The coating shall be smooth, free of beading or sharp projections along the edges, and shall adhere tenaciously to the surface of the metal.

1040.3.5.5 The test specimen size and method of tests for determining the weight of coating shall be as prescribed in AASHTO T 65 (ASTM A 90). At the option of the engineer material may be accepted on the basis of magnetic gauge determinations made in accordance with ASTM E 376.

1040.3.6 End Sections. End sections, buffer ends, and end shoes for bridge anchor sections shall be formed of material of a class and type the same as or superior to that used for the beam to which they are attached.

1040.3.7 Fabrication. The beams, end sections, buffer ends, and end shoes shall be shaped and punched in conformance with the requirements shown on the plans. They shall be ready for assembly when delivered. Only drilling or cutting necessary for special connections and for sampling will be permitted in the field. Warped or deformed beams will be rejected. Beams to be erected on a radius of 46 m (150 ft.) or less shall be shop curved to the approximate curvature of the installation.

1040.3.8 Connections and Splices. All beam connections or splices shall be formed with oval shoulder button headed bolts to minimize projections on the traffic face of guard rail. Bolts and nuts shall conform to the requirements of ASTM A 307, and shall be galvanized as specified in AASHTO M 232 (ASTM A 153).

1040.3.9 Washers and Back-Up Plates. Washers shall be rectangular as shown on the plans. Washers shall be galvanized in accordance with the requirements of ASTM A 153. Back-up plates shall consist of 0.3 m (1 ft.) sections of beams and shall be of the same class and type specified for the full length beams.

1040.3.10 Post Connectors for Terminal Sections. Intermediate post connectors and terminal post connectors shall be fabricated, as shown on the plans, of steel conforming to the requirements of AASHTO M 183 (ASTM A 36). They shall be galvanized in accordance with requirements of AASHTO M 111 (ASTM A 123).
1040.3.11 Marking.

1040.3.11.1 Each beam element shall be identified by the following:

a. Name or Brand of Manufacturer
b. Identification Symbols or Code for Heat Number and Coating Lot
c. AASHTO Specification Number
d. Class and Type

If approved by the engineer, the AASHTO specification number may be omitted, and other designations for Class and Type may be used.

1040.3.11.2 Markings shall not be placed at such location that they will be obscured after erection, or in a manner that the brand will be conspicuous to any traffic.

Markings placed on the traffic face of the beam shall be placed in the valley of the center corrugation and shall be die imprinted with letters and numerals not exceeding 13 mm (1/2 in.) in height.

1040.3.11.3 Marking material shall be such as to resist obliteration during storage, transportation, and erection.

1040.3.11.4 Markings for end sections, buffer ends, end shoes, and back-up plates may be on durable tags securely attached to each section or to each bundle. Markings shall include name or brand of manufacturer, Class and Type. Heat number and coating designations are not required. If approved by the engineer, the AASHTO specification number may be omitted, and other designations for Class and Type may be used.

1040.3.12 Basis of Acceptance.

1040.3.12.1 All material shall be subject to inspection and sampling at the fabricating plant or warehouse, or after delivery to the site of construction. The contractor or supplier shall provide equipment and personnel required to obtain samples as directed by the engineer.

1040.3.12.2 Acceptance by Sampling. The engineer may take one piece of guard rail beam, a back-up plate, an end section, a buffer end, and end shoes from each 200 pieces in a lot, or from each lot if less than 200 pieces are included therein, for determination of compliance with specification requirements. If one piece fails to meet requirements, two other pieces shall be tested. If either of these pieces fails to conform to the requirements of this specification, the lot of material represented by these samples will be rejected. A lot shall be considered that quantity of material, offered for inspection at one time, which bears the same heat and coating identification.
1040.3.12.3 Acceptance by Brand Registration and Guarantee.

1040.3.12.3.1 By mutual agreement between the fabricator and engineer, acceptance may be based upon a Brand Registration and Guarantee filed with the engineer by the fabricator. For acceptance of a brand, the fabricator shall furnish a Brand Registration and Guarantee meeting the approval of the engineer and showing the brand name or designation, the manner in which it will appear on the fabricated beams, the typical mechanical properties, chemical composition if specified, the class and type of guard rail, and other specified properties. The fabricator shall also guarantee that as long as material is furnished under that brand and designation, it will conform fully to the requirements of the specifications and shall be replaced without cost to the County when found not in conformity with any of the specified requirements. The Brand Registration and Guarantee shall be sworn to for the fabricator by a person having legal authority to bind the company. Upon approval of a Brand Registration and Guarantee, that brand will be accepted without further certification. If in subsequent actual field use there is evidence of misbranding, as determined by random sampling and detection of inadequate tensile strength, yield strength, elongation, improper chemical composition, inadequate or improper coating, deficient thickness, or improper fabrication, the material will be rejected and approval for further use withdrawn until subsequently reapproved. Samples for tests of any material offered for use may be taken at any time deemed desirable by the engineer.

1040.3.12.3.2 The manufacturer or fabricator shall make such tests and measurements as necessary to insure that the material produced complies with all specification requirements. These tests and measurements shall be so certified by the identification symbols or code used on the beam that the manufacturer can produce specific reports showing these test results. Copies of reports of these tests shall be kept on file and shall be submitted to the engineer upon request.

1040.3.12.3.3 The brand shall be removed or obliterated by the manufacturer or fabricator on all materials where control tests, as outlined herein, do not show conformance to this specification.

1040.4 Channel Rail. Channel rail for guard rail shall be structural steel meeting the requirements of, AASHTO M 183/M 183 (ASTM A 36M/A 36). Rail shall be galvanized by the hot-dip process in accordance with the requirements of AASHTO M 111 (ASTM A 123). Bolts, nuts, and washers shall be galvanized in accordance with the requirements of AASHTO M 232 (ASTM A 153). Bolts shall conform to the dimensions shown on the plans.

1040.5 Blocks. Wood blocks for guard rails shall conform to the requirements of Sec. 1050. Steel blocks for guard rail shall conform to the requirements of Sec. 1040.2.

1040.6 Repair of Galvanizing. All galvanized materials for guard rails shall be handled in a manner to avoid damage to the surfaces. Any galvanized material on which the spelter coating has been bruised or broken will be rejected or may, with the approval of the engineer, be repaired by the metallizing process in accordance with Sec. 1020.22.2, or by the zinc alloy stick method in accordance with Sec. 712.14.
1040.7 Guard Cable, Guard Fence, and Fittings.

1040.7.1 Guard Cable. Cable for guard cable shall be zinc coated steel wire strand; 13 mm (1/2 in.) diameter; seven wire strand, Common, Siemens-Martin or High Strength grade; Class A coating; and shall conform to the requirements of ASTM A 475.

1040.7.2 Guard Fence. Tension cables for guard fence shall be 19 mm (3/4 in.) Type I or II wire rope with Class B coating and shall conform to the requirements of AASHTO M 30. Fabric, posts, and related appurtenances for guard fence shall be as shown on the plans and shall conform to the requirements of Sec. 1043.

1040.7.3 Fittings. Eyebolts, turnbuckles, and clips for cable connections and end anchors shall be steel forgings conforming to the requirements of AASHTO M 102 (ASTM A 668), or may be pearlitic malleable iron conforming to the requirements of ASTM A 220. All miscellaneous parts comprising cable connections, fasteners, and end anchors shall be galvanized in accordance with the requirements of AASHTO M 232 (ASTM A 153).

1040.8 Certifications. When requested by the engineer, the contractor shall furnish manufacturer's certifications in triplicate, which state that the material supplied will conform to the requirements of these specifications. The certifications shall include, or have attached, specific results of laboratory tests for specified physical and chemical properties as determined from samples representative of the material. Test data required will be designated by the engineer.
SECTION 1041
CONSTRUCTION SIGNS

1041.1 Scope. This specification covers signs for warning and control of traffic during highway construction.

1041.2 Signs and Sign Panels. All signs with an area of not more than 1.5 m² (16 sq. ft.) shall be fabricated of either mild steel or aluminum, except as designated on the plans. Sign faces with an area larger than 1.5 m² (16 sq. ft.) shall be fabricated of mild steel, aluminum, or of 16 mm (5/8 in.) or 19 mm (3/4 in.), 5 ply, high density type overlaid Douglas Fir plywood. Metal signs may have embossed borders or legends. All signs shall be fabricated to provide satisfactory structural rigidity.

1041.3 Reflectorizing. All signs shall have a reflectorized background unless otherwise designated on the plans. Reflectorization shall be provided by use of reflective sheeting. Reflective sheeting shall be a commercially available product which consists of glass spheres embedded beneath a flexible, transparent plastic forming a smooth outer surface as exposed to use. It shall have a precoated pressure sensitive, tack-free solvent, or heat activated adhesive backing which shall tightly adhere to the sign panels.

1041.4 Legend and Border Painting. The legend and border of all signs shall be painted by use of silk screen process, except that roller application for embossed legends or borders will be permitted. Paint shall be good quality, commercially available, stencil ink or paint. Free-hand painting will not be permitted.

1041.5 Legends, dimensions, and gloss shall be in accordance with the “Manual on Uniform Traffic Control Devices” published by the Federal Highway Administration, the plans, or as directed by the engineer.

1041.6 Certifications. If requested by the engineer, the contractor shall furnish the manufacturer’s certifications in triplicate which state that the material supplied will conform to the requirements of these specifications. The certifications shall include or have attached specific results of laboratory tests for specified physical and chemical properties as determined from samples representative of the materials. Test data required will be designated by the engineer.
SECTION 1043
FENCE MATERIAL

1043.1 Scope. These specifications cover the materials required in the construction of chain-link fence and woven wire fence.

1043.2 Chain-Link Fence. Chain-link fence and gates shall be comprised (1) of fabric composed of individual pickets helically wound and interwoven in the form of a continuous chain-link fabric without knots or ties except knuckling or twisting and barbing at the ends of pickets and in the selvage of the fabric only, and (2) of posts, rails, ties, bands, bars, rods, tension wire and other fittings and hardware.

1043.2.1 Fabric. Fabric shall consist of woven wire in the form of approximately uniform square mesh, having parallel sides and horizontal and vertical diagonals of approximately uniform dimensions. The mesh size shall be 50 mm (2 in.), measured in either direction as the minimum clear distance between the, wires forming the parallel sides of the mesh. A tolerance of plus or minus 3 mm (1/8 in.) will be permitted. The height of fabric shall be the overall dimensions from ends of barbs or knuckles, measured without tension applied. A variation in height of plus or minus 25 mm (one inch) will be permitted. Unless otherwise specified in the contract, the size of the wire shall not be smaller than shown in Table I.

<table>
<thead>
<tr>
<th>Fabric Height (mm)</th>
<th>Gage</th>
<th>Nominal Diameter (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>914, 1067</td>
<td>11</td>
<td>3.05 (0.120)</td>
</tr>
<tr>
<td>1219, 1524</td>
<td>9</td>
<td>3.76 (0.148)</td>
</tr>
<tr>
<td>1829, 2134</td>
<td>6</td>
<td>4.88 (0.192)</td>
</tr>
</tbody>
</table>

* Permissible variation in diameter of coated wire: ± 0.13 mm (0.005 in.)

1043.2.1.1 Zinc-Coated Steel Fabric. Wire constituting the fabric shall have a minimum tensile strength of 552 MPa (80,000 psi) based on the coated wire diameter. It shall be zinc-coated (hot-dip galvanized) at the rate of not less than 610 g/m² (2.0 oz./sq. ft.) of uncoated wire surface after weaving. Excessive roughness, blisters, salammoniac spots, bruises, flaking, and other defects, if present to any considerable extent, will be cause for rejection. Excessive lumps, beads, and drops of zinc will be excluded in determination of coating weight.

1043.2.1.2 Aluminum-Coated Steel Fabric. Wire constituting the fabric shall have a minimum tensile strength of 552 MPa (80,000 psi) based on the coated wire diameter. It shall be coated with aluminum alloy applied at the rate of not less than 122 g/m² (0.40 oz./sq. ft.) of
uncoated wire surface for No. 6 and No. 9 gages, and not less than 106 g/m² (0.35 oz./sq. ft.) of uncoated wire surface for No. 11 gage wire.

1043.2.1.3 Aluminum Alloy Fabric. Wire constituting the fabric shall be of aluminum alloy having a minimum tensile strength of 375 MPa (54,000 psi) and a minimum yield strength of 325 MPa (47,000 psi). The contractor shall furnish manufacturer’s certification in triplicate showing typical, physical properties representative of the material and certifying that it conforms to the requirements specified.

1043.2.1.4 Vinyl Coated Steel Fabric-Extruded Type. Wire constituting the fabric shall have a minimum tensile strength of 310 MPa (45,000 psi) based on the coated wire diameter. The wire shall be initially coated with zinc, then vinyl coated. The vinyl coating shall be polyvinyl chloride (PVC); be uniformly gray or green as approved; have a specific gravity of 1.3 maximum when tested in accordance with ASTM D 792; have a durometer hardness of A90 ±3 when tested in accordance with ASTM D 2240. The vinyl coating shall not fade, crack, blister, or split as a result of accelerated aging tested in accordance with ASTM D 1499 for a minimum of 2000 hours at 630 C ±50 C (1450 F ±90 F). Coating thickness shall be as shown in Table II.

<table>
<thead>
<tr>
<th>TABLE II</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Metric Units</strong></td>
</tr>
<tr>
<td>Coated Wire Size Gage mm</td>
</tr>
<tr>
<td>6</td>
</tr>
<tr>
<td>9</td>
</tr>
<tr>
<td>11</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>English Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gage</td>
</tr>
<tr>
<td>6</td>
</tr>
<tr>
<td>9</td>
</tr>
<tr>
<td>11</td>
</tr>
</tbody>
</table>

The contractor shall submit a certification in triplicate certifying that the vinyl material and vinyl coated steel fabric meets the requirements of these specifications. The certification shall include or have attached, typical test results on the vinyl coating material for specific gravity, hardness, and accelerated aging as specified herein. The engineer will sample these materials in the same manner as other fence materials.

1043.2.2 Posts, Braces, Rails, and Gate Frames. Those members for use with zinc-coated steel fabric or with aluminum coated steel fabric shall be of zinc-coated steel, and those for use with aluminum alloy fabric shall be of aluminum alloy. Members for use with vinyl coated fabric may be either zinc coated steel or aluminum alloy.
1043.2.2.1 Zinc-Coated Steel Members. The base metal of zinc-coated steel posts, brace rails, gate frames, including corner connectors, stretcher bars and truss rods shall be of good commercial quality weldable steel. They shall be protected on all surfaces with a zinc coating applied in conformance with the requirements of AASHTO M 111 (ASTM A 123), except that members fabricated of pipe may be zinc-coated to meet the requirements of ASTM A 120. Uncoated cut ends of pipe, posts, and rail will be acceptable. Tolerances in weight and dimension of galvanized steel pipe will be permitted in accordance with the requirements of ASTM A 120. A tolerance of plus or minus 5 percent in the weight of rolled steel H section posts will be permitted. Permissible tolerances of other shapes shall be shown on the plans.

1043.2.2.2 Aluminum Alloy Members. Aluminum posts, brace rails, and gate frames shall be of aluminum alloy having a minimum tensile strength of 210 MPa (30,000 psi), a minimum yield strength of 170 MPa (25,000 psi), and a minimum elongation of 8 percent. Tolerances in weight and dimension of aluminum alloy pipe will be permitted in accordance with the requirements of ASTM B 241.

1043.2.2.3 Tension Wire. Tension wires shall be coiled spring wire with an uncoated wire diameter of 4.50 mm ±0.07 mm (0.177 in. ±0.003 inch). It shall have a zinc coating of not less than 244 g/m² (0.80 oz./sq. ft.) of uncoated wire surface, or an aluminum coating of not less than 122 g/m² (0.40 oz./sq. ft.) of uncoated wire surface. If vinyl coated fabric is used, the tension wire shall have a zinc coating of not less than 244 g/m² (0.80 oz./sq. ft.) and a vinyl coat of not less than 0.25 mm (0.010 in.)

1043.2.3 Wire Ties. Wire fabric ties, wire ties, and hog rings for use with zinc coated steel fabric or with aluminum-coated steel fabric shall be of zinc-coated steel wire, aluminum-coated steel wire, or aluminum alloy wire; those for use with aluminum alloy fabric shall be of aluminum alloy wire; and those for use with vinyl coated steel fabric shall be vinyl coated steel wire or vinyl coated aluminum alloy wire. Wire shall be No. 9 gage, except C-clips for attaching fabric to H section posts shall be No. 6 gage.

1043.2.3.1 Zinc-Coated Wire Ties. The wire used for zinc-coated wire fabric ties. clips, wire ties, and hog rings shall be of ductile steel, zinc-coated (hot-dip galvanized) at a rate of not less than 214 g/m² (0.7 oz./sq. ft.) of uncoated wire surface.

1043.2.3.2 Aluminum Alloy Wire Ties. Wire fabric ties, wire ties, and hog rings of aluminum shall be of aluminum alloy having a minimum tensile strength of 152 MPa (22,000 psi). C-clips for attaching fabric to H section posts shall not be used.

1043.2.3.3 Aluminum-Coated Wire Ties. The wire used for aluminum coated wire ties shall be ductile steel coated with aluminum alloy at a rate not less than 92 g/m² (0.30 oz./sq. ft.) of surface.

1043.2.3.4 Vinyl Coated Wire Ties. The wire used for vinyl coated wire ties shall be ductile steel or aluminum alloy and shall be uniformly coated with the same vinyl material as used to coat the fence fabric. Vinyl coated aluminum alloy wire shall be of aluminum alloy
having a minimum tensile strength of 152 MPa (22,000 psi).

1043.2.4 Miscellaneous Fittings and Hardware. Miscellaneous fittings and hardware for use with zinc-coated steel fabric or with aluminum-coated steel fabric shall be of zinc-coated steel, and those for use with aluminum alloy fabric shall be of aluminum alloy.

1043.2.4.1 Zinc-Coated Steel Fittings and Hardware. Miscellaneous steel fittings and hardware shall be of commercial grade steel or better quality, wrought or cast as appropriate to the article, and sufficient in strength and other properties to provide a balanced design when used with fabric, posts, and wires of the qualities specified herein. All steel fittings and hardware including any items thinner than 3 mm (1/8 in.) shall be protected with a zinc coating conforming to the requirements of AASHTO M 111 (ASTM A 123).

1043.2.4.2 Aluminum Alloy Fittings and Hardware. Miscellaneous aluminum fittings and hardware shall be wrought or cast aluminum alloy conforming to the minimum requirements set forth in Table III. The contractor shall furnish manufacturer’s certification in accordance with the requirements of Sec. 1043.2.1.3.

TABLE III

<table>
<thead>
<tr>
<th>Item</th>
<th>Tensile Strength, min MPa (psi)</th>
<th>Yield Strength, min MPa (psi)</th>
<th>Elongation in 50 mm (2 in.), percent, (0.2% offset) min</th>
</tr>
</thead>
<tbody>
<tr>
<td>Raft ends and brace ends</td>
<td>207  30000</td>
<td>138  20000</td>
<td>3</td>
</tr>
<tr>
<td>Stretcher bars and bands</td>
<td>207  30000</td>
<td>173  25000</td>
<td>10</td>
</tr>
<tr>
<td>Flat band ties</td>
<td>138  20000</td>
<td>117  17000</td>
<td>5</td>
</tr>
<tr>
<td>Turnbuckles</td>
<td>207  30000</td>
<td>138  20000</td>
<td>3</td>
</tr>
<tr>
<td>Truss or brace rods</td>
<td>290  42000</td>
<td>242  35000</td>
<td>10</td>
</tr>
<tr>
<td>Post tops</td>
<td>207  30000</td>
<td>138  20000</td>
<td>2.5</td>
</tr>
<tr>
<td>Bolts</td>
<td>428  62000</td>
<td>276  40000</td>
<td>10</td>
</tr>
<tr>
<td>Nuts</td>
<td>290  42000</td>
<td>242  35000</td>
<td>10</td>
</tr>
<tr>
<td>Gate hinge, barbed wire extension arms, and other fittings</td>
<td>207  30000</td>
<td>138  20000</td>
<td>3</td>
</tr>
</tbody>
</table>

1043.2.5 Fabrication. Fabrication of materials furnished under these specifications shall conform to the sizes, shapes, and dimension shown on the plans and shall show careful, finished workmanship in all respects. Fabric shall be knuckled at both selvages for fabric 1500 mm (60 in.) and under in height, and shall be knuckled at one selvage and twisted and barbed at the other for fabric 1800 mm (72 in.) and over in height. Barbing shall be done by cutting the wire on the bias.
1043.2.6 Gates. Frames shall be fastened at the corners by clamps and braces or by welding. When corners are to be welded, the ends of the vertical member shall be hemispherically notched, by removal of metal, to fit snugly to the horizontal members. The joint shall be uniformly and continuously fillet welded. The welded area and adjacent damaged spelter shall be regalvanized by the hot-dip galvanizing or metallizing process; or covered with two coats of zinc dust-zinc oxide paint, or two coats of zinc-rich paint. The materials and application processes for repair of welded areas shall meet the approval of the engineer. Each gate frame shall be cross braced with not less than two 9 mm (3/8 in.) adjustable truss rods. The filler for gates shall be chain-link fabric of the same kind used for the fence. This filler shall be attached to the frame with stretcher bars and wire ties or clamps. Gates 1.8 m (6 ft.) or less in height shall be equipped with two hinges, and gates more than 1.8 m (6 ft.) in height shall have three hinges. All gates (walk and drive) shall be equipped with a latch and locking attachment. Gatekeepers and center rests of an approved design shall be installed for double drive gates.

1043.2.7 Test Specimens. Specimens for testing specified properties shall consist of finished products or portions thereof of suitable size to enable proper performance of the intended tests. If any test specimen shows defects or develops flaws, two additional specimens will be cut from the remainder of the sample and tested. If either of the additional specimens fails to meet the requirements in every respect, the entire lot will be subject to rejection.

1043.2.8 Marking. Each roll of fabric shall carry a tag showing the kind of metal and coating, the name or mark of the manufacturer, and other information sufficient for proper identification of the lot or shipment. Containers or bundles of posts, rail, wire, fittings, and other appurtenances shall be identified as to manufacturer or supplier and kind of metal, and shall provide other information sufficient for proper identification of the lot or shipment.

1043.2.9 Barbed Wire. Barbed wire for use with zinc-coated, aluminum-coated or vinyl-coated steel fabrics shall be zinc-coated or aluminum-coated steel. Zinc-coated barbed wire shall consist of two 2.51, 2.18, or 1.70 mm (.099, .086, or .067 in.) line wires twisted with 4-point barbs uniformly spaced approximately 100 to 125 mm (4 to 5 in.) apart and shall conform to the requirements of AASHTO M 280 (ASTM A 121) except the minimum weight of coating shall be 244 g/m² (0.80 oz./sq. ft.) of uncoated wire surface for all sizes. Aluminum-coated barbed wire shall conform to the requirements for zinc-coated barbed wire except that the coating shall be aluminum alloy. The weight of coating shall not be less than 76 g/m² (0.25 oz./sq. ft.) of surface for both line wires and barbs. However, barbs of suitable aluminum alloy will be permitted. Barbed wire for use with aluminum alloy fabric shall be aluminum alloy 5052-H38, ASTM B 211. Aluminum alloy barbed wire shall consist of two 2.8 mm (0.110 in.) line wires twisted with 4-point, 2.0 mm (.080 in.) diameter wire barbs spaced 125 mm (5 in.) apart.

1043.3 Woven Wire Fence. Woven wire fence shall be composed of woven wire, barbed wire, brace wire, posts, ties, fittings, and hardware.

1043.3.1 Fabric. The fabric shall be made of zinc-coated or aluminum-coated steel wire. Zinc-coated fabric shall conform to the requirements of AASHTO M 279 (ASTM A 116) Class 3 coating. Line wires shall have tension curves. Aluminum-coated fabric shall conform to the requirements for zinc-coated fabric except that the coating shall be aluminum alloy applied at the
rate of not less than 76 g/m\(^2\) (0.25 oz/sq. ft.) of uncoated wire surface.

1043.3.2 Barbed Wire. Barbed wire for use with zinc-coated steel fabric or aluminum-coated steel fabric shall conform to the requirements of Sec. 1043.2.9.

1043.3.3 Wood Posts. Wood posts and braces shall conform to the requirements of Sec. 1050.6.

1043.3.4 Steel Posts. Steel posts and braces shall conform to the requirements of Sec. 1043.2.2.1. Corner, end, and pull posts shall be pipe of the sizes and weights shown on the plans. Line posts shall be of the lengths and shapes shown on the plans. They shall have a nominal weight of 2.0 kg/in (1.33 lb./ft.) and a minimum weight of 1.9 kg/in (1.28 lb./ft.), exclusive of anchor plate.

1043.3.5 Post Tops and Miscellaneous Hardware. Post tops and miscellaneous fittings and hardware shall conform to the requirements of Sec. 1043.2.4.1.

1043.3.6 Brace Wire. Brace wire shall be No. 9 gage and of materials conforming to the requirements of Sec. 1043.3.1.

1043.3.7 Staples. Staples shall be of the screw shank type or equivalent, a minimum of 32 mm (1 1/4 in.) long, galvanized, and of good commercial quality.

1043.3.8 Wire Ties. Wire used for ties shall conform to the requirements of Sec. 1043.2.3 except that it may be No. 11 gage.

1043.4 Galvanized pipe handrails and fittings shall be in accordance with Sec. 1043.2.2.1 and Sec. 1043.2.4.1.

1043.4.1 Grout shall be aluminum oxide mortar.

1043.5 Wrought iron railings and fittings shall be in accordance with ASTM A 73 and be fabricated of materials approved by the engineer.
SECTION 1044
STEEL POSTS FOR MARKERS
AND DELINEATORS

1044.1 Scope. These specifications cover galvanized steel posts used for mounting mile markers, object markers, delineators, drain and right-of-way markers, and for similar purposes.

1044.2 General Requirements. Posts shall be of open hearth, basic oxygen, or Bessemer steel, rolled from new billets or standard section tee rails. No other materials such as those known by the terms “rerolled,” “rail steel equivalent,” or “rail steel quality” shall be substituted.

1044.3 Shape and Dimensions. Posts shall be of a channel or modified channel section.

1044.3.1 Posts for mile markers, object markers and delineators shall be of the dimensions shown on the plans.

1044.3.2 Posts for drain and right-of-way markers shall have a weight not less than 2.7 kg/m (1.80 lb./ft.), nor more than 3.35 kg/m (2.25 lb./ft.), all tolerances included, and shall be of the lengths shown on the plans. Permissible variations in length shall be a maximum of 25 mm (1 in.) under and 50 mm (2 in.) over that shown on the plans. Posts shall have not less than five 10 mm (3/8-in.) holes, drilled or punched, along the centerline of the web. Holes shall be on 50 mm (2 in.) centers beginning 25 mm (1 in.) from the top of posts. Anchors or pointed ends on posts will not be required.

1044.4 Galvanizing. Posts shall be galvanized after fabrication in accordance with the requirements of AASHTO M 111 (ASTM A 123).

1044.5 Samples and Inspection. When requested, two posts shall be furnished for testing purposes from such lots as the engineer may determine.
1045.1 Paint and Paint Material.

1045.1.1 General. All single component paints shall be ready-mixed at the factory to comply with the specification formula for the type of paint ordered; shall be well ground to a uniform consistency and smooth texture; shall be free from dirt, water and other foreign matter; shall be of such consistency that they will have good application, covering and leveling properties; and shall dry within the specified period to a good film without running, streaking or sagging. If tinted paint is specified, the tinting material shall be thoroughly and uniformly incorporated within the body of the paint to form a shade which shall match that of a sample submitted for the purpose. Any paint which has livered or in any way hardened or thickened in the container, or in which the pigment has settled out so that the paint cannot be readily broken up with a paddle to a smooth uniform paint of good application consistency, will be rejected. The grinding equipment used in the manufacture of the paint shall meet the approval of the engineer. In no case will the use of a colloid mill, steel ball mill or high speed mill be permitted.

1045.1.1.1 All percentages and proportions are on a mass (weight) basis unless otherwise stated.

1045.1.2 Sampling. Each batch or lot of pigment and vehicle constituents for mixed paints shall be sampled and approved prior to being incorporated into a paint mixture when requested by the County Engineer. Each batch or lot of paint shall be sampled and approved prior to use. Each batch or lot of each component of multiple-component paints shall be sampled and approved prior to use.

1045.1.3 Packaging. All containers shall be approved by the engineer as to type and mass (weight) and shall be free of physical defects. The lining of the container shall not react with the paint. All containers shall be cleaned of any paint spilled during filling operations. Except when supplied in containers of less than 19 L (5 gal.), all mixed paint shall be packaged in strong substantial 0.6 mm (24 gage) or heavier, new metal containers having lug-type replaceable tops. They shall bear a label on which shall be clearly shown the name of the manufacturer, the kind of paint, the lot number, date of manufacture and net mass (weight) of contents. The lot number and date of manufacture shall be stamped, stenciled, or painted directly onto the container using a weatherproof, durable material.

1045.1.3.1 Multiple-component paint shall be packaged in multiple-compartment containers or in separate containers. The components shall be packaged in such proportions that the pigment, mixed with the vehicle and activator, if used, will yield 4 or 19 L (1 or 5 gal.) of mixed paint. Each container shall bear a label on which shall be clearly shown the name of the manufacturer or brand name of paint, the lot number, date of manufacture, shelf life and, in the case of organic zinc silicate paint, the individual net masses (weights) of pigment and vehicle.
The lot number and date of manufacture shall be stamped, stenciled, or painted directly onto the container using a weatherproof, durable material. The label on the vehicle container shall also include complete instructions for use of the paint.

**1045.1.4 Determination of Quantities.** Quantities of paint shall be determined by volume. One liter (gallon) shall equal 0.001 m$^3$ (231 cu. in.) at 25$^0$ C (77$^0$ F).

**1045.2 Inorganic Zinc Silicate Paint.** Inorganic zinc silicate paint shall be a two-component self-curing type which, when mixed, and applied in accordance with the requirements of Sec 712, cures without the use of a separate curing solution, and shall have the properties described herein.

**1045.2.1 Pigment.** The zinc pigment component shall comply with the requirements of ASTM D 520 for Type I.

**1045.2.2 Vehicle.** The vehicle component shall consist primarily of an alkyl silicate in an appropriate alcohol solvent. Total solids, by mass (weight), in the vehicle component shall not be less than 21 nor more than 45 percent. The solids content shall be determined by drying the sample to a constant mass (weight) at 100$^0$ C (212$^0$ F).

**1045.2.3 Mixed Paint.** Mixed paint shall conform to the following requirements:

a) The zinc portion shall be at least 85 percent by mass (weight) of the total solids of the dried coating.

b) The total solids, when heated at 100$^0$ C (212$^0$ F) for 3 hours, shall be not less than 80 percent by mass (weight).

c) The paint shall tolerate up to one percent water contamination without gellation.

d) The usable pot life of the mixed paint shall be not less than 12 hours at 25$^0$ C (77$^0$ F). There shall be no hard settling which cannot be easily redispersed during this period.

e) The inorganic zinc coating shall be so formulated as to produce a distinct contrast in color with the blast cleaned metal surfaces and with the vinyl finish coat.

**1045.2.4 Resistance Tests.** Test panels of steel meeting the requirements of ASTM D 609 shall be prepared by cleaning all surfaces to the same degree specified under Sec 712. A 76 µm (3 mil) coating (dry thickness) shall then be applied to the test panels in accordance with the manufacturer's current printed instructions. The coating shall be cured as recommended by the manufacturer. Each of the following tests shall be performed on one or more test panels. The material will not be accepted if any individual test panel fails any of the following tests:

a) Fresh Water Resistance. Panels shall be scribed down to base metal with an X of at least 50 mm (2 in.) legs and shall be immersed in fresh tap water at 24$^0$ ± 3 C (75$^0$ ± 5
The panels shall show no rusting, blistering, or softening when examined after 30 days.

b) Salt Water Resistance. Panels shall be scribed down to base metal with an X of at least 50 mm (2 in.) legs and immersed in 5 percent sodium chloride at 24° ± 3 C (75° ± 5 F). The panels shall show no rusting, blistering, or softening upon examination after 7, 14 and 30 days. The sodium chloride solution shall be replaced with fresh solution after each examination.

c) Weathering and Salt Fog Resistance. Panels shall be tested in the weatherometer in accordance with ASTM G 23, Type D for 300 hours, beginning the test at the beginning of the wet cycle. After this period the panels shall be removed and scribed with an X of at least 50 mm (2 in.) legs down to base metal. The test panels shall then be tested in accordance with ASTM B 117. After 1000 hours of continuous exposure in the salt spray chamber, the coating shall show no loss of bond, nor shall the coating show rusting or blistering beyond 1.5 mm (1/16 in.) from the center of the scribe mark.

d) Resistance to Elevated Temperatures and Thermal Shock. Panels shall be exposed to a temperature of 260° C (500° F) for one hour, then quenched immediately in 18° ± 3 C (65° ± 5 F) water. Panels subjected to this test shall show no blistering or flaking of the coating.

1045.2.5 Manufacturer and Brand Name Approval for Inorganic Zinc Primer. Prior to approval and use of inorganic zinc, the manufacturer shall submit in triplicate to the County Engineer, a certified test report from an approved independent testing laboratory showing specific test results conforming to all quantitative and resistance test requirements of these specifications. The certified test report shall also contain the exact ratio, by mass (weight), of the pigment component to the vehicle component of the paint used for the tests, the lot tested, the manufacturer's name, brand name of paint, and date of manufacture. Upon approval by the engineer of this certified test report, further resistance tests will not be required, except as hereinafter noted, of that manufacturer for that brand name of paint. New certified test results shall be submitted any time the manufacturing process or the paint formulation is changed, and may be required by the engineer when sampling and testing of material offered for use indicates nonconformance to any of the requirements herein specified.

1045.3 Blank.

1045.4 Blank.

1045.5 High Solids Inorganic Zinc Silicate Coating.

1045.5.1 High solids inorganic zinc coating shall be a solvent base multiple component material which, when mixed and applied in accordance with the requirements of Sec 712, cures
without the use of a separate curing solution. High solids inorganic zinc coating shall comply with the requirements of AASHTO M 300, Type IA, except the volatile organic compounds (VOC) shall not exceed 420 g/L (3.50 lbs./gal.). If thinning is necessary for application, the maximum VOC shall not exceed 420 g/L (3.50 lbs./gal.).

1045.5.2 Manufacturer and Brand Name Approval for Inorganic Zinc Primer. Prior to approval and use of high solids inorganic zinc, the manufacturer shall submit to the County Engineer, a certified test report from an approved independent testing laboratory showing specific test results conforming to all quantitative and resistance test requirements of these specifications. The certified test report shall also contain the exact ratio, by mass (weight), of each component of the coating used for the tests, the lot tested, the manufacturer's name, brand name of coating and date of manufacture. Upon approval by the engineer of this certified test report, further resistance tests will not be required, except as hereinafter noted, of that manufacturer for that brand name of coating. New certified test results shall be submitted any time the manufacturing process or the coating formulation is changed, and may be required by the engineer when sampling and testing of material offered for use indicates nonconformance to any of the requirements herein specified.

1045.6 High Solids Epoxy System G Intermediate Coating.

1045.6.1 The coating shall be a two-component, modified epoxy primer with an amine/amide type curing system compatible as an intermediate coat over inorganic zinc primer and suitable for topcoating with polyurethane.

1045.6.2 Pigment. The pigment shall be a minimum of 43 percent by mass (weight) of the coating.

1045.6.3 Vehicle. The vehicle shall be a maximum of 57 percent by mass (weight). The vehicle shall consist of an epoxy resin.

1045.6.4 Mixed Coating.

Color – Provide a contrast between the primer and the finish coat.

<table>
<thead>
<tr>
<th>Mix Ratio</th>
<th>1:1 by Volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mass (Weight) per Liter (Gallon), kg (lbs.), min</td>
<td>1.20 (10.0)</td>
</tr>
<tr>
<td>Solids, percent by mass (weight)</td>
<td>79</td>
</tr>
<tr>
<td>ASTM D 1644 for 72 hours at 37.8(^\circ) C (100(^\circ) F) min.</td>
<td>79</td>
</tr>
<tr>
<td>Pigment, percent by mass (weight), min.</td>
<td>43</td>
</tr>
<tr>
<td>Viscosity, Krebs-Stormer, 25(^\circ) C (77(^\circ) F) KU</td>
<td>80-130</td>
</tr>
<tr>
<td>Volatile Organic Content*, max., g/L (lb./gal)</td>
<td>420(3.50)</td>
</tr>
<tr>
<td>Fineness of Grind, Hegeman Gage, min.</td>
<td>4</td>
</tr>
<tr>
<td>Sag Resistance, Leneta Anti-Sag Meter, μm (mils) wet, min.</td>
<td>203 (8)</td>
</tr>
<tr>
<td>Pot Life at 21(^\circ) C (70(^\circ) F), hours, min.</td>
<td>4</td>
</tr>
<tr>
<td>Dry to Touch, hours, max.</td>
<td>3</td>
</tr>
<tr>
<td>--------------------------</td>
<td>---</td>
</tr>
<tr>
<td>Dry to Handle, hours, max.</td>
<td>6</td>
</tr>
</tbody>
</table>

*Maximum when thinned for application.*

**1045.6.5 Manufacturer and Brand Name Approval.** Prior to approval and use of the specified coating system, the manufacturer shall submit to the County Engineer a one-gallon (4 L) sample of the coating proposed. The manufacturer shall also submit a certified test report from an approved independent testing laboratory showing specific test results obtained on the specified coating system for Relative Humidity Resistance ASTM D 1735 or D 2247, 3000 hours, Salt Fog Resistance ASTM B 117, 3000 hours and Accelerated Weathering ASTM G 23 Method 1, Type EH (Carbon Arc), 4000 hours. ASTM G 26, Method 2, Xenon Arc or G 53 QUV (Fluorescent UV-Condensation Type using Type A lamps) may be used as an alternate to Carbon Arc.

**1045.6.5.1** All coats of the system to be tested shall be applied to properly prepared steel test panels. Each coat of the system shall be from the same manufacturer. Test panels for salt fog exposure shall be scribed as described in ASTM D 1654-92 and, when rated according to ASTM D 1654-92, each panel must receive a rating of 7 or greater. No panel tested shall exhibit more than slight rusting, undercutting, discoloration, fading, blistering, chalking, loss of gloss, or change in color. All testing shall be performed on duplicate sets of test panels, and upon completion of the prescribed exposure testing, the manufacturer shall submit one set of the exposed panels to the County Engineer.

**1045.6.5.2** The manufacturer shall also provide documentation that the specified coating system has performed satisfactorily for three years. The document shall include the name, address and telephone number of the proprietary agency and location of the structures. Upon approval of the coating by the engineer, further submittals for preliminary approval will not be required of that manufacturer for that brand name of coating, except as hereinafter noted. A new sample shall be submitted any time the manufacturing process or the batching proportions are changed. The engineer may withdraw manufacturer and brand name approval when sampling and testing of material offered for use indicates nonconformance to any of the requirements herein specified. All data submitted for preliminary approval will be considered confidential to St. Charles County Highway Department.

**1045.7 Polyurethane System G Finish Coating.**

**1045.7.1** The coating shall be a two-component, aliphatic acrylic polyurethane suitable for use over Sec 1045.6, High Solids Epoxy Intermediate Coating. The coating shall cure to a semi-gloss to high gloss, abrasion resistant surface and shall provide an easily cleanable finish.

**1045.7.2 Pigment.** The pigment shall be a minimum of 29 percent for gray and a minimum of 24 percent for brown by mass (weight) of the total coating. The pigment shall consist of titanium dioxide, color retentive tinting pigments, extender pigments and UV stabilizers.
1045.7.3 Vehicle. The vehicle shall be a maximum of 71 percent for gray and a maximum of 76 percent for brown by mass (weight) of the total coating. The vehicle shall consist of an aliphatic acrylic polyurethane.

1045.7.4 Mixed Coating.

Color, Federal Standard 595b

<table>
<thead>
<tr>
<th></th>
<th>Gray 26373</th>
<th>Brown 30045</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mass (Weight) per Liter (Gallon), kg (lbs.), min.</td>
<td>1.20 (10.0)</td>
<td>1.14 (9.3)</td>
</tr>
<tr>
<td>Solids, percent by mass (weight) ASTM D 1644 for 72 hours at 37.8(^0) C (100(^0) F), min.</td>
<td>74</td>
<td>71</td>
</tr>
<tr>
<td>Solids by Volume, min.</td>
<td>63</td>
<td>58</td>
</tr>
<tr>
<td>Pigment, percent by mass (weight), min.</td>
<td>29</td>
<td>24</td>
</tr>
<tr>
<td>Viscosity, Krebs-Stormer, 25(^0) C (77(^0) F), KU</td>
<td>65-96</td>
<td>65-96</td>
</tr>
<tr>
<td>Volatile Organic Content*, g/L (lb./gal), max.</td>
<td>420 (3.50)</td>
<td>420 (3.50)</td>
</tr>
<tr>
<td>Fineness of Grind, Hegeman Gage, min.</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Sag Resistance, Leneta Anti-Sag Meter, (\mu)m (mil) wet, min.</td>
<td>203 (8)</td>
<td>203 (8)</td>
</tr>
<tr>
<td>Pot Life at 21(^0) C (70(^0) F), hours, min.</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Dry to Touch, hours, max.</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Dry to Handle, hours, max.</td>
<td>8</td>
<td>8</td>
</tr>
</tbody>
</table>

*Maximum when thinned for application.

1045.7.5 Manufacturer and Brand Name Approval. Manufacturer and brand name approval shall be in accordance with Sec 1045.6.5.

1045.8 Waterborne Acrylic System H Intermediate and Finish Coating.

1045.8.1 The intermediate coating shall be a single component waterborne acrylic compatible as a coating over inorganic zinc primers.

1045.8.2 The finish coating shall be a single component waterborne acrylic suitable for use over a waterborne acrylic intermediate coating. The coating shall cure to a tough, abrasion resistant surface which performs well in weathering exposures. The gray finish coat shall cure to a semi-gloss finish, and the brown finish coat shall cure to a low-gloss finish.

1045.8.3 Pigment. The pigment shall be a minimum of 18 percent for gray and a minimum of 15 percent for brown by mass (weight) of the total coating. The pigment shall consist of titanium dioxide, color retentive tinting pigments and extender pigment.
1045.8.4 Vehicle. The vehicle shall be a maximum of 82 percent for gray and a maximum of 85 percent for brown by mass (weight) of the total coating. The vehicle shall consist of acrylic resin suitable for use in exterior coatings.

1045.8.5 Mixed Coating.

Color - Intermediate Coat
Provide a contrast between primer and finish coat.

Color - Finish Coat
Federal Standard 595b

<table>
<thead>
<tr>
<th></th>
<th>Gray 26373</th>
<th>Brown 30045</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mass (Weight) per Liter (Gallon), kg (lbs.), min.</td>
<td>1.20 (10.0)</td>
<td>1.11 (9.3)</td>
</tr>
<tr>
<td>Solids, percent by mass (weight), min.</td>
<td>42</td>
<td>42</td>
</tr>
<tr>
<td>Solids, percent by volume, min.</td>
<td>34</td>
<td>34</td>
</tr>
<tr>
<td>Pigment, percent by mass (weight), min.</td>
<td>18</td>
<td>15</td>
</tr>
<tr>
<td>Percent Non-volatile Vehicle, by mass (weight) of coating, min.</td>
<td>22</td>
<td>28</td>
</tr>
<tr>
<td>Viscosity, Krebs-Stormer, 25 °C (77 °F), KU</td>
<td>80-100</td>
<td>80-100</td>
</tr>
<tr>
<td>Volatile Organic Content, g/L (lb./gal), max.</td>
<td>420 (3.50)</td>
<td>420 (3.50)</td>
</tr>
<tr>
<td>Fineness of Grind, Hegeman Gage, min.</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>Sag Resistance, Leneta Anti-Sag Meter, μm (mils) wet, min.</td>
<td>203 (8)</td>
<td>203 (8)</td>
</tr>
<tr>
<td>Dry to Handle, hours, max.</td>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>

1045.8.6 Manufacturer and Brand Name Approval. Prior to approval and use of waterborne acrylic intermediate and finish coats, the manufacturer shall obtain manufacturer and brand name approval in accordance with Sec 1045.6.5.
SECTION 1048
PAVEMENT MARKING MATERIALS

1048.1 Scope. This specification covers preformed pavement marking tape, thermoplastic pavement marking materials, preformed removable pavement marking tape, and preformed temporary pavement marking tape.

1048.2 Type 1 Preformed Marking Tape.

1048.2.1 Type 1 preformed marking tape shall be capable of being laid into new, dense and open graded asphalt wearing surfaces during the final roller operation. After application the tape shall be immediately ready to receive traffic.

1048.2.2 Composition. The tape shall consist of a mixture of polymeric materials, pigments and glass beads distributed throughout the cross-sectional area with a reflective layer of glass beads embedded in the top surface. The tape shall be sufficiently flexible so as to conform to the roadway without cracking or breaking.

1048.2.3 Dimensions. The tape without adhesive shall have a minimum thickness of 1.5 mm (60 mils). A patterned surface is allowable, but shall have a minimum thickness of 1.5 mm (60 mils) over at least 50 percent of its surface. The tape shall have a nominal width of 100 mm (4 in.) and the edges shall not be tapered.

1048.2.4 Adhesive. The tape shall be supplied with a precoated factory-applied adhesive for immediate application to asphalt pavement without the use of heat, solvent, or other adhesive operations. The tape and adhesive shall be of a type that water used on the compaction roller will not be harmful to successful application.

1048.2.5 Reflectance. The tape shall be readily visible when exposed to automobile headlights at night and shall show the following minimum reflective values at 0.2 degree and 0.5 degree divergence measured in accordance with MoDOT Test Method T8. The reflective values shall be expressed as candelas per lux, per square meter (per foot candle, per sq. ft.) of material, measured at 45 degrees angle of incidence on 0.3 m x 0.6 m (1 ft. x 2 ft.) panel covered with strips of the tape in a longitudinal orientation.

<table>
<thead>
<tr>
<th>Divergence Angle</th>
<th>White</th>
<th>Yellow</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.2 degree</td>
<td>0.60</td>
<td>0.35</td>
</tr>
<tr>
<td>0.5 degree</td>
<td>0.40</td>
<td>0.25</td>
</tr>
</tbody>
</table>

The reflected color shall be white or yellow as required for the specified application.

1048.2.6 Approval. To obtain approval of Type 1 preformed marking tape, the
manufacturer shall submit material and application specifications, samples of the tape, and a history of satisfactory use as a pavement marking tape to the engineer for testing and evaluation. The quantity, types, and widths of tape submitted shall be at the discretion of the engineer. Following the testing and evaluation, satisfactory tape will be placed on a prequalified list.

1048.2.6.1 For acceptance on the project, the contractor shall furnish to the engineer a manufacturer’s certification in triplicate stating the manufacturer and trade name, and certifying that the material furnished is of the same composition as originally prequalified and in no way has been altered or changed.

1048.3 Type 2 Preformed Marking Tape.

1048.3.1 Type 2 preformed marking tape shall be designed for application to new asphalt wearing surfaces immediately after final rolling operations. After application the tape shall be capable of immediately receiving traffic.

1048.3.2 Composition. The tape shall consist of glass beads imbedded in a white or yellow plastic film. The tape shall be sufficiently flexible so as to conform to the roadway without cracking or breaking.

1048.3.3 Dimensions. The tape shall have a minimum thickness, without adhesive of 3.0 mm (12 mils). The tape shall have a nominal width of 100 mm (4 in.) and the edges shall not be tapered.

1048.3.4 Adhesive. The tape shall be supplied with a precoated, factory-applied, pressure sensitive adhesive for immediate application to newly paved asphalt surfaces without the use of heat, solvent, or other adhesive operations.

1048.3.5 Reflectivity. The tape shall be readily visible when exposed to automobile headlights at night and shall show the following minimum reflective values at 0.2 degree and 0.5 degree divergence measured in accordance with MoDOT Test Method T8. The reflective values shall be expressed as candelas per lux, per square meter (per foot candle, per sq. ft.) of material, measured at 45 degrees angle of incidence on a 0.3 m x 0.6 m (1 ft. x 2 ft.) panel covered with strips of the tape in a longitudinal orientation.

<table>
<thead>
<tr>
<th>Divergence Angle</th>
<th>White</th>
<th>Yellow</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.2 degree</td>
<td>1.25</td>
<td>0.70</td>
</tr>
<tr>
<td>0.5 degree</td>
<td>1.00</td>
<td>0.60</td>
</tr>
</tbody>
</table>

The reflected color shall be white or yellow as required for the specified application.

1048.3.6 Approval. To obtain approval of Type 2 preformed marking tape, the manufacturer shall submit material and application specifications, samples of the tape, and a history of satisfactory use as a pavement marking tape to the engineer for testing and evaluation.
The quantity, types, and widths of tape submitted shall be at the discretion of the engineer. Following the testing and evaluation, satisfactory tape will be placed on a prequalified list.

1048.3.6.1 For acceptance on the project, the contractor shall furnish to the engineer a manufacturer’s certification in triplicate stating the manufacturer and trade name, and certifying that the material furnished is of the same composition as originally prequalified and in no way has been altered or changed.

1048.4 Thermoplastic Pavement Marking Material.

1048.4.1.1 Thermoplastic material shall comply with AASHTO M 249, except material formulated with alkyd resin shall have a maximum specific gravity of 2.35. The pre-mix beads shall be uncoated and shall conform to AASHTO M 247, Type 1.

1048.4.2 Primer. Primer, if required, shall be as recommended by the manufacturer of the thermoplastic material.

1048.4.3 Sampling and Testing of Thermoplastic Material.

1048.4.3.1 The engineer shall have a free access to the material and every facility shall be extended to him for the purpose of inspection. A sample will be taken from each lot of thermoplastic marking material presented for inspection. A lot is defined as 10000 kg (22,000 lbs.), or fraction thereof, presented for inspection at one time regardless of the number of composition batches in the lot. A sample will consist of one 20 kg (50 lb.) sample of material packaged in accordance with Sec. 1048.4.5. The engineer reserves the right to sample at the point of manufacture, at intermediate points of storage, or at destination.

1048.4.3.2 The thermoplastic material shall comply with AASHTO M 249 and AASHTO T 250, as applicable.

1048.4.4 Certification and Acceptance of Thermoplastic Material.

1048.4.4.1 The contractor shall furnish a manufacturer’s certification in triplicate to the engineer, for each composition batch contained in the inspection lots certifying that the materials supplied conform to all requirements specified. The certification shall include or have attached typical results of tests for all specified requirements.

1048.4.4.2 Acceptance of the material will be based on the manufacturer’s certification and upon the results of such tests as may be performed by the engineer.

1048.4.5 Packaging and Marking of Thermoplastic Material.

1048.4.5.1 Thermoplastic material may be furnished as blocks approximately 305 mm x 940 mm x 50 mm (12 in. x 37 in. x 2 in.) or as granular material in bags. Either unit shall have a weight of approximately 20 kg (50 lbs.).
1048.4.5.2 Granular hydrocarbon thermoplastic material may be packaged in thermally degradable bags which are designed to melt with the material and which do not adversely affect the application of performance of the thermoplastic material. The bag or packaging for alkyd thermoplastic material may be melted with the thermoplastic material, provided the bag has a statement by the manufacturer printed on it to the effect that it is designed to be melted with the thermoplastic material.

1048.4.5.3 Each package shall be labeled or marked with the color of the material, name of the manufacturer, date of manufacture, batch number, type of material (alkyd, hydrocarbon, or epoxy), net weight of contents, and the temperature to which the material shall be heated for application.

1048.4.6 Drop-On Glass Beads.

1048.4.6.1 The glass beads for drop-on application on the thermoplastic pavement marking material shall be moisture resistant and shall be manufactured from glass of a composition that is highly resistant to traffic wear and to the effects of weathering. The glass beads shall comply with the requirements of AASHTO M 247 except as herein modified.

1048.4.6.2 Gradation. The drop-on glass beads shall meet the following gradation requirements:

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Percent Passing Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>850 μm (No. 20)</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>600 μm (No. 30)</td>
<td>75</td>
<td>95</td>
</tr>
<tr>
<td>300 μm (No. 50)</td>
<td>15</td>
<td>35</td>
</tr>
<tr>
<td>150 μm (No. 100)</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>75 μm (No. 200)</td>
<td>0</td>
<td>1</td>
</tr>
</tbody>
</table>

1048.4.6.3 Silica Content. The glass beads shall be made of glass containing no less than 58.0 percent (SiO₂) when tested in accordance with Sec. 1048.4.6.4.2.

1048.4.6.4 Sampling and Testing of Glass Beads.

1048.4.6.4.1 The engineer shall have free access to the material and every facility shall be extended to him for the purpose of inspection. The engineer reserves the right to sample at the point of manufacture, at intermediate points of storage, or at destination. The engineer will determine the location and frequency of sampling.

1048.4.6.4.2 The glass beads shall be tested in accordance with AASHTO M 247 and T 250, except that the silica (SiO₂) content of the glass beads shall be determined in accordance with ASTM C 169, Procedure for Referee Analysis.
1048.4.6.5 Certification and Acceptance of Drop-On Glass Beads.

1048.4.6.5.1 The contractor shall furnish a manufacturer’s certification, in triplicate, to the engineer, for each lot, certifying the beads conform to all requirements specified. The certification shall include or have attached specific results of test performed for roundness, refractive index, flow characteristics, and gradation. The certifications shall show the quantity and lot number.

1048.4.6.5.2 Acceptance of the beads will be based on the manufacturer’s certification and upon the results of such tests as may be performed by the engineer.

1048.4.6.6 Packaging and Marking of Drop-On Glass Beads.

1048.4.6.6.1 The glass beads shall be packaged in clean containers or bags that repel rather than absorb moisture.

1048.4.6.6.2 Each container shall be marked with the manufacturer’s name, net weight, and lot designation.

1048.5 Preformed Removable Pavement Marking Tape.

1048.5.1 Preformed removable tape shall be capable of being removed manually either by hand or with a roll up device and shall leave no objectionable or misleading image after removal.

1048.5.2 Color. The tape shall be white or yellow as required for the specific application.

1048.5.3 Reflectivity. The tape shall be readily visible when exposed to automobile headlights at night and shall show the following minimum reflective values at 0.2 degree and 0.5 degree divergence measured in accordance with MoDOT Test Method T8. The reflective values shall be expressed as candelas per lux, per square meter (per foot candle, per sq. ft.) of material, measured at 45 degrees angle of incidence on a 0.3 m x 0.6 m (1 ft. x 2 ft.) panel covered with strips of the tape in a longitudinal orientation.

<table>
<thead>
<tr>
<th>Divergence Angle</th>
<th>White</th>
<th>Yellow</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.2 degree</td>
<td>1.5</td>
<td>1.0</td>
</tr>
<tr>
<td>0.5 degree</td>
<td>1.0</td>
<td>0.5</td>
</tr>
</tbody>
</table>

The reflected color shall be white or yellow as required for the specified application.

1048.5.4 Adhesive. The tape shall have a precoated pressure sensitive adhesive that requires no activation procedures. The adhesive shall be resistant to oil, chemicals, acids, solvents, and water.
1048.5.5 Dimensions. The tape shall have a minimum thickness of 380 μm (15 mils) and shall have a nominal width of 100 mm (4 in.). Following application, the tape shall remain conformed to the texture of the pavement.

1048.5.6 Durability. The tape shall be weather resistant and show no appreciable fading, lifting, or shrinkage during its useful life. Samples of the tape applied to standard specimen plates and tested in accordance with Federal Test Method No. 141, Method 6192, using a CS-17 wheel and 1000 gram load shall show no significant change of color after 2000 cycles.

1048.5.7 Appearance. The tape as applied shall be in good condition, free of cracks, and with edges straight and unbroken.

1048.5.8 Approval.

1048.5.8.1 Prior to approval and use of preformed removable tape, the manufacturer shall submit material and application specifications and samples of the tape for testing and evaluation. The quantity, types, and widths of tape submitted shall be at the discretion of the engineer. Following the testing and evaluation, satisfactory tape will be placed on a prequalified list.

1048.5.8.2 Preformed removable tape appearing on the prequalified list may be accepted for use on the basis of brand name, color, and width as shown in the prequalified list, so long as satisfactory performance is obtained in the field.

1048.6 Preformed Short Term Pavement Marking Tape.

1048.6.1 Color. The tape shall be either white or yellow as required for the specific application.

1048.6.2 Reflectivity. The tape shall be readily visible when exposed to automobile headlights at night and shall show the following minimum reflective values at 0.2 degree and 0.5 degree divergence measured in accordance with MoDOT Test Method T8. The reflective values shall be expressed as candelas per lux, per square meter (per foot candle, per sq. ft.) of material, measured at 45 degree angle of incidence on a 0.3 m x 0.6 m (1 ft. x 2 ft.) panel covered with strips of the tape in a longitudinal orientation.

<table>
<thead>
<tr>
<th>Divergence Angle</th>
<th>White</th>
<th>Yellow</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.2 degree</td>
<td>1.5</td>
<td>1.0</td>
</tr>
<tr>
<td>0.5 degree</td>
<td>1.0</td>
<td>0.5</td>
</tr>
</tbody>
</table>

The reflected color shall be white or yellow as required for the specified application.

1048.6.3 Adhesive. The tape shall have a precoated pressure sensitive adhesive that requires no activation procedures. The adhesive shall be resistant to oil, chemicals, acids, solvents, and water.
1048.6.4 **Dimensions.** The tape shall have a minimum thickness of 380 μm (15 mils) and shall have a nominal width of 100 mm (4 in.). Following application, the tape shall remain conformed to the texture of the pavement.

1048.6.5 **Durability.** The tape shall be weather resistant and show no appreciable fading, lifting, or shrinkage during its useful life. Samples of the tape applied to standard specimen plates and tested in accordance with Federal Test Method No. 141, Method 6192, using a CS-17 wheel and 1000 gram load shall show no significant change of color after 2000 cycles.

1048.6.6 **Appearance.** The tape as applied shall be in good condition, free of cracks, and with edges straight and unbroken.

1048.6.7 **Approval.**

1048.6.7.1 Prior to approval and use of preformed short term marking tape, the manufacturer shall submit material and application specifications and samples of the tape for testing and evaluation. The quantity and type of tape submitted shall be at the discretion of the engineer. In addition, the manufacturer shall submit a certification stating that the material conforms to all of the requirements of these specifications. Following the testing and evaluation, satisfactory tape will be placed on a prequalified list.
SECTION 1050
LUMBER, TIMBER, PILING, POSTS, AND POLES

1050.1 Scope. These specifications cover wood products of Southern Pine and Douglas Fir of the West Coast Region as defined in ASTM D 1165.

1050.2 Posts.

1050.2.1 Posts for Guard Cable. Posts for guard cable may be round or rectangular as shown on the plans. Round posts shall comply with the applicable requirements of Sec. 1050.2.3. Rectangular posts shall be standard rough sawn and of the grade specified in Sec. 1050.2.3.1. All posts shall be of the species and pressure-treated as shown in Table I.

1050.2.2 Posts and Blocks for Guard Rail. Posts and blocks for guard rails shall be rectangular, standard rough sawn, and of the size and shape shown on the plans.

1050.2.2.1. Posts and blocks shall be of the species and pressure-treated as shown in Table I. All framing and boring shall be done before treatment. Douglas Fir shall be “Dense No. 1 Structural Grade” conforming to the requirements of Paragraph 13 l-bb of the current Standard Grading Rules for West Coast Lumber. Southern Pine shall be “No. 1 SR Grade” conforming to the requirements of Paragraph 406 of the current Standard Grading Rules for Southern Pine Lumber.

1050.2.3 Posts for Fences. Posts for fences shall be round and of the sizes and lengths shown on the plans. They shall be of the species and pressure-treated as shown in Table I. Allowable tolerances for size and length are as follows:

<table>
<thead>
<tr>
<th>Minimum</th>
<th>Diameter Tolerance</th>
</tr>
</thead>
<tbody>
<tr>
<td>100 mm (4 in.) or smaller</td>
<td>+13 mm (1/2 in.), no minus</td>
</tr>
<tr>
<td>Larger than 100 mm (4 in.)</td>
<td>+25 mm (1 in.), no minus</td>
</tr>
</tbody>
</table>

Length
All Diameters No limit on over length, -25 mm (1 in.)

1050.2.3.1 Grade. Wood for posts shall be sound, free of decay, excessive knots, and of split ends and seasoning checks that might affect serviceability. Posts shall also be free of multiple crooks; however, crooks in one plane only, which comply with Sec. 1050.2.3.2, will not be cause for rejection.
1050.2.3.2 Straightness. A straight line drawn from the center of one end of the post to the center of the opposite end shall not deviate from the longitudinal axis of the post at any point by more than one percent of the length of the post.

1050.2.3.3 Manufacture. Post shall be clean peeled by mechanical or hand processes, and all bark shall be removed except that strips of inner bark not more than 13 mm (1/2 in.) wide nor more than 75 mm (3 in.) long will be permitted to remain on the peeled post. All protruding knots shall be trimmed flush, and all spurs and splinters shall be removed. The natural taper of round posts shall be followed in machine peeling operations. The ends of all posts shall be square except that posts to be driven shall be machine pointed on the small end prior to treatment.

1050.2.4 Posts for Signs. Posts for signs shall be rectangular, rough sawn or surfaced four sides (S4S), with square cut ends, and shall be of the grade, size, and length shown on the plans. They shall be of the species and pressure-treated as shown in Table I. If framing and boring is done after pressure treatment, field treatment shall be in accordance with the requirements of Sec. 1050.7.

1050.3 Lumber and Timber.

1050.3.1 Species and Grade Requirements. Unless otherwise specified, lumber and timber to be used as a permanent part of the structure shall be of the species shown in Table I. The grade to be used will be shown on the plans. Lumber and timber for temporary structures shall be of the species and grades shown on the plans.

1050.3.2 Dressing Requirements. Lumber and timber shall be standard rough sawn or shall be surfaced as specified in the contract. Lumber and timber shall be cut to exact lengths or to permissible variations in lengths as shown in the contract.

1050.3.3 Treatment. If treatment is specified, lumber and timber shall be pressure-treated as shown in Table I.

1050.4 Electric Substation, Service and Span Wire Assembly Poles.

1050.4.1. These poles shall be of the length and class designated in the contract, and shall conform to the requirements of ANSI 05.1. They shall be of the species and pressure-treated as shown in Table I. The poles may be gained and drilled in the field after treatment. Areas exposed shall be treated as specified in Sec. 1050.7, before crossarms or equipment are mounted.

1050.4.2 Pole Crossarms. The species, grade, and treatment of crossarms to be erected on substation and service poles will be as shown on the plans.

1050.5 Round Timber Piles.

1050.5.1 All round timber piles shall conform to the requirements of ASTM D 25, except for size which shall conform to the size requirements of Table II for the class specified in the
contract. Piles for permanent structures shall be clean peeled.

1050.5.2 Piles to be treated shall be of the species and pressure treated as shown in Table I. Framing and boring will not be required before treatment. However, exposed untreated areas resulting from framing of treated piling shall be field treated as specified in Sec. 1050.7. Untreated piles for use in unexposed locations or in temporary bridges shall be of the species shown in Table I or of other species approved by the engineer.

1050.6 Timber Preservatives.

1050.6.1 Creosote. Creosote shall conform to the requirements of AWPA P1.

1050.6.2 Pentachlorophenol. The preservative shall be pentachlorophenol meeting the requirements of AWPA P8 in a hydrocarbon solvent meeting the requirements of AWPA P9, Type A.

1050.6.3 Ammoniacal Copper Arsenate (ACA) or Chromated Copper Arsenate (CCA). These preservatives shall comply with the requirements of AWPA P5.

1050.6.4 Copper Napthenate for Repairs. This preservative shall be prepared with a solvent conforming to AWPA Standard P9. The preservative concentration shall contain a minimum of 2 percent copper metal.

1050.6.5 Responsibility for Quality. Responsibility for using preservatives to meet these specifications shall rest entirely with the contractor, and use of preservatives which fails to meet these requirements will subject the entire charge of material to rejection or to approved re-treatment with proper preservative.

1050.6.6 Final Steaming. All guard rail, guard cable, and sign posts, substation, service, and span wire poles, and lumber and timber shall be cleaned by a final steam bath in accordance with AWPA C2, C4, or CS as applicable. In lieu of steam cleaning, sign posts may be strip stacked and air dried for a minimum of 60 days after treatment.

1050.7 Care After Treatment. Care shall be taken in handling pressure-treated material. It shall not be dragged across the ground. Cant hooks, peavies, pickaroons, and end cant hooks shall not be used on the side surfaces of treated materials. All handling of treated round stock with pointed tools shall be confined to the ends. If the material is accidentally damaged, or framing at site is required, such injuries, cuts, or holes shall be liberally field-treated with two brush coats of preservative of the same type used for original treatment or of copper napthenate. The second coat shall be applied after the first coat has been absorbed. Creosote preservative shall be hot when applied. Holes shall be treated by plugging one end and filling with preservatives. A bent funnel or other suitable device shall be used for treating horizontal holes.

1050.8 Inspection.

1050.8.1 All materials shall be rigidly inspected for compliance with these specifications
in accordance with AWPA Standard M2.

1050.8.2 Timber products treated within St. Charles County or within 100 air miles of the border will be inspected by St. Charles County Highway Department personnel.

1050.8.3 The inspection of lumber, timber, piling, posts, and poles from locations other than shown in Sec. 1050.8.2 shall be performed by an approved inspection agency and the cost for inspection shall be borne by the contractor. No direct payment will be made for the cost of inspection, and it will be considered as covered under the unit bid price for the specified item.

1050.8.3.1 An approved inspection agency is defined as a laboratory which has been accredited by the American Lumber Standards Committee, P.O. Box 210, Germantown, MD, or an experienced qualified testing laboratory approved by the engineer.

Inspection agencies not accredited by the American Lumber Standards Committee shall submit for approval to the County Engineer, St. Charles County Highway Department; 201 N. Second Street, Suite 429, St. Charles, Missouri, 63301 a resume of their agency which shall include a history of inspection of timber and treated products, and a listing of highway departments which have approved them and for which they have performed inspections.

1050.8.4 The contractor shall furnish to the engineer a certification from the supplier stating that the material furnished complies with all the requirements of these specifications. The certification shall include or have attached a listing of the material being supplied. Except as noted, the certification shall have attached a certified test report as detailed in Section 7.2 of AWPA Standard M2 from the inspection agency attesting to complete compliance with these specifications. Electric substation, service, and span wire assembly poles do not require the certified test report.

1050.8.5 Acceptance of material will be based on satisfactory supplier and inspection agency certifications, and upon the results of any tests deemed necessary by the engineer at destination to ascertain compliance with these specifications.
### TABLE I
Metric Units (kg/m³)

<table>
<thead>
<tr>
<th>Species</th>
<th>Type of Preservative and minimum Retention (Kilograms per cubic meter of wood)</th>
<th>Treated in Accordance with AWPA Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Southern Pine</td>
<td>Douglas Fir</td>
</tr>
<tr>
<td>Round Posts for Guard Cable</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Rectangle Posts for Guard Cable</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Posts and Blocks for Guard Cable</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Posts for Fences</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Posts for Signs</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Lumber and Timber</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Poles</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Round Timber Piles</td>
<td>X</td>
<td></td>
</tr>
</tbody>
</table>

### English Units (lbs./ft.³)

<table>
<thead>
<tr>
<th>Species</th>
<th>Type of Preservative and Minimum Retention (pounds per cubic foot of wood)</th>
<th>Treated in accordance with AWPA Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Southern Pine</td>
<td>Douglas Fir</td>
</tr>
<tr>
<td>Round Posts for Guard Cable</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Rectangle Posts for Guard Cable</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Posts and Blocks for Guard Cable</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Posts for Fences</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Posts for Signs</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Lumber and Timber</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Poles</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Round Timber Piles</td>
<td>X</td>
<td></td>
</tr>
</tbody>
</table>
### TABLE II
Circumferences and Diameters of Timber Piles

#### Metric Units (mm)

<table>
<thead>
<tr>
<th>Length in Meters</th>
<th>Class A 1 m. From Butt</th>
<th></th>
<th>Class A Tip</th>
<th></th>
<th>Class B 1 m. From Butt</th>
<th></th>
<th>Class B Tip</th>
<th></th>
<th>Class C 1 m. From Butt</th>
<th></th>
<th>Class C Tip</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Min</td>
<td>Max</td>
<td>Min</td>
<td>Max</td>
<td>Min</td>
<td>Max</td>
<td>Min</td>
<td>Max</td>
<td>Min</td>
<td>Max</td>
<td>Min</td>
</tr>
<tr>
<td>Up to 15</td>
<td>1200</td>
<td>380</td>
<td>1450</td>
<td>460</td>
<td>710</td>
<td>230</td>
<td>965</td>
<td>305</td>
<td>1600</td>
<td>510</td>
<td>660</td>
</tr>
<tr>
<td>Over 15</td>
<td>1200</td>
<td>380</td>
<td>1450</td>
<td>560</td>
<td>630</td>
<td>200</td>
<td>1040</td>
<td>330</td>
<td>1600</td>
<td>510</td>
<td>560</td>
</tr>
</tbody>
</table>

#### English Units (in.)

<table>
<thead>
<tr>
<th>Length in Feet</th>
<th>Class A 3 Ft. From Butt</th>
<th></th>
<th>Class A Tip</th>
<th></th>
<th>Class B 3 Ft. From Butt</th>
<th></th>
<th>Class B Tip</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Min</td>
<td>Max</td>
<td>Min</td>
<td>Max</td>
<td>Min</td>
<td>Max</td>
<td>Min</td>
</tr>
<tr>
<td>Up to 50</td>
<td>47</td>
<td>15</td>
<td>57</td>
<td>18</td>
<td>28</td>
<td>9</td>
<td>38</td>
</tr>
<tr>
<td>Over 50</td>
<td>47</td>
<td>15</td>
<td>57</td>
<td>18</td>
<td>25</td>
<td>8</td>
<td>41</td>
</tr>
</tbody>
</table>
SECTION 1054
CONCRETE ADMIXTURES

1054.1 Scope. These specifications cover air-entraining admixtures, water reducing admixtures, retarding admixtures, and accelerating admixtures for concrete.

1054.2 Air-Entraining Admixtures.

1054.2.1 Air-entraining admixtures shall conform to the requirements of AASHTO M 154 except as modified herein.

1054.2.2 Manufacturer’s Certification and Guarantee. The manufacturer shall submit a certification and guarantee to the engineer, showing the brand name and designation; the composition and description of the admixture; the manufacturing ranges for specific gravity at 25°C (77°F), percent total solids, and pH; the infrared spectrum; the manner in which it will be identified on containers; and certifying that it will conform to the requirements of these specifications. The certification shall include or have attached specific test results as required in Sec. 1054.2.2.1 or 1054.2.2.2. The manufacturer shall also guarantee that as long as material is furnished under that brand and designation it will be of the same composition as originally approved and will in no way be altered or changed.

1054.2.2.1 For an air-entraining admixture other than that specified in Sec. 1054.2.2.2, the certification shall include results of tests conforming to the requirements of AASHTO M 154. Tests for bleeding, bond strength, and volume change will not be required.

1054.2.2.2 For an air-entraining admixture which is an aqueous solution of vinsol resin, manufactured by neutralizing the resin with caustic soda (sodium hydroxide), the certification shall include results of tests showing the ratio of sodium hydroxide to vinsol resin, and the percentage of solids based on the residue dried at 105°C (221°F). The certification or test report shall also state that no other additive or chemical agent is present in the solution.

1054.2.3 Approval and Acceptance. Upon approval of the air-entraining admixture and the manufacturer’s certification and guarantee, that brand and designation will be accepted for use without further certification. If, in actual field use, there is evidence of unsatisfactory results, variability or change in composition, or misbranding, the material will be rejected and approval for further use withdrawn, until it is again prequalified. Samples of air-entraining admixture offered for use may be taken at any time considered necessary by the engineer.

1054.2.4 Packaging and Marking. The containers in which air-entraining admixtures are delivered shall be plainly marked with the manufacturer’s name, the brand name and designation of the material, lot number, and net quantity. Bulk shipments shall be accompanied by a delivery ticket showing this information. If the manufacturer supplies air-entraining admixtures in more than one concentration, one concentration shall be designated as standard
and others as double strength or triple strength with the containers marked accordingly in letters at least 25 mm (one in.) high, or for bulk shipments in a prominent manner on the delivery ticket.

1054.3.1 Water-reducing admixtures shall comply with the requirements of AASHTO M 194, Type A, except as modified herein.

1054.3.2 Manufacturer’s Certification and Guarantee. The manufacturer shall submit a certification and guarantee to the engineer showing the brand name and designation; the composition or description of the admixture; the manufacturing ranges for specific gravity at 25\(^0\) C (77\(^0\) F), percent total solids, and pH; the infrared spectrum; the manner in which it will be identified on containers; and certifying that it will conform to the requirements of these specifications. The certification shall include or have attached specific test results complying with AASHTO M 194, Type A, and the recommendation for use including amounts to be added. The manufacturer shall also guarantee that as long as the material is furnished under that brand and designation it will be of the same composition as originally approved and will in no way be altered or changed.

1054.3.3 Approval and Acceptance. Upon approval of the water-reducing admixture and the manufacturer’s certification and guarantee, that brand and designation will be accepted for use without further certification. If, in actual field use, there is evidence of unsatisfactory results, variability or change in composition, or misbranding, the material will be rejected and approval for further use withdrawn until it is again prequalified. Samples of any water-reducing admixture offered for use may be taken at any time considered necessary by the engineer.

1054.3.4 Packaging and Marking. The containers in which water reducing admixtures are delivered shall be plainly marked with the manufacturer’s name, the brand name and designation of the material, lot number, and net quantity. Bulk shipments shall be accompanied by a delivery ticket showing this information.

1054.4 Retarding Admixtures.

1054.4.1 Retarding admixtures shall conform to the requirements of AASHTO M 194, Type B or D, except as modified herein.

1054.4.2 Manufacturer’s Certification and Guarantee. The manufacturer shall submit a certification and guarantee to the engineer showing the brand name and designation; the composition or description of the admixture; the manufacturing ranges for specific gravity at 25\(^0\) C (77\(^0\) F), percent total solids, and pH; the infrared spectrum; the manner in which it will be identified on containers; and certifying that it will conform to the requirements of these specifications. The certification shall include or have attached specific test results complying with AASHTO M 194, Type B or D, and the recommendation for use including amounts to be added. The manufacturer shall also guarantee that as long as the material is furnished under that brand and designation it will be of the same composition as originally approved and will in no way be altered or changed.

1054.4.3 Approval and Acceptance. Upon approval of the retarding admixture and the
manufacturer’s certification and guarantee, that brand and designation will be accepted for use without further certification. If, in actual field use, there is evidence of unsatisfactory results, variability or change in composition, or misbranding, the material will be rejected and approval for further use withdrawn until it is again prequalified. Samples of any retarding admixture offered for use may be taken at any time considered necessary by the engineer.

1054.3.4 Packaging and Marking. The containers in which retarding admixtures are delivered shall be plainly marked with the manufacturer’s name, the brand name and designation of the material, lot number, and net quantity. Bulk shipments shall be accompanied by a delivery ticket showing this information.

1054.5 Accelerating Admixture.

1054.5.1 Accelerating admixtures shall conform to the requirements of AASHTO M 194, Type C or Type E, except as modified herein.

1054.5.2 Manufacturer’s Certification and Guarantee. The manufacturer shall submit a certification and guarantee to the engineer showing the brand name and designation; the composition or description of the admixture; the manufacturing ranges for specific gravity at 25° C (77° F), percent total solids, and pH; the infrared spectrum; the manner in which it will be identified on containers; and certifying that it will conform to the requirements of these specifications. The certification shall include or have attached specific test results complying with AASHTO M 194, Type C or Type E, and the recommendation for use including amounts to be added. The manufacturer shall also guarantee that as long as the material is furnished under that brand and designation it will be of the same composition as originally approved and will in no way be altered or changed.

1054.5.3 Approval and Acceptance. Upon approval of the accelerating admixture and the manufacturer’s certification and guarantee, that brand will be accepted for use without further certification. If, in actual field use, there is evidence of unsatisfactory results, variability or change in composition, or misbranding, the material will be rejected and approval for further use withdrawn until it is again prequalified. Samples of any accelerating admixture offered for use may be taken at any time considered necessary by the engineer.

1054.5.4 Packaging and Marking. The containers in which accelerating admixtures are delivered shall be plainly marked with the manufacturer’s name, the brand name and designation of the material, lot number, and net quantity. Bulk shipments shall be accompanied by a delivery ticket showing this information.
1055.1 Liquid Membrane-Forming Compounds.

1055.1.1 Scope. This specification covers liquid membrane-forming compounds suitable for curing portland cement concrete. The compounds are suitable for use as curing media not only for fresh concrete, but also for further curing of concrete after removal of forms or after initial moist curing.

1055.1.2 General Requirements. Liquid membrane-forming compounds shall conform to the requirements of AASHTO M 148 for Type 1-D, clear or translucent with fugitive dye, or Type 2, white pigmented, curing compounds. The vehicle shall be Class A.

1055.1.3 Storage Stability. The membrane-forming compounds shall be storable for at least 6 months without deterioration, except that compounds of the water-emulsion type will not be expected to resist freezing. The compound shall not settle to the extent that it cannot be readily restored to uniformity by moderate stirring or by agitating with compressed air.

1055.1.4 Packing and Marking. The liquid membrane-forming compound shall be delivered in the manufacturer’s original clean, sealed containers. Each container shall be legibly marked with the name of the manufacturer, the brand name of the compound and class of vehicle, the nominal percentage of nonvolatile material, the manufacturer’s batch or lot number and the place of manufacture. The contents of the containers shall in all respects be the same as the sample tested.

1055.1.5 Manufacturer’s Certification and Guarantee for White Pigmented Curing Compound. The contractor shall furnish a manufacturer’s certification in triplicate for each lot of white pigmented curing compound delivered showing typical results of tests for reflectance; or the manufacturer shall have filed a prescribed certification and guarantee with the Testing Laboratory. Upon approval of the material and of the certification and guarantee, material of that brand name may be accepted without further certification for reflectance properties. To obtain such approval, the manufacturer shall submit a notarized certification and guarantee setting forth the brand name and designation, the composition or description of the curing material, and the manner in which it will be identified on the container. The manufacturer shall further certify that the material conforms to the requirements of these specifications and shall list typical values of current tests for consistency, drying time, reflectance, and moisture retention. The manufacturer shall also guarantee that as long as material is furnished under that brand and designation, it will be of the same composition as that originally approved, and in no way will be altered or changed.

1055.1.6 Sampling. Each lot or batch of liquid membrane-forming compound shall be sampled, tested, and approved prior to use.
1055.2 Waterproof Paper.

1055.2.1 Scope. This specification covers waterproof paper for curing portland cement concrete.

1055.2.2 General Requirements. Waterproof paper shall consist of two sheets of kraft paper cemented together with a bituminous material in which are embedded cords or strands of fiber running in both directions of the paper. It shall conform to the requirements of AASHTO M 171

1055.3 Polyethylene Sheeting.

1055.3.1 Scope. This specification covers white polyethylene sheeting for curing portland cement concrete and white, clear, or color tinted polyethylene sheeting for moisture barrier under portland cement concrete pavement.

1055.3.2 General Requirements. Polyethylene sheeting shall be a single sheet manufactured to meet the requirements of either AASHTO M 171 or National Bureau of Standards Voluntary Product Standard, PS 17.

1055.3.2.1 Polyethylene sheeting for curing portland cement concrete shall be white and shall conform to all requirements of either AASHTO M 171 or PS 17.

1055.3.2.2 Polyethylene sheeting for moisture barrier under portland cement concrete pavement shall have a nominal thickness of 100 μm (4.0 mils) and a plain surface finish. The sheeting may be white, clear, or color tinted. White or clear sheeting shall conform to the requirements of either AASHTO M 171 or PS 17, with the exceptions listed below. Color, tinted sheeting shall conform to PS 17, with the exceptions listed below.

(a) Reflectance requirements of AASHTO M 171 and PS 17 shall not apply.

(b) Moisture loss requirements, AASHTO M 171, shall not apply.

(c) Water vapor transmission requirements, PS 17, shall not apply.

(d) Luminous transmittance requirements, PS 17, shall not apply.

(e) Minimum net weight requirements, PS 17, shall not apply.

1055.3.3 Certification and Acceptance. The contractor shall furnish a manufacturer’s certification in triplicate that the material supplied conforms to the requirements specified. The engineer reserves the right to sample, test, and approve or disapprove material at any time after it is offered for use.
1055.4 White Polyethylene-Burlap Sheeting.

1055.4.1 Scope. This specification covers white polyethylene-burlap sheeting for curing portland cement concrete.

1055.4.2 General Requirements. White polyethylene-burlap sheeting shall consist of burlap bonded on one side with white opaque polyethylene. The polyethylene sheeting shall conform to the requirements of Sec. 1055.3 and shall be securely bonded to the burlap so there will be no separation of the materials during use. The material shall be free from deleterious matter harmful to concrete.

1055.5 Burlap and Mats.

1055.5.1 Scope. This specification covers burlap and mats of jute or cotton for use in curing portland cement concrete.

1055.5.2 General Requirements. Burlap shall be fabric made from jute or other suitable fibers. Jute mats shall consist of two plies of burlap stitched together to maintain the shape and stability of the unit. Cotton mats shall consist of filler or cotton bats covered with unsized cloth or burlap, and tufted or stitched to maintain the shape and stability of the unit. Burlap and mats shall, in the judgment of the engineer, be of such construction and in such condition as required to adequately maintain free moisture on the surface of the concrete with the type of system being used to provide the water. Material shall be free from deleterious matter harmful to concrete.
SECTION 1056
RED CONCRETE TINTING MATERIAL

1056.1 Red Concrete Tinting Material. This material shall consist of an intimate mixture of iron aggregate and red mineral oxide pigment of an approved tint with such other additives as are deemed necessary by the manufacturer. It shall contain 7.0 to 10.0 percent red oxide pigment. The material shall be free from oil, grease, dirt, and nonferrous particles. It shall not contain any material which might promote oxidation of the iron particles when exposed to air and moisture, or which might have any detrimental effect on concrete. The iron aggregate portion of the tinting material shall conform to the following requirements:

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Percent Passing by Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.36 mm (No. 8)</td>
<td>95 – 100</td>
</tr>
<tr>
<td>1.18 mm (No. 16)</td>
<td>65 – 87</td>
</tr>
<tr>
<td>600 μm (No. 30)</td>
<td>30 – 60</td>
</tr>
<tr>
<td>300 μm (No. 50)</td>
<td>0 – 20</td>
</tr>
<tr>
<td>150 μm (No. 100)</td>
<td>0 - 5</td>
</tr>
</tbody>
</table>
SECTION 1057
MATERIALS FOR JOINTS

1057.1 Joints for Concrete Pavement, Base, Median, Median Strip, Paved Approach, Curb, Curb and Gutter, Gutter, and Sidewalk.

1057.1.1 Dowel Bars. Dowels for transverse joints shall meet the requirements for AASHTO M 31, AASHTO M 42, or AASHTO M 53 for Plain Rounds. They shall be epoxy coated in accordance with Sec. 1036, except the coating thickness shall be 125 μm (5 mils) minimum, the flexibility of the coating will not apply, and the cut ends are not required to be coated. They shall be free of cutting burrs and other projections. The free end of the dowel bar for a length of at least 280 mm (11 in.) shall be coated with an approved graphite grease. Graphite grease shall contain a minimum of 25 percent graphite and shall be certified by the manufacturer or shown on the container label. It shall be applied in manner that will result in a thorough covering of that section of the bar with a thin uniform coating. Dowel supporting units shall conform to one of the types shown on the plans.

1057.1.2 Tie Bars. Tie bars for longitudinal joints and construction joints shall be round, deformed, and shall meet the requirements of AASHTO M 31, AASHTO M 42, or AASHTO M 53, except that tie bars which are to be bent and straightened shall conform to the requirements of AASHTO M 31, Grade 40.

1057.1.3 Joint Sealants.

1057.1.3.1 Material for sealing joints in new concrete shall be a polymer based hot pour elastic type meeting specification requirements of ASTM D 3405. The product shall be comprised of at least 5 percent crumb rubber. The sealant shall be supplied in solid form which, when melted and properly applied, forms a resilient and adhesive compound that will effectively seal cracks and joints in both asphalt and portland cement concrete pavements. The sealant shall have a minimum pot application life of twelve (12) hours and have a re-heat capability of at least one (1) time after initial heat-up.

1057.1.3.2 Materials for sealing cracks in asphaltic concrete pavements and in previously sealed joints shall be a polymer based hot poured elastic type meeting specification requirements of ASTM D 1190. The product shall be comprised of at least 15 percent crumb rubber. The sealant shall be supplied in solid form which, when melted and properly applied, forms a resilient and adhesive compound that will effectively seal cracks and joints in both asphalt and portland cement concrete pavements. The sealant shall have a minimum pot application life of twelve (12) hours and have a re-heat capability of at least one (1) time after initial heat up.

1057.1.3.3 Material for sealing joints containing grey foam rubber expansion material shall be a one component, pourable grade polyurethane sealant that is self leveling. The product must be supplied ready-to-use in approximately one liter (1 qt.) cartridges with no premixing
requirement. The material shall be capable of adhering to a prepared joint without the use of primers and provide serviceable joint sealant at temperatures between \(-40^\circ C\) and \(82^\circ C\) \((-40^\circ F\) and \(180^\circ F\)). The material shall be supplied in either limestone or grey color.

The following (average) physical properties of the material must be satisfied:

<table>
<thead>
<tr>
<th>Property</th>
<th>Requirement</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tensile Strength</td>
<td>3450 kPa (500 psi)</td>
<td>(ASTM D 412)</td>
</tr>
<tr>
<td>Elongation</td>
<td>1000 percent</td>
<td>(ASTM D 412)</td>
</tr>
<tr>
<td>Penetration</td>
<td>50 to 80</td>
<td>(ASTM D 5*)</td>
</tr>
</tbody>
</table>

*Samples prepared, cured for 96 hours and tested at room temperature.

At \(24^\circ C\) \((75^\circ F)\) and 50 percent relative humidity, a 6 mm \((1/4\text{ in.})\) thickness of sealant will “set” or skin over within 24 hours, and the sealant shall cure completely in one week.

1057.1.4 Preformed Fiber Expansion Joint Material. This material shall conform to the requirements of ASTM D-1751.

1057.1.5 Preformed Rubber Expansion Joint Material. This material shall conform to the requirements of ASTM D-5249.

1057.2 Joints for Concrete Structures.

1057.2.1 Plastic Waterstop.

1057.2.1.1 Material Requirements. Plastic waterstop shall consist of a basic resin of polyvinyl chloride (PVC) with additional resins, plasticizers, and stabilizers as necessary to produce a durable material with a high fatigue point, resistant to acid and alkali solutions, showing little deterioration under accelerated aging tests and shall meet the approval of the engineer. It shall have a tensile strength of not less than 12 400 kPa \((1800\text{ psi})\) and an ultimate elongation of not less than 200 percent.

1057.2.1.2 Manufacture. The waterstop shall be a continuous strip, ribbed on both sides and with a hollow bulb center, a “U” shaped reinforced center-pleat section or other approved type of center section.

1057.2.1.3 The contractor shall furnish a manufacturer’s certification in triplicate, showing typical test results representative of the material and certifying that the material supplied conforms to all of the requirements specified.

1057.2.2 Rubber Waterstop.

1057.2.2.1 Material Requirements. Rubber waterstop shall consist of a durable, elastic, cured rubber compound capable of effectively sealing joints in concrete against the infiltration of moisture. It shall meet the following requirements:
Hardness -- The Shore A durometer hardness shall be 60 to 70.

Elongation -- The elongation shall be not less than 450 percent.

Tensile strength -- The tensile strength shall be not less than 20 700 kPa (3,000 psi).

Water Absorption -- The water absorption shall be a maximum of 5 percent by weight after immersion in water for 2 days at 70°C (158°F).

Tensile Strength After Aging -- The tensile strength of the test specimen, after accelerated aging test of 7 days at 70°C (158°F), shall be not less than 80 percent of the tensile strength prior to the aging test.

The tensile strength of the test specimen, after accelerated aging test of 48 hours in oxygen at 70°C (158°F) and 2070 kPa (300 psi), shall be not less than 80 percent of the tensile strength prior to the test.

Compression Set - The compression set after 22 hours at 70°C (158°F) shall be not more than 30 percent.

Specific Gravity -- The specific gravity shall be 1.17 plus or minus 0.03.

1057.2.2.2 Manufacture. The waterstop shall be manufactured in such manner that the finished product will have an integral cross section that will be dense, homogeneous, and free from porosity and other imperfections. Minor surface defects such as surface peel areas covering less than 625 mm² (1 sq. in.), and surface cavities or bumps less than 6 mm (1/4 in.) in the longest lateral dimension and less than 1.6 mm (1/16 in.) deep, will be acceptable.

1057.2.2.3 Certification. The contractor shall furnish a manufacturer’s certification in triplicate, showing typical test results representative of the material and certifying that the material supplied conforms to all of the requirements specified.

1057.2.3 Copper Sheeting for Flashing. Copper sheeting shall be of soft grade containing not less than 99.7 percent copper, and shall stand being bent cold through an angle of 180 degrees flat upon itself without cracking on the outside of the bent portion. Test specimens shall show elongations in 50 mm (2 in.) of not less than 20 percent. The weight per square meter (sq. ft.) of the sheeting to be used will be shown on the plans. Tolerances in thickness shall conform to ASTM B 248.

1057.2.4 Preformed Sponge Rubber Expansion and Partition Joint Filler. This material shall conform to the requirements of AASHTO M 154, Type I, Sponge Rubber, except that extrusion not to exceed 10.0 mm (2.5 in.) will be permitted for material exceeding 25 mm (1 in.) thick. The sponge rubber may be black, light gray to grayish-buff, or greenish-buff in color.

1057.2.5 Preformed Fiber Expansion Joint Material. This material shall conform to the requirements of AASHTO M 213.
1057.2.6 Concrete Joint Sealer, Hot-Poured Elastic Type. The sealer material shall conform to the requirements of Sec. 1057.1.3.

1057.3 Plastic Joint Compound for Vitrified Clay and Concrete Pipe. This compound shall be homogeneous blend of bituminous or butyl rubber material, inert filler, and suitable solvents or plasticizing compounds thoroughly mixed at the factory to a uniform consistency suitable for sealing joints of vitrified clay and concrete pipe. The compound shall conform to the following requirements:

- Bitumen, soluble in CS$_2$, or Butyl Rubber, (Hydrocarbon Blend), ASTM D 482 with 650$^\circ$C (1200$^\circ$F) max test temperature,
  percent by weight, min .................................. 45
- Ash, percent by weight .................................. 15-50
- Penetration, standard cone, 150 g,
  5 sec., 25 C (use 250 ml sample tin)
  Trowel grade. bulk type.................................. 110-250
  Extruded rope or flat tape type ......................... 50-120

The above penetration ranges include test tolerances. Primer, as recommended by the manufacturer, shall be used with extruded rope or flat tape types, if required to maintain the material in position while pipe sections are being joined.

1057.4 External Sealing Bands for Precast Concrete Structures. Any system, which is intended to band and seal joints for precast concrete structures, shall conform to ASTM C 877.
SECTION 1060
ELECTRICAL CONDUIT

1060.1 Rigid Metallic Conduit and Tubing. This specification covers (1) zinc coated rigid steel conduit, (2) zinc coated electrical metallic tubing, (3) fittings for rigid metal conduit and electrical metallic tubing.

1060.1.1 Rigid Steel Conduit, Zinc Coated. This material shall conform to the requirements of ANSI C80.1, except that conduit shall be galvanized on both the inside and the outside surfaces by the hot-dip process. The weight of zinc coating shall be not less than 153 g/m² (0.5 oz./sq. ft.) of actual coated surface determined in accordance with ASTM A 90 (AASHTO T 65). The zinc coating shall meet the requirements for ductility regardless of the time of manufacture of the conduit. The interior or exterior surfaces, or bath, may be given a coating of suitable material to facilitate installation of wires and cables and to permit the conduit to be readily distinguished from pipe used for other than electrical purposes.

1060.1.2 Electrical Metallic Tubing, Zinc Coated. This material shall conform to the requirements of ANSI C 80.3, except that the weight of zinc coating shall be not less than 153 g/m² (0.5 oz./sq. ft.) of actual coated surface, as determined in accordance with ASTM A 90 (AASHTO T 65). The zinc coating shall meet the requirements for ductility regardless of the time of manufacture of the tubing.

1060.1.3 Fittings for Rigid Metal Conduit and Electrical Metallic Tubing. Fittings shall conform to the requirements of ANSI C 80.4.

1060.1.4 Inspection. Conduit, tubing, and fittings will be inspected for compliance with the specifications, and any desired samples will be taken at either the project location or warehouse, at the option of the engineer. Test specimens for determining the weight of coating will be not less than 50 mm (2 in.) in length, cut not less than 150 mm (6 in.) from the end of the length of conduit or tubing selected for testing. If the prescribed two additional samples for retests are taken, and either does not comply, the lot represented will be rejected.

1060.2 Rigid Nonmetallic Conduit. This specification covers rigid conduit, bends, couplings, and fittings made of PVC (unplasticized polyvinyl chloride). PVC material shall conform to the requirements of the Underwriters’ Laboratories Standard for Rigid Nonmetallic Conduit, UL 651. PVC conduit shall be schedule 40 and conform to the requirements for heavy-wall type.

1060.2.1 Inspection. The materials will be inspected for compliance with the specifications, and any desired samples will be taken at either the project location or warehouse, at the option of the engineer.

1060.2.2 Certifications. If requested by the engineer, the contractor shall furnish a
manufacturer’s certification in triplicate, showing typical test results representative of the material, and certifying that the material supplied conforms to all of the requirements specified.
SECTION 1070
WATER

1070.1 Water.

1070.1.1 Water for use in mixing and curing concrete, and in mortar and grout, shall be reasonably clean; shall be free from injurious amounts of oil, acid, alkali salt, organic matter, vegetable matter, or other deleterious substances; and shall meet the requirements of AASHTO T 26.

1070.1.2 Water approved by the St. Charles County Department of Health for drinking purposes may be accepted without being tested. Requirements for testing water for mixing or curing purposes may be waived when, in the judgment of the engineer, the water is considered satisfactory for the purpose.
SECTION 1074
GEOTEXTILE

1074.1 Scope. This specification covers geotextile for use in subsurface drainage, sediment control, erosion control or as a permeable separator.

1074.2 Material. Geotextiles shall meet the physical and chemical requirements of AASHTO M 288 for the specified application except as modified herein.

1074.2.1 General
1074.2.1.1 No specific permeability values are required.

1074.2.1.2 The U.S. Standard sieve number corresponding to the apparent opening size (AOS) shall not exceed 150 \(\mu m\) (100) for geotextile used in contact with any soil with more than 50 percent passing the 75 \(\mu m\) (No. 200) sieve nor shall the AOS exceed 212 \(\mu m\) (70) when used between any two dissimilar granular material, less than 50 percent passing the 75 \(\mu m\) (No. 200) sieve, or when used to control movement of fines from a granular backfill through structural joints or into a drain pipe.

1074.2.1.3 During shipment and storage, geotextiles shall be protected from direct sunlight, ultra-violet rays, temperatures greater than 60\(^\circ\)C (140\(^\circ\)F), mud, dust and debris.

1074.2.2 Type 1, Subsurface Drainage. Type 1 geotextile is intended for use in subsurface drainage as a filter to protect drainage media from clogging with fines from adjacent soil. Typical applications include lining of drainage trenches and wrapping drain pipes.

1074.2.2.1 The minimum permittivity shall be 1.3 sec\(^{-1}\).

1074.2.2.2 The material may be either AASHTO Class A or Class B unless otherwise specified.

1074.2.2.3 When material is furnished in the form of a knitted or woven sock to be stretched to fit snugly around perforated pipe, the grab strength requirements for AASHTO Class B applications may be reduced by 33 percent provided the minimum elongation is greater than 50 percent.

1074.2.3 Type 2, Sediment Control. Type 2 geotextile is intended for use in supported or non-supported sediment control fencing.

1074.2.4 Type 3, Erosion Control. Type 3 geotextile is intended for uses such as erosion control of slopes and channels when placed under rock blanket, rock ditch liner, etc.
1074.2.4.1 The minimum permittivity shall be 1.0 sec\(^{-1}\).

1074.2.4.2 The material may be either AASHTO Class A or Class B unless otherwise specified.

1074.2.5 **Type 4, Separation.** Type 4 geotextile is intended for use as a separation material to prevent mixing of dissimilar material and to control migration of backfill material through joints in structural elements. Typical applications include use between soil and select granular backfills behind retaining structures, box culvert joint wraps, placement behind mechanically stabilized earth wall facing panels, cover for drainage blankets and soil/rock fill separation in slide repairs.

1074.2.5.1 The minimum permittivity shall be 1.0 sec\(^{-1}\).

1074.2.5.2 The material may be either high or medium survivability level unless otherwise specified.

1074.3 **Certification and Acceptance.**

1074.3.1 The contractor shall furnish a manufacturer's certification to the engineer, for each lot of material furnished stating the name of the manufacturer, the chemical composition of the filaments or yarns and certifying that the material supplied conform to all requirements specified. The certification shall include or have attached typical results of tests from specific lots for all specified requirements.

1074.3.2 Acceptance of the material will be based on the manufacturer's certification and upon the results of such tests as may be performed by the engineer.
SECTION 1075
GEOGRID SYSTEMS

1075.1 All requests for geogrid stabilization systems must be accompanied by a soils report and slope reinforcement design, submitted by a certified geotechnical consultant possessing a Professional Engineer’s license to practice in the State of Missouri.

1075.2 Geogrid material shall be an open mesh structure that is dimensionally stable and which is manufactured specifically for soil reinforcement. The following minimum property values for each geogrid material used will be specified by the consultant.

<table>
<thead>
<tr>
<th>Property</th>
<th>Test Method*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Long Term Design Load</td>
<td>GG4</td>
</tr>
<tr>
<td>Tensile Modulus</td>
<td>GG1</td>
</tr>
<tr>
<td>Junction Strength</td>
<td>GG2</td>
</tr>
<tr>
<td>Interaction Coefficient</td>
<td>GG5</td>
</tr>
</tbody>
</table>

*Test Method Standards - Geosynthetic Research Institute or related ASTM Standard.

The consultant may impose additional requirements on materials used in the fabrication of geogrid systems.

1075.3 The manufacturer shall submit product information and a certification from an independent testing laboratory that the material meets or exceeds the required property specifications.

1075.3.1 If requested, the manufacturer shall submit material samples to the engineer for testing. Sample sizes will be based on the type and pattern of grid proposed for use.