A.L. FRANKS ENGINEERING

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El Dorado, AR 71730
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ADDENDUM NO. 1

TO: ALL PLAN HOLDERS

RE: ADEM GODFREY DRAINAGE IMPROVEMENTS-
CITY OF MONTICELLO, ARKANSAS
MNT-01-23

ADDENDUM DATE: March 13, 2024

BID DATE: March 14, 2024

The Plans, Specifications and Contract Documents for the above referenced project are hereby modified as follows:

1. Remove and Replace Bid Proposals. **See Bid Items 19 and 20**
2. Remove Technical Specifications with the attached Technical Specifications. **See the attached Appendix A added to the end of the Technical Specifications.**

Clarification: RollMax Erosion Control Matting shall be placed for the full length of the ditch except for the locations shown to have Rip Rap.

ADDENDUM NO. 1 ISSUED BY:

A.L. FRANKS ENGINEERING

STATE OF ARKANSAS LICENSED PROFESSIONAL ENGINEER No. 21958 CODY J. STRINGER

Cody Stringer, P.E.
Project Manager

CITY OF MONTICELLO, ARKANSAS

GODFREY DITCH DRAINAGE IMPROVEMENTS

BID PROPOSAL

ITEM	QTY	UNIT	DESCRIPTION	UNIT PRICE	TOTAL PRICE
1	1	L.S.	Mobilization including preparatory work and operations, including but not limited to, movement of personnel, equipment, supplies, and incidentals to the project site for the lump sum price of _____ Dollars and _____ Cents/L.S	$ _____	$ _____
2	320	L.F.	Clearing, grubbing, removal and disposal of existing site features within the project boundary including but not limited to debris of various types, brush and any other existing site features encountered within the **Ditch #1** project area for the unit price of _____ Dollars and _____ Cents/L.F.	$ _____	$ _____

ITEM	QTY	UNIT	DESCRIPTION	UNIT PRICE	TOTAL PRICE
3	510	L.F.	Clearing, grubbing, removal and disposal of existing site features within the project boundary including but not limited to debris of various types, brush and any other existing site features encountered within the **Ditch #2** project area for the unit price of _____ Dollars and _____ Cents/L.F.	$_____	$_____
4	560	L.F.	Clearing, grubbing, removal and disposal of existing site features within the project boundary including but not limited to debris of various types, brush and any other existing site features encountered within the **Ditch #3** project area for the unit price of _____ Dollars and _____ Cents/L.F.	$_____	$_____

ITEM	QTY	UNIT	DESCRIPTION	UNIT PRICE	TOTAL PRICE
5	390	L.F.	Clearing, grubbing, removal and disposal of existing site features within the project boundary including but not limited to debris of various types, brush and any other existing site features encountered within the **Ditch #4** project area for the unit price of _____ Dollars and _____ Cents/L.F.	$_____	$_____
6	790	L.F.	Clearing, grubbing, removal and disposal of existing site features within the project boundary including but not limited to debris of various types, brush and any other existing site features encountered within the **Ditch #5** project area for the unit price of _____ Dollars and _____ Cents/L.F.	$_____	$_____

ITEM	QTY	UNIT	DESCRIPTION	UNIT PRICE	TOTAL PRICE
7	1	L.S.	Removal and disposal of existing 36" culverts and asphalt within the project boundary including but not limited to excavation, sawcutting, removal and disposal as necessary per the plans and specifications for the lump sum price of _____ Dollars and _____ Cents/L.S.	$ _____	$ _____
8	320	L.F.	Regrade **Ditch #1** as need to restore unobstructed flow and stabilization as necessary per the plans for the unit price of _____ Dollars and _____ Cents/L.F.	$ _____	$ _____

ITEM	QTY	UNIT	DESCRIPTION	UNIT PRICE	TOTAL PRICE
9	510	L.F.	Regrade **Ditch #2** as need to restore unobstucted flow and stabilization as necessary per the plans for the unit price of _____ Dollars and _____ Cents/L.F.	$ _____	$ _____
10	560	L.F.	Regrade **Ditch #3** as need to restore unobstucted flow and stabilization as necessary per the plans for the unit price of _____ Dollars and _____ Cents/L.F.	$ _____	$ _____

ITEM	QTY	UNIT	DESCRIPTION	UNIT PRICE	TOTAL PRICE
11	390	L.F.	Regrade **Ditch #4** as need to restore unobstucted flow and stabilization as necessary per the plans for the unit price of _____ Dollars and _____ Cents/L.F.	$ _____	$ _____
12	790	L.F.	Regrade **Ditch #5** as need to restore unobstucted flow and stabilization as necessary per the plans for the unit price of _____ Dollars and _____ Cents/L.F.	$ _____	$ _____

ITEM	QTY	UNIT	DESCRIPTION	UNIT PRICE	TOTAL PRICE
13	395	L.F.	Cleanout culverts and regrade **Ditch #6** as need to restore unobstucted flow and stabilization as necessary per the plans for the unit price of _____ Dollars and _____ Cents/L.F.	$ _____	$ _____
14	30	L.F.	Furnish and install all material, equipment, and labor for placement of double 4'x4' box culverts including grading, subgrade, compaction, concrete, reinforcment, and any incidentals to the project site as shown in the plans and specifications for the unit price of _____ Dollars and _____ Cents/L.F.	$ _____	$ _____

BID PROPOSAL CONTINUED

ITEM	QTY	UNIT	DESCRIPTION	UNIT PRICE	TOTAL PRICE
15	1	L.S.	Furnish and Install all material, labor, and equipment, for placement of cast in place headwall and wing walls for a straight culvert inlcuding grading, subgrade, compaction, concrete, reinforcement, and any incidentals to the project site as shown on the plans and specifications for the lump sum price of _____ Dollars and _____ Cents/L.S.	$_____	$_____
16	1	L.S.	Furnish and Install all material, labor, and equipment, for placement of cast in place headwall and wing walls for a special headwall on the north side of the box culverts inlcuding grading, subgrade, compaction, concrete, reinforcement, and any incidentals to the project site as shown on the plans and specifications for the lump sum price of _____ Dollars and _____ Cents/L.S.	$_____	$_____

ITEM	QTY	UNIT	DESCRIPTION	UNIT	TOTAL
17	1,600	S.Y.	Furnish all equipment, material, and labor to install 12”-18” Rip Rap drainage (24” Min. Depth) 35 lb. min. on filter fabric including any grading or suitable backfill per the plans and specifications for the unit price of _____ Dollars and _____ Cents/S.Y.	$ _____	$ _____
18	28	S.Y.	Furnish and Install ACHM Surface Mix (3" avg. thickeness) including tack coat, 9" class 7, sawcutting, handwork, compaction and all incidentals required for complete installation as shown in the plans and specifications for the unit price of _____ Dollars and _____ Cents/S.Y.	$ _____	$ _____

ITEM	QTY	UNIT	DESCRIPTION	UNIT	TOTAL
19	8,050	SY	Provide and Install RollMax erosion Control product C350 or approved equal for channel sideslope armor from top of bank to top of bank, including fill material, site work, anchors, labor and equipment necessary to install the system in accordance with manufacturer recommendations extending from beyond top of bank to top of bank at the locations shown in the plans and further described in the specifications for the unit price of _____ Dollars and _____ Cents/SY	$ _____	$ _____
20	8,050	SY	Perform seeding (Spring/Summer of 2024) with approved ARDOT seed mixture to establish permanent vegetation along channel sideslopes upon final grading of work areas as shown in the plans and specifications for the unit price of _____ Dollars and _____ Cents/SY	$ _____	$ _____
			TOTAL OF ALL ITEMS	$ _____	

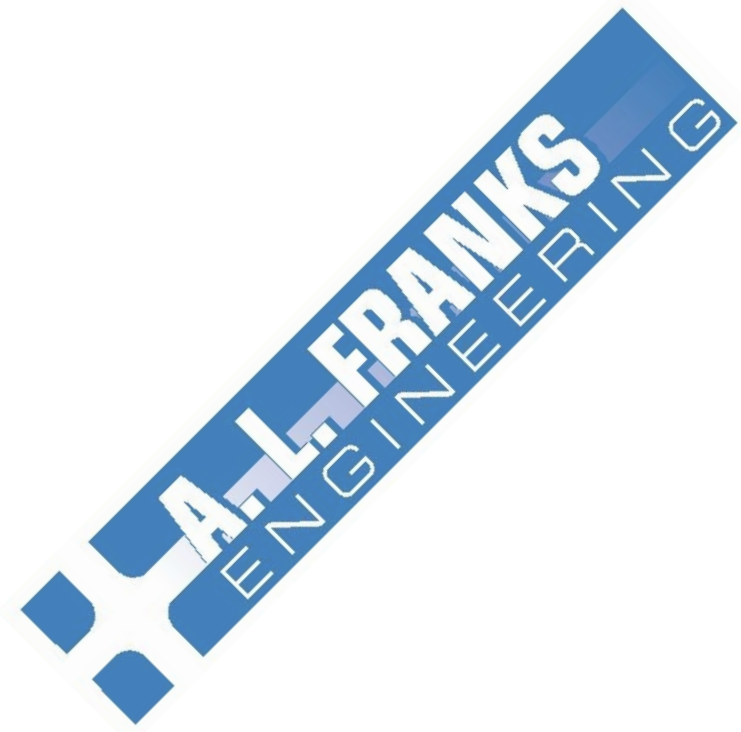
NOTES:

1. Submission of the completed Bid Proposal is considered evidence to the Owner that the Contractor fully and clearly understands the complete scope of work and all actions and materials required to complete the work.

2. Items required but not specifically called out in the Bid Proposal shall be included in other items.

3. Time required to complete the base bid work shall be __90__ calender days.

TECHNICAL SPECIFICATIONS



A.L. FRANKS ENGINEERING

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TECHNICAL SPECIFICATIONS

All construction requirements will meet the *ARKANSAS 2014 STANDARD SPECIFICATION FOR HIGHWAY CONSTRUCTION*. In the event that the technical specifications and the *ARKANSAS 2014 STANDARD SPECIFICATION FOR HIGHWAY CONSTRUCTION* contradict each other, the more stringent shall govern.

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SECTION 201

CLEARING AND GRUBBING

201.01 Description. This work shall consist of cutting, removing from the ground, and properly disposing of trees, stumps, hedge, brush, roots, logs, weeds, rubbish, sod, refuse dumps, sawdust piles, lumbering slash, and other materials within the limits of the right of way or other designated areas which interfere with the work or are considered objectionable.

This work shall also include selective clearing, preserving existing vegetation, scalping, and the preservation of objects designated to remain.

201.02 General. Areas shall be classified as clearing and/or grubbing when trees are 4" or more in diameter, measured 12" above the ground. The area shall be classified as scalping if the trees or stumps are less than 4" in diameter measured 12" above the ground.

(a) **Clearing.** The cutting and removal of all trees, brush, and other objectionable growth, and the removal and disposal of logs, rubbish piles, refuse dumps, sawdust piles, lumbering slash, and other objectionable matter from the surface of the ground in the areas shown on the plans or designated by the Engineer.

(b) **Grubbing.** The grubbing and removal of all stumps, roots, and other objectionable matter, lying wholly or in part below the surface of the ground.

(c) **Selective Clearing.** The trimming of selected trees and shrubs, the removal from the ground and disposal of logs, root pods, brush, refuse dumps, and other undesirable debris, and the cutting, removal, and disposal of all undergrowth, stumps, and standing trees, except those trees and shrubs designated to be preserved. The selective clearing areas will be shown on the plans.

(d) **Preserved Vegetation.** Areas of the right of way containing trees and brush and designated on the plans as Preserved Vegetation areas shall not be disturbed except as described below. This operation normally applies to areas of natural growth occurring in the medians, interchanges, and wide rights of way between a line 10' beyond the construction limits and the right of way lines, or as designated.

(e) **Scalping.** Areas not classified as clearing and grubbing and which are within construction limits shall be scalped, if appropriate. Scalping shall include the removal and disposal of material such as saplings less than 4" in diameter measured

12" above the ground, logs, brush, roots, grass, residue of agricultural crops, refuse dumps, and decayed matter.

(f) **Clearing and Grubbing Trees.** The cutting, grubbing, and removal of individual, isolated trees and stumps greater than 4" diameter measured 12" above the ground as shown on the plans or designated by the Engineer to be removed.

201.03 Construction Requirements. The right of way for the project shall be cleared as defined above, except those objects designated to remain shall be carefully protected from abuse, marring, or damage during construction operations. Trees shall be felled and removed in such a manner as to avoid injury to other trees or other objects designated to remain. In case of injury to bark, limbs, or roots of vegetation designated to remain, the Contractor shall repair such damage by corrective pruning or other appropriate methods. Trees or other debris falling outside the right of way shall be removed and disposed of in accordance with these specifications.

Holes remaining after removal of trees, stumps, etc., shall be backfilled with material approved by the Engineer and compacted as directed except in areas to be excavated. The Contractor shall complete the operation by blading, bulldozing, or other approved methods, so that the right of way shall be free of holes, ditches, or other abrupt changes in elevations that resulted from the clearing and grubbing operations.

Parking and/or servicing of equipment under the branches of trees designated to remain will not be allowed when the Engineer considers the extent of such activity to be abusive or detrimental to the retained vegetation.

201.04 Clearing and Grubbing. The right of way shall be cleared of stumps, brush, logs, rubbish, trees, and shrubs, with the exception of such trees, shrubs, and areas designated on the plans or by the Engineer for preservation. Grubbing will not be required in areas which will have a fill height of 3' or more above undisturbed stumps cut within 6" of the natural ground. Sound stumps may be left outside the construction limits when they are severed flush with or below the natural ground, or the slope line in areas to be rounded at the top of the back slopes.

Low-hanging, unsound, or unsightly branches shall be removed from trees or shrubs designated to remain. Branches of trees extending over the roadbed shall be trimmed to give a clear height of 20' above the roadbed surface. Trimming shall be done by skilled workers and in accordance with good tree surgery practices.

Merchantable timber in the clearing area which has not been removed from the right of way prior to the beginning of construction shall become the property of the Contractor, unless otherwise provided.

When perishable material is burned, it shall be under the constant care of a competent watcher. Burning shall be accomplished at such times and in such manner that the surrounding vegetation, adjacent property, or anything designated to remain on

the right of way will not be jeopardized. Upon notice from the Engineer that meteorological conditions render burning undesirable, the Contractor shall cease all burning until such time as the Contractor is notified by the Engineer that meteorological conditions are suitable for a resumption of burning operations.

When specified, burning will not be permitted unless the material to be burned is placed in an incineration pit and an acceptable forced air combustion device is used that will minimize the emission of smoke, fly ash, and other pollutants. This device shall be constructed so that the forced air is directed over the fire by the use of plenums or ducts. The use of open fans or mulch blowers will not be permitted. The Contractor shall comply with all Federal, State, County, and City laws, regulations, or ordinances applicable to the disposal of clearing and grubbing material.

Materials and debris which cannot be burned shall be removed from the right of way and disposed of at locations off the project, outside the limits of view from any public road, street, park, or other public facility. As an alternate, the materials may be buried and the area seeded in accordance with Section 620 at no cost to the Owner. In either case, the Contractor shall have a written agreement with the property owner.

The Contractor shall make all necessary arrangements with the property owner for obtaining suitable disposal locations and the cost involved shall be included in the price bid for the applicable items. Copies of all agreements with property owners are to be furnished to the Engineer.

When the Contractor completes work at the disposal sites, the Engineer will inspect the sites and if found in accordance with the agreement, will release the Contractor from further responsibility for the disposal site. The Contractor shall be responsible for resolving disputes or claims arising from the disposal operation.

201.05 Selective Clearing. This work shall be performed in such a manner so as to leave the designated areas in a park-like condition and susceptible to economical mowing. Disposal of all material shall conform to the methods set out in the Clearing and Grubbing requirements. Trees will normally be selected which will give a spacing of 20 to 30 feet.

Stumps, trees, and shrubs, except those designated to be preserved, shall be severed flush with or below the ground.

Trimming of selected trees and shrubs shall be done in such a manner that they will not be otherwise damaged.

Movement and operation of equipment shall be such that roots, branches, and trunks of trees and shrubs selected for retention will not be scarred, broken, or otherwise damaged to the extent that the life of the plant is endangered.

201.06 Preserved Vegetation. Trees, shrubs, brush, vines, and other natural perennial vegetation shall be allowed to remain in the areas designated on the plans and as directed by the Engineer.

Clearing and grubbing may be required through preserved vegetation areas for drainage outlets, channels, or other required construction.

Where fence is to be installed along the right of way line in wooded areas, the Contractor may clear a strip approximately 10' wide within the right of way to accommodate fence erection equipment. The Contractor shall exercise care so that trees, shrubs, and brush to remain are not damaged.

201.07 Scalping. The Contractor shall scalp areas where excavation or embankment is to be made, except that mowed sod need not be removed where the embankment to be constructed is more than 3' in height.

Suitable material resulting from the scalping operations shall be placed the finished slopes, adjacent to the area from which it is obtained, after the excavation or embankment operations are complete.

Unsuitable material shall be disposed of as specified for Clearing and Grubbing. In areas where excess scalped material is encountered the excess material shall be wasted in accordance with subsection 210.08.

201.08 Method of Measurement and Payment. Clearing and Grubbing, Selective Clearing, and Clearing and Grubbing Trees will not be measured for separate payment and will be considered subsidiary to the appropriate item included in the bid schedule.

SECTION 202

REMOVAL AND DISPOSAL OF STRUCTURES

202.01 Description. This item shall consist of the removal and satisfactory disposal of curb and curb and gutter; portland cement or asphalt concrete driveways, parking areas, sidewalks and steps, and concrete pavement; existing fence, guard rail, retaining walls, manholes, catch basins, concrete or masonry basements, foundations, or slabs, tanks and lines, and old culverts, all of which are not designated or permitted to remain. The work may also include demolishing and/or Special Provisions, together with all appurtenances, either attached or detached, including but not limited to canopies, porches, awnings, piping, poles, attached signs, auxiliary buildings or sheds.

The provisions of Section 202 shall not apply to underground petroleum storage tanks.

202.02 General. The attention of the bidder is directed to the necessity for careful examination of the entire site to determine, at the time of bid preparation, the full extent of work to be accomplished. The entire site shall be cleared of all man-made obstructions and debris, of whatever nature, and prepared in all respects for the construction of the highway facilities.

The Contractor shall not unnecessarily interfere with the use of any adjacent sidewalks, streets, or roads.

Salvage materials in buildings to be demolished and materials in other man-made obstructions will become the property of the Contractor and shall be removed from the job site. The Contractor shall have no claim against the Owner because of the absence of any pre-existing buildings, materials, equipment, or fixtures from the items to be removed.

Moveable buildings remaining for the Contractor's disposition may be removed from the right of way intact if the Contractor so elects, or they may be demolished in place with the removal of resulting material and debris.

202.03 Construction Requirements. The disposal of all materials and debris shall be in accordance with the requirements of Section 201.

All surface items such as curb or curb and gutter, driveways, parking areas, walks, steps, pavement, and walls shall be separated or broken away from the adjacent part of any structure designated to remain in place by a vertical saw cut along the line designed by the Engineer. The edge of the structure left in place shall be approximately

vertical with no abrupt change sin alignment. Any damage to or removal of the structure designated to remain in place shall be repaired or replaced at no cost to the Owner.

Holes, ditches, or other abrupt changes in elevation caused by the removal operations which could obstruct drainage or be considered hazardous or unsightly shall be backfilled, compacted, and left in a workmanlike condition.

Old culverts or parts thereof that interfere with the new construction shall be removed. Steel and timber superstructures and abutments, and the tops of all concrete and masonry box culverts that are to be abandoned shall be removed entirely. Concrete and masonry abutments shall be removed entirely or broken down to an elevation at least 2' below the subgrade elevation.

Where old box culverts or pipe culverts are to be extended or otherwise incorporated into the new work, only such part of the old structure shall be removed as to provide a proper connection to the new work. The connecting edges or joints shall be cut, chipped, and trimmed to the required lines and grades without weakening or damaging the part of the structure to be retained.

Work required in cutting back an existing concrete box culvert which is to be extended shall be accomplished in accordance with the applicable standard drawing. For a pipe culvert extension, the headwall and the attached end joint of concrete pipe or the flared end section on all types of pipe shall be removed to accommodate the extension.

Pipe culverts, the tops of which are located within 3' of the elevation of the finished roadway, shall be removed. Pipe culverts at lower elevations, if in suitable condition in the judgment of the Engineer, may be abandoned in place, in which case the headwalls shall be removed and the ends of the culvert plugged by means of concrete or large dumped rock plugs, at no cost to the Owner.

Material from old culverts, determined by the Engineer to have salvage value, shall become the property of the Owner. Salvaged material shall be carefully removed to avoid damage and shall be placed in neat piles of like material outside the construction limits but within the right of way. Other salvaged material shall be disposed by the Contractor as approved by the Engineer.

At the Contractor's option, and to the extent compatible with proper progress of the work, the removal of existing masonry may be coordinated with the grading operation. Broken concrete, stone, brick, and like material may be placed in embankments in parallel layers, with no material closer than 12" to the subgrade surface. The voids shall be completely filled with suitable material and thoroughly compacted. The material may be used in the construction of riprap, tree wells, and similar structures. When used as riprap, broken concrete shall meet the requirements of Section 816.

Trenches resulting from the removal or demolition of old culverts shall be filled with approved material placed in layers in accordance with Section 606.

Existing basements, sumps, pits, septic tanks, or wells which are outside the construction limits shall be backfilled as soon as possible. Backfill shall be compacted to the extent practicable. Masonry and broken concrete, free of organic matter, may be used for such backfill to an elevation no less than 2' below finished elevation. The area shall be dressed and left in a neat condition.

Masonry foundations shall be obliterated, or if in fill sections, may be left in place if covered by not less than 2' of embankment. Floor slabs left in place shall be shattered and left in a permeable condition. Broken concrete, free of protruding reinforcing steel, may be placed in embankment in accordance with subsection 210.09 covering the use of rock in embankment.

Tanks shall be removed from the site and the resulting excavation backfilled as specified above. Extreme care shall be exercised to avoid inadvertently cutting any buried fuel lines which may be under pressure. Fuel tanks shall be purged before removal.

The Contractor may clear a strip approximately 10' wide within the right of way to accommodate removal equipment. Clearing shall be performed in accordance with Section 201.

202.04 Method of Measurement and Payment. The removal and disposal of the structures covered by this specification will be paid for based on the percentage of work performed and on the total lump sum bid price. The Engineer will approve percentage based pay requests prior to payment.

SECTION 210

EXCAVATION AND EMBANKMENT

210.01 Description. This item shall consist of excavation, construction of embankment, and disposal or compaction of all material which is encountered within the limits of the work not being removed under some other item. The work shall be accomplished in reasonably close conformity with the lines, grades, thicknesses, and typical cross sections shown on the plans or established by the Engineer. All excavation will be classified as common excavation, rock excavation, unclassified excavation, muck excavation, or borrow as hereafter described.

210.02 Common Excavation. Common excavation shall consist of all excavation not included as rock excavation or excavation which is otherwise classified.

210.03 Rock Excavation. Rock excavation shall consist of igneous, metamorphic, and sedimentary rock which cannot be excavated without blasting or the use or rippers, and all boulders or other detached stones each having a volume of ½ cubic yard or more.

210.04 Unclassified Excavation. Unclassified excavation shall consist of the excavation and disposal of all materials of whatever character encountered in the work.

210.05 Muck Excavation. Muck excavation shall consist of the removal and disposal of highly saturated mixtures of soil and organic matter, not suitable for use in embankments. This item shall be used only when included in the contract, unsuitable material shall be removed in accordance with subsection 210.08.

210.06 Borrow. Borrow material shall consist of a soil, or a mixture of soil and stone or gravel or other acceptable material, reasonably free from sod, stumps, logs, roots, or other perishable or deleterious matter, and shall be capable of forming a stable embankment when compacted. The stone or gravel shall be of such size as not to interfere with compaction requirements specified in subsection 210.10. Unless otherwise designated in the contract, the Contractor shall make arrangements for obtaining borrow and shall pay all costs involved.

The Contractor shall notify the Engineer sufficiently in advance to allow sufficient time for testing the borrow material.

210.07 Construction Requirements. General. The excavation and embankments for the roadway, intersections, and entrances shall be finished to

reasonably smooth and uniform surfaces. No materials shall be wasted unless they are surplus to the needs of the job and only with the permission of the Engineer.

Unless otherwise specified, rock shall be excavated to a minimum depth of 8" and not to exceed a maximum depth of 12" below subgrade within the limits of the roadbed, and the excavation backfilled with material designated on the plans or approved by the Engineer. Care shall be taken that undrained pockets shall not be left in the surface of the rock.

Borrow material should not be placed until after suitable roadway excavation has been placed in the fill.

Obliteration of old roadways shall include filling of all ditches and rough grading of the old roadway to restore approximately the original contour of the ground or to produce a pleasing appearance by forming natural, rounded slopes. Roadway obliteration will be paid for as excavation.

Unless otherwise provided for on the plans or in the specifications, the removal of any existing base course or asphalt pavement necessary for constructing new pavement connections, or of asphalt paving in existing island locations or other areas not specifically addressed, will be measured and paid for as unclassified excavation.

When the Contractor's excavation operations encounter remains of prehistoric people's dwelling sites or artifacts of historical or archaeological significance, the operations shall be temporarily discontinued. The Engineer will contact archaeological authorities to determine the disposition thereof.

Where excavation to the finished grade section results in a subgrade or slopes of unsuitable soil, the Engineer may require the Contractor to remove the unsuitable materials and backfill to the finished grade section with approved material. The Engineer may designate as unsuitable those soils that cannot be stabilized in place through normal drying and compactive efforts, when satisfactory weather and ground conditions exist. The Contractor shall conduct construction operations in such a way that the engineer can take the necessary cross section measurements before the backfill is placed.

In the construction of embankment, grading operations shall be conducted, as far as practicable, so that the most suitable soil is placed in the top layer of the embankment. To that end, the Engineer may order specific excavated materials, either from the regular roadway section or from borrow pits, placed in stockpiles for future use.

It is intended that the right of way be left in a neat and presentable condition at the completion of the grading work, and especially that it be left in a condition to be economically mowed where terrain will permit. To that end, stump holes, piles of loose material, and other scars on the surface shall be dressed by use of a motor patrol or

other suitable equipment. No direct payment will be made for this work but it shall be considered as a part of the several items of excavation.

Particular care and discretion shall be exercised in the location and use of haul lanes through tree screens in order to preserve existing growth. Haul lanes shall have prior approval by the Engineer.

210.08 Excavation Operation. All suitable material removed from the excavation shall be used, as far as practicable, in the formation of the embankment, in the subgrade, slopes, and shoulders, and at such other places as directed. All unsuitable material removed shall be placed on the slopes or other locations as designated by the Engineer.

The excavation of muck shall be handled in a manner that will not permit the entrapment of muck within the backfill. The Contractor shall allow the Engineer adequate time to take all necessary elevations and measurements for determining the volume of muck excavation removed. The backfilling of the excavated area shall follow immediately behind the excavation of the muck. The material used for backfilling of the excavated area shall follow immediately behind the excavation of the muck. The material used for backfilling up to the ground line or water level, whichever is higher, shall be rock or other suitable granular material selected from the roadway excavation or obtained from other approved sources.

All excess or unsuitable excavated material that cannot be used in embankments may be placed on the side slopes of the nearest fill in a satisfactory manner and shall be placed so as to maintain a distinct shoulder line by generally keeping all such material at least 24" below the subgrade elevation. Excavated material that cannot be utilized as described above shall be hauled away and disposed of by the Contractor. Selection and procurement of sites for the disposal of such material shall be the responsibility of the Contractor subject to the approval of the Engineer. Excess or unsuitable material shall not be left in unsightly piles but shall be leveled off and/or shaped so as to present a neat appearance and not obstruct drainage. The work involved in disposing of excess or unsuitable material, including hauling, shall not be paid for directly but shall be considered as a part of the work pertaining to the several classes of excavation.

Except in solid rock or other materials which in the judgment of the Engineer require a modified slope, all slopes shall be trimmed to the slopes shown in the cross section drawings, and care must be exercised so that no material shall be loosened below the required slopes. All roots, stumps, and other foreign matter in the sides and bottoms of the ditches or drainage outlets shall be removed or cut to conform to the slope, grade, and shape of the section shown. Side ditches shall be excavated reasonably true to lines, grades, and cross sections as shown on the plans or as directed.

Where excavation can be performed only by drilling and blasting, a presplit or breakline shall be produced along the cut slope, except presplitting will not be required in cuts less than 6' in depth. In blasting rock on side slopes less than 6' in depth, a reasonably uniform face shall be left, regardless of whether or not the excavation is carried beyond the specified slope. All breakage and slide materials shall be removed by the Contractor and disposed of as directed.

The presplitting or breakline involves a single row of holes drilled along the neat excavation line and the blasting charge fired before any adjoining main excavation area is blasted. To establish the breakline, holes for presplitting shall be so spaced and of such diameter that they can be properly loaded and tamped in such a manner as to produce a relatively smooth plane along the designated backslope prior to shooting the interior portion of the cut. The exact spacing and diameter shall be determined by the Contractor to accomplish the desired finished section and shall be changed if the pattern of drilling and blasting fails to do so. In the event the cut is too deep for the presplitting to be done in one operation, an 18" offset or bench will be allowed for each succeeding line of drill holes. Presplitting operations shall be discontinued when the rock face is of such character that no apparent advantage is gained.

The Contractor's attention is called to the fact that where traffic must be maintained, all necessary precaution shall be taken to protect the traveling public during blasting operations. The Contractor will be required to comply with all Federal, State, and local laws and regulations pertaining to the use of explosives.

Boulders and rock fragments not incorporated in embankments shall not be left scattered about over the right of way but shall be disposed of as directed. Payment will be made for the removal of such material from its original position only.

210.09 Embankment Construction. Embankment construction shall consist of constructing roadway embankments, including preparation of the areas upon which they are to be placed; the construction of dikes within or outside the right of way; the placing and compacting of approved material within roadway areas where unsuitable material has been removed; and the placing and compacting of embankment material in holes, pits, and other depressions within the roadway area. Only approved materials shall be used in the construction of embankments and backfills.

Rocks, broken concrete, or other solid materials shall not be placed in embankment areas where piling is to be placed or driven.

When embankment is to be placed and compacted on hillsides, or when new embankment is to be compacted against existing embankments, or when embankment is built ½ width at a time, the slopes shall be continuously benched as the work is brought up in layers. Benching shall be of sufficient width to permit operations of placing and compacting equipment. Each horizontal cut shall begin at the intersection of the original ground and the vertical sides of the previous cuts. Unless otherwise specified, suitable material thus cut out shall be recompacted along with the new

embankment material at no cost to the Owner. If the engineer directs such material to be wasted or placed in another location, the excavated material will be measured and paid for under the appropriate item of excavation.

Unless otherwise shown on the plans, where an embankment is to be made, all sod and vegetable matter shall be removed from the surface upon which the embankment is to be constructed and later placed on the completed embankment slopes. The cleared surface shall then be completely broken up by plowing, scarifying, or disking to a minimum depth of 6 inches. This area shall then be recompacted in accordance with subsection 210.10.

Whenever a compacted road surface containing asphalt or granular material lies within 3' of the subgrade, such old road surface shall be scarified to a depth of at least 8 inches. This scarified material shall then be recompacted to a stable condition.

If embankment material can be deposited on one side only of abutments, wing walls, 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 or excessive pressure against the structure. When noted on the plans, the fill adjacent to the end bent of a bridge shall not be placed higher than the bottom of the backwall of the bent 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 always at approximately the same elevation on both sides of the structure.

Roadway embankment shall be placed in parallel layers not exceeding 8", loose measurement, and shall be compacted as specified before the next layer is placed. Effective spreading equipment shall be used on each lift to obtain uniform thickness prior to compacting. As the compaction of each layer progresses, continuous leveling and manipulating will be required to assure uniform density. Water shall be added or removed, if necessary, in order to obtain the required density. Construction equipment shall be routed uniformly over the entire surface of each layer.

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 may be placed in the embankment in layers not exceeding in thickness the approximate size of the larger rocks (30" maximum). Rock or boulders too large to permit placing in 30" layers shall be reduced in size as necessary to permit this placement. The 12" of the embankment immediately below finished subgrade may be placed in one layer with no rock exceeding 8" in its greatest dimension. Each layer shall be constructed so that rock voids are substantially filled with rock fines and/or earth. The rock shall be placed and manipulated in uniform layers and rock fines and/or earth shall be distributed throughout each embankment layer and manipulated as herein indicated. Rock shall not be end dumped over the edges of the layer being constructed, but shall be deposited on the layer and moved ahead so as to advance the layer with a mixture of rock fines and/or earth.

Construction of the embankment by casting material directly into place with draglines, cableways, or other similar machines will not be permitted.

The Contractor shall be responsible for the stability of all constructed embankments and shall replace, at no cost to the Owner, any portions which have become displaced due to carelessness or negligent work. After the completion to a section of roadway, it shall be maintained at finish grade and cross section by blading when and to the extent directed by the Engineer.

In those portions of embankments which are immediately adjacent to structures or are for other reasons inaccessible to the compaction equipment in use, only suitable material shall be used and it shall be placed in successive parallel layers of not more than 6" thickness, loose measurement. Each layer shall be uniformly mixed and compacted to the requirement of the specific item by the use of mechanical equipment. Hand tamping will not be permitted.

In all places where subsection 210.10 does not apply, the following method shall be used in the construction of embankments:

The embankment shall be started full width to the slope stakes and shall be constructed to the specified grade over the full width in uniform layers parallel to the finished surface and not more than 8" in thickness, loose measurement. The maximum depth of layer as specified may be modified by the Engineer as particular conditions justify, such as the placing of the first layer over mucky or marshy areas, or on slopes too steep for the operations of equipment. In such areas the embankment may be constructed in one layer to the minimum elevation at which equipment can be operated. Above such elevation the embankment shall be constructed in layers of the specified thickness. Where the material for embankment construction consists of rock or fragmented material of such size as to render depositing of material in 8" layers impractical, embankments may be placed in layers of thickness not to exceed the size of rock used (30" maximum).

Each layer of embankment shall be compacted evenly and densely by distributing the movement of construction equipment uniformly over the entire embankment area.

The material in each layer shall have the moisture content for proper compaction. When too dry, water shall be added and when too wet, the material shall be aerated by manipulation with suitable equipment. When weather conditions are such that the proper moisture content cannot be maintained, operations shall be suspended until such time as weather conditions are considered favorable.

Each layer of embankment shall be compacted and stable before the succeeding layer is placed.

Embankments shall be constructed in sections of not less than 200 feet in length, or the full length of the embankment if less than 200 feet.

210.10 Special Compaction of Earthwork. This item shall consist of the compaction of embankments, the compaction of the natural ground surface on which embankment less than 3' in height is to be constructed, and the compaction of the roadbed through sections in excavation, and shall apply to all projects, or portions thereof, where so designated on the plans or in the special provisions. This item will not apply in cleared areas where grubbing is not required and it is impractical to work compaction equipment. The requirements of this subsection are supplementary to the requirements of subsection 210.09.

All equipment, tools, and machinery used on this work shall be suitable for the soil to be compacted, and shall be maintained in good operating condition. Unless otherwise provided, compaction of earthwork shall be accomplished by any satisfactory method or methods that will obtain the density hereinafter specified.

The material in each layer of embankment shall be compacted to a density, as determined by AASHTO T 191 or T 238, of not less than 95% of the maximum density obtained by AASHTO T 99, with correction for coarse particles retained on the #4 sieve not to exceed 30% in accordance with AASHTO T 224. If more than 30% coarse particles are retained on the #4 sieve, not less than 95% of the maximum density obtained in the laboratory by AASHTO T 180 is required. Specified density will not be required immediately adjacent to wingwalls of box culverts.

The moisture content of the material being compacted throughout each entire layer shall be substantially that of optimum moisture of the particular soil type. It shall be the responsibility of the Contractor to bring the moisture content throughout each layer of the embankment to be compacted to substantially that of optimum moisture by the addition of water or by aeration as may be necessary to increase or decrease moisture under the conditions encountered.

The density of the embankment shall be obtained and maintained or restored prior to placing a subsequent layer of embankment, base course, or surfacing.

The following procedures are to be followed in securing the required compaction:

The embankment shall be constructed to grade over the full width in uniform layers parallel to the finished surface and not more than 8" in thickness, loose measure. Each layer shall have the moisture content and be compacted to meet the requirements hereinbefore provided. The maximum depth of layer as specified may be modified by the Engineer as particular conditions justify, such as the placing of the first layer over marshy area, or on slopes too steep for the operation of equipment. In such areas the embankment may be constructed in one layer to the minimum elevation at which equipment can be operated and above such elevation the layers shall not exceed the specified maximum thickness of 8", loose measure.

Density requirements will not apply to portions of embankment constructed of material so rocky that it cannot be satisfactorily tested in accordance with the above requirements. In such case, the extent of compactive effort by rolling will be determined by the Engineer based upon the amount of breakage and consolidation which can be accomplished, the volume of which shall be included in the measurement of special compaction. When the nature of the material is such that consolidation by rolling is impractical, rolling will not be required.

After the roadbed has been excavated to line and grade, the surface shall be loosened to a depth of 6" below the finished elevation, the entire area within the limits of the roadbed section processed, the material brought within the range of moisture content and compacted to meet the requirements of these specifications. The section shall be reshaped to conform to the typical section during the compaction operation.

When the roadbed is excavated from solid rock and backfilled with material conforming to the definition for Common Excavation or Unclassified Excavation, or with Borrow, the backfill shall be compacted as provided above.

210.11 Compacted Embankment. When the item "Compacted Embankment" is included in the contract, the following provisions shall apply.

All excavation and embankment shall be constructed to reasonably close conformity with the lines, grades, thicknesses, and typical cross sections shown on the plans or established by the Engineer. Excavation or embankment constructed beyond the plan limits generally will not be permitted without adequate justification and specific approval by Change Order.

All suitable excavated material may be used in part or in total to construct the embankments within the areas of Compacted Embankment or it may be removed from the project and the embankments constructed with new material meeting the requirements of Borrow.

Embankment that is constructed shall be compacted in accordance with the provisions of subsection 210.10.

Where excavation to the finished grade 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 grade section with approved material. The excavation of unsuitable material and backfill will be measured and paid for under the appropriate classification of excavation and backfill.

Selection and procurement of sites for the disposal of material removed from the project shall be the responsibility of the Contractor subject to the approval of the Engineer. Sites used for disposal of unused material shall be left in a neat and presentable condition acceptable to the Engineer and the property owner involved.

These sites shall be seeded. The work involved in disposing of the material, including hauling, will not be paid for directly but will be considered as included in the appropriate classification of excavation.

Borrow, Special Compaction of Earthwork, and Overhaul will not be measured or paid for directly, but will be considered a part of the item Compacted Embankment and/or the appropriate classification of excavation. All work involved in excavation and construction of embankments will be measured and paid for as provided for in Subsection 210.12 and 210.13 under the appropriate items of excavation, presplitting, and/or compacted embankment. Excavation or embankment constructed outside the plan limits without the specific approval of the Engineer will not be included in the measurement of excavation or embankment and will not be paid for.

210.12 Method of Measurement. (a) All accepted excavation and borrow will be measured by the 100 foot station of roadway preparation.

210.13 Basis of Payment. No excavation or embankment will be measured for payment but shall be considered subsidiary to other bid items.

SECTION 212

SUBGRADE

212.01 Description. This item shall consist of shaping, compacting, and otherwise preparing the completed roadbed for the placing of base and surface courses and pavements in accordance with these specifications and in substantial conformity with the lines, grades, and cross sections shown on the plans.

212.02 Construction Requirements. (a) General. The subgrade shall be prepared in such a manner as to insure that the base, surface course, or pavement will be placed on a firm foundation that is stable and reasonably free from dust pockets, wheel ruts, or other defects.

The subgrade area shall be scarified to such depth as is necessary for shaping, and shaped and compacted to the required grade and section. The top 8" of the subgrade shall be compacted to a density, as determined by AASHTO T 191, of not less than 95% of the maximum density obtained by AASHTO T 99, with correction for coarse particles retained on the #4 sieve, not to exceed 30% in accordance with AASHTO T 224. If more than 30% coarse particles are retained on the #4 sieve, not less than 95% of the maximum density obtained by AASHTO T 180 in the laboratory is required. This compaction shall be accomplished by any satisfactory method or methods that will obtain the required density. The Contractor shall bring the moisture content of the material to be compacted to substantially that of optimum moisture by the addition of water or by manipulation and aeration as necessary to increase or decrease the moisture content under the conditions encountered.

When the subgrade is to be stabilized with lime or portland cement, the top 8" shall be compacted prior to treatment to the extent necessary to prevent rutting under normal operation of construction equipment.

Compaction operations may be omitted when an old stone or gravel roadbed is used as a foundation or subgrade for a base course or pavement where scarifying for shaping is unnecessary and its stability is approved by the Engineer.

Existing asphalt surface course in place shall be scarified and the material broken down to a maximum size of 2" and shaped and compacted to a stable condition and to the required grade and section after being thoroughly mixed with any base course material that may be in place unless the Engineer considers the existing surface suitable for retention.

All soft and yielding material and other portions of the subgrade which will not compact readily when rolled or tamped shall be removed. Holes or depressions made by the removal of unsuitable material as directed above shall be filled with approved material and the entire subgrade brought to the lines, grade, and cross section shown on the plans and compacted to the required density.

If the succeeding course is not placed immediately after the subgrade has been prepared and the subgrade becomes cut up, rough, or unstable, it shall again be shaped and recompacted in accordance with the above requirements.

(b) Subgrade for Portland Cement Concrete Base or Pavement (Forms). Portions of the subgrade composed of unsuitable materials shall be removed as directed, backfilled with approved material and the entire subgrade brought to line and grade and compacted as specified above.

The subgrade shall be prepared for the paving by shaping and compacting to the full width in accordance with the typical section shown on the plans. The material obtained in excess of that required for shaping due to variations in elevation shall be used to complete the shoulders, widen the roadbed, flatten the slopes, or be disposed of as shown on the plans or directed by the Engineer. After shaping, the entire area within the form lines shall be compacted to the required density. Any portion of the subgrade which is not accessible to normal compaction equipment shall be thoroughly compacted with manually operated mechanical tampers.

After the subgrade has been prepared and consolidated and the forms set and accepted, the surface of the subgrade shall be tested for crown and elevation by the use of an approved scratch template held in a vertical position and moved backward and forward on the side forms. The scratch template shall be so designed that the ends of the prongs will indicate the true position of the subgrade when the template is riding on the forms. Excess material indicated by the scratch template shall be removed. The use of a scratch template will not be required on subgrades or subbases constructed of materials other than earth or sand, but the required degree of accuracy on the subgrade or subbase surface shall be obtained by other approved methods.

To bring low areas up to the correct subgrade elevation, approved material shall be furnished and tamped or rolled until the filled material is as thoroughly compacted as the surrounding subgrade on which no additional material has been placed. Ruts and depressions caused by hauling shall be filled and consolidated as they develop. As a final check of subgrade conditions, a template or planer shaped to the true cross section of the bottom of the pavement shall be drawn on the forms immediately ahead of concrete operations and any excess material shall be removed before the concrete is placed. Low places in the subgrade, as indicated by the final check, shall be filled with concrete and no additional compensation shall be allowed for the extra quantities of concrete involved, or shall be filled with approved material and compacted to required density.

If the succeeding course is not placed immediately after the subgrade has been prepared and the subgrade becomes cut up, rough, or unstable, it shall again be shaped and recompacted in accordance with the above requirements.

212.03 Method of Measurement and Basis of Payment. All accepted subgrade preparation shall be subsidiary to other bid items.

SECTION 303

AGGREGATE BASE COURSE

303.01 Description. This item shall consist of a foundation course for surface course, for other base courses, or for pavements. It shall be constructed on the prepared subgrade or other completed base course in accordance with these specifications and in substantial conformity with the lines, grades, compacted thickness, and typical cross section shown on the plans.

303.02 Materials. Aggregate Base Course shall be either gravel and/or crushed stone so proportioned as to meet the requirements for a class of aggregate specified in Table 303-1, except for classes 7 and 8, which shall be crushed stone.

The Contractor shall have the option of using any higher numbered class Aggregate Base Course than that specified, provided that payment will be for the class specified on the plans.

Material furnished for Aggregate Base Course, Class 3 through Class 8, shall have a percent of wear by the Los Angeles Test not greater than 45 as determined by AASHTO T 96.

When it is necessary to blend two or more materials, each material shall be proportioned separately through mechanical feeders to insure uniform production. Premixing or blending to avoid separate feeding will not be permitted. Blending materials on the roadway in order to obtain a mixture that will comply with the requirements specified herein will not be permitted.

For the purpose of this specification, shale and slate are not considered to be gravel or stone. The material furnished shall be reasonably free from shale, slate, and other objectionable, deleterious, or injurious matter.

For Class 1 and 2 material, the fraction passing the #200 sieve shall not be greater than three-fourths of the fraction passing the #40 sieve. For Classes 3 through 8, the fraction passing the #200 sieve shall not be greater than two-thirds of the fraction passing the #40 sieve. For Classes 3 through 8 the fraction passing the #40 sieve shall have a liquid limit not greater than 25.

In order to insure that gravel is uniformly graded, the percent passing and retained on the various sieves shall be as follows for Classes 3, 4, and 5:

Sieve Passing	Sieve Retained	Percent
3/4"	3/8"	5 Min.
3/8"	#4	5 Min.
#4	#10	5 Min.
#10	#40	4 Min.

When the material contains aggregate larger than that specified above for the class called for in the proposal, it must be removed by screening or by screening and crushing. The removal of large size aggregate by hand methods will not be permitted.

303.03 Construction Requirements. The base course material shall be placed on a completed and approved subgrade or existing base that has been bladed to substantially conform to the grade and cross section shown on the plans.

The subgrade shall be prepared as specified in Section 212 and shall be free from an excess or deficiency of moisture at the time of placing base course material. the subgrade shall also comply, where applicable, with the requirements of other items that may be contained in the contract that provide for the construction, reconstruction, or shaping of the subgrade or the reconstruction of the existing base course.

Base course material shall not be placed on a frozen subgrade or subbase.

The aggregate shall be placed on the subgrade or other base course material and spread uniformly to such depth and lines that when compacted it will have the thickness, width, and cross section shown on the plans.

If the specified compacted depth of the base course exceeds 7", the base shall be constructed in two or more layers of approximately equal thickness.

The material shall be spread the same day that it is hauled. Spreading shall be performed in such manner that no segregation of coarse and fine particles nor nests or hard areas caused by dumping the aggregate on the subgrade will exist. Care shall be taken to prevent mixing of subgrade or unspecified material with the base course material in the blading and spreading operation.

When the base course is placed adjacent to an existing or newly constructed asphalt surface course or Portland cement concrete pavement, the aggregate shall not be dumped or mixed on the pavement surface. Mechanical spreading equipment shall be used, if necessary, to place the base course on the subgrade.

If sufficient working space is not available to allow proper aeration or addition of water to the base, the base material shall be mixed by any satisfactory method prior to placement.

Each course shall be thoroughly mixed for the full depth of the course and shall be compacted by any satisfactory method that will produce the density hereinafter specified. The aggregate shall be maintained substantially at optimum moisture during the mixing, spreading, and compacting operations, water being added or the material aerated as may be necessary. The specified grade and cross section shall be maintained by blading throughout the compaction operation. The material in each course shall be compacted to a density, as determined by AASHTO T 191 or T 238, of not less than 100% of the maximum density determined in the laboratory by AASHTO T 180. The aggregate shall be compacted across the full width of application.

The compacted base course shall be tested for depth and any deficiencies corrected by scarifying, placing additional material, mixing, reshaping, and recompacting to the specified density, as directed.

Where neither prime coat nor surfacing is provided in the same contract with the base course, the material in the base course shall be uniformly compacted, stable, and free of segregated areas.

The Contractor shall maintain the base course in a satisfactory condition until accepted.

303.04 Method of Measurement. Aggregate base course will be measured by the square yard.

303.05 Basis of Payment. Work completed and accepted and measured as provided above will be paid for at the contract unit price bid per square yard for Aggregate Base Course of the particular class specified, which price shall be full compensation for preparing the subgrade; for furnishing material; for spreading, finishing, watering, manipulating, and compacting; and for all labor, equipment, tools, and incidentals necessary to complete the work.

TABLE 303-1

AGGREGATE BASE COURSE GRADING (AASHTO T 11 AND T 27)
AND CRUSHING (AHTD TEST METHOD 304) REQUIREMENTS

SIEVE	CLASS 1	CLASS 2	CLASS 3	CLASS 4	CLASS 5	CLASS 6	CLASS 7	CLASS 8
				PERCENT PASSING				
3"	100	100	100					
2"	95-100	95-100	95-100					
1½"			85-100	100	100	100	100	
1"								100
3/4"	60-100	60-100	60-100	60-100	60-100	50-90	50-90	65-100
3/8"	40-80	40-80	40-80	40-80	40-80			
#4	30-60	30-60	30-60	30-60	30-60	25-55	25-55	25-55
#10	20-50	20-50	20-45	20-45	20-45			
#40	10-35	10-35	10-35	10-35	10-35	10-30	10-30	10-30
#200	3-15	3-15	3-12	3-12	3-12	3-10	3-10	3-10
Max. Plasticity Index (Minus #40 Matl.)	13	10	6	6	6	6	6	6
Minimum Percent Crushed (Retained on #4 Sieve)					15			
Minimum Percent Crusher-Run Material						90	90	90

SECTION 307

CEMENT TREATED BASE COURSE

307.01 Description. This item shall consist of a treated base course, composed of a compacted mixture of existing subgrade or soil aggregate, Portland cement, and water, and shall be constructed according to these specifications and in substantial conformity with the lines, grades, compacted thickness, and typical cross section shown on the plans.

Unless otherwise provided, the Contractor may use either the travel plant or central plant method as described below.

307.02 Composition. The mixture shall be composed of existing subgrade, base course and surface course materials, and/or an imported soil aggregate, with Portland cement and water added.

The mixture shall contain not less than 4% cement by volume of compacted mixture, 1420 kg (94 pounds) of cement being considered as 1 cu m (1 cubic foot). At least 30 days before the beginning of stabilizing operations, adequate quantities of soil and cement shall be supplied to the Engineer for determination of cement requirements. The Engineer will specify, based on laboratory tests, the exact percentage of cement to be used.

Specimens of soil aggregate, cement, and water shall develop a compressive strength of at least 2.7 MPa (400 psi) in 7 days.

307.03 Materials. The materials used shall comply with the following requirements:

(a) Water. Water used in mixing or curing shall be clean and free from injurious amounts of oil, salt, or other deleterious substances. Where the source of water is relatively shallow, it shall be maintained at such a depth and the intake so enclosed as to exclude grass, vegetable matter, or other foreign materials.

(b) Cement. Cement shall comply with ASSHTO M 85 for Portland Cement, Type 1, or ASSHTO M 240 for Blended Hydraulic Cement, Type IP. When cement is furnished in sacks, each sack shall contain not less than 42.6 kg (94 pounds) of cement.

Fly ash may be used as a partial replacement for the cement. Replacement amounts, not exceeding 25% by weight, shall be determined through trial batch

investigations using the specific materials proposed for the project. Mixtures with fly ash shall meet the same requirements as mixtures without fly ash. All trial batches required by this specification shall be accomplished by the Contractor, observed by the Engineer, and approved by the Engineer of Materials. Fly ash shall comply with AASHTO M 295, Class C or F. Mixing of Class C and Class F fly ashes will not be permitted. Fly ash will not be allowed as a substitute for high early strength or blended cements.

For in-place stabilization, the fly ash and cement shall be blended to form a homogeneous mixture before application on the roadway.

The use of cement salvaged from used or discarded sacks will not be allowed. Cement placed in storage shall be suitably protected. Any loss of quality occurring during the storage period will be cause for rejection. If the cement furnished shows erratic behavior under the field conditions incident to the mixing and placing of the mixture, or in the time of the initial or final set, the Contractor will at once, without notice from the Engineer, cease the use of that brand of cement and furnish material of such properties as to ensure quality work conforming to these specifications.

(c) Soil Aggregate. Soil aggregate shall meet the requirements of subsection 302.02 for any class provided therein.

(d) Asphalt.

(1) Emulsified asphalt shall comply with subsection 403.03(d) for Grade CSS-1 or CSS-1h.

(2) Medium curing cut-back asphalt shall comply with subsection 403.03(b) for the grade selected by the Engineer.

(3) Rapid curing cut-back asphalt shall comply with subsection 403.03(a) for the grade selected by the Engineer.

The type of asphalt used for protection and cover for the treated base course shall be at the option of the Contractor, subject to the Engineer's approval.

307.04 Construction Requirements. Sufficient equipment shall be available so that the work may proceed in proper sequence to completion without unnecessary delay. Equipment, tools, and machinery used shall be maintained in a satisfactory working condition.

The application of cement and mixing of the cement and soil aggregate will be allowed only on an approved subgrade, free of excess moisture. No work will be allowed on a frozen subgrade. The Contractor's operations shall be such as to prevent the drifting of cement or dust off the right-of-way.

(a) Preparation of the Roadbed. Prior to other construction operations, the existing roadbed, including the shoulders, shall be brought to line and grade and shaped to the typical cross section of the completed roadbed and compacted to sufficient density to prevent rutting under normal operations of construction equipment. All soft areas shall be corrected to provide uniform stability. When soil aggregate is utilized, the subgrade shall be prepared according to Section 212.

(b) Pulverizing. After shaping and compacting the roadbed, the material to be processed shall be scarified and pulverized before application of cement. Pulverizing shall continue during mixing operations until a minimum of 80% by weight of the material, exclusive of coarse aggregate, will pass a 4.75 mm (#4) sieve. Material retained on a 75 mm (3") sieve and other unsuitable material shall be removed.

(c) Application and Mixing of Cement. The application and mixing of cement with the aggregate material shall be performed according to one of the following methods:

(1) Travel Plant Method. The specified quantity of cement shall be applied uniformly on the material to be processed, and shall not exceed that which can be processed the same working day. When bulk cement is used the equipment shall be capable of handling and spreading the cement in the required amount. The moisture content of the material to be processed shall be sufficiently low to permit a uniform and intimate mixture of the aggregate material and cement.

Mixing shall be accomplished by means of a self-propelled or self-powered machine equipped with a mechanical rotor or other approved type of mixer that will thoroughly blend the aggregate with the cement. Mixing equipment shall be so constructed as to assure positive depth control. Care shall be exercised to prevent cement from being mixed below the depth specified. Machines designed to process less than the full width of base at a single pass shall be operated so that the full width of base can be compacted and finished in one operation. Water shall be uniformly added and incorporated in the mixture. The water supply and distribution equipment shall be capable of supplying the total required amount of water to the section being processed within 3 hours. If more than one pass of the mixer is required, at least one pass shall be made before water is added. Mixing shall continue after all water has been applied until a uniform mixture of aggregate, cement, and water has been obtained for the full depth of the course.

The aggregate and cement mixture that has not been compacted and remains undisturbed more than 30 minutes shall be remixed. In the event of rain adding excessive moisture to the uncompacted material, the entire section shall be reworked. Should the Contractor be unable to finish the section within the

same day, the section shall be reconstructed and an amount equal to 50% of the original amount of cement added to the mixture at no cost to the Owner.

(2) Central Plant Method. When a central plant is used, the soil aggregate, cement, and water shall be mixed in a pugmill either of the batch or continuous flow type. The plant shall be equipped with feeding and metering devices that will add the soil aggregate, cement, and water into the mixer in accurately proportioned amounts as determined by the laboratory design. Aggregate and cement shall be dry-mixed sufficiently to prevent cement balls from forming when water is added. Mixing shall continue until a uniform mixture of aggregate, cement, and water has been obtained.

The mixture shall be hauled to the roadway in trucks equipped with protective covers. Immediately before spreading the mixture, the subgrade or foundation course shall be moistened and kept moist, but not excessively wet, until covered by the mixture. The mixture shall be placed on the roadbed in a uniform layer by an approved spreader or spreaders. No more that 60 minutes shall elapse between adjacent spreader runs and not more than 60 minutes shall elapse between the time of mixing and the beginning of compaction. The layer shall be uniform in depth, and in such quantity that the completed base will conform to the required grade and cross section. Dumping of the mixture in piles or windrows will not be permitted.

(d) Compaction and Surface Finish. The mixture shall be compacted to a density, as determined by ASSHTO T 238, Method B, of not less than 95% of the maximum laboratory density obtained by ASSHTO T 134. The moisture content of the mixture during compaction shall not vary more than ±5% from the optimum moisture as determined by AASHTO T 134.

The surface of the treated roadway shall be reshaped to the required lines, grade, and cross section after the mixture has been compacted. It shall then be scarified lightly to loosen any imprints left by the compacting or shaping equipment and rolled thoroughly. The operation of final rolling shall include the use of pneumatic tired rollers. The rolling shall be done in such manner as to produce a smooth, closely knit surface, free of cracks, ridges, or loose material, and conforming to the crown, grade, and line shown on the plans. The density, surface compaction, and finishing operation shall not require more than two hours.

Water shall be added, if necessary, during the finishing operation to maintain the mixture at the proper moisture content for securing the desired surface.

Areas inaccessible to rollers or finishing and shaping equipment shall be throughly compacted to the required density by other approved compacting methods and shaped and finished as specified.

(e) Joints. As soon as final compaction and finishing of a section has been completed, the base shall be cut back perpendicular to the center line to a point where uniform cement content with proper density has been attained and where the vertical face conforms to the typical section shown on the plans. When the road mix method is used, a header shall be placed against the vertical face of the finished section and securely staked in place. This header shall be left in place until all mixing operations on the adjoining section have been completed, after which the header shall be removed and the trench backfilled with processed material. This material shall be compacted so that a well-sealed joint is formed and a smooth riding surface is obtained.

As an alternate to using a header, the subsequent day's operation may be started by cutting back into the previously placed course to the extent necessary to obtain uniform grade and compaction.

(f) Surface Test. The finished surface of the treated base course shall conform to the general surface provided for by the plans. It shall not vary more than 6 mm (1/4") from a 3 m (10') straightedge applied to the surface parallel to the center line of the roadway, nor more than 12 mm (1/2") from a template conforming to the cross section shown on the plans. Excess material shall be disposed of as directed.

(g) Protection and Cover. Immediately after the rolling and shaping has been completed, the surface of the treated base course shall be covered by a protective coating of asphalt to prevent loss of moisture during the curing period and to serve as a prime coat for the later application of wearing course. The asphalt shall comply with the requirements listed herein and shall be applied by means of an approved pressure distributor at the rate of 0.4 to 1.1 L/sq m (0.1 to 0.3 gallon per square yard) to provide complete coverage without excessive runoff. The actual rate of application will be determined by the Engineer. When used, emulsified asphalt shall be diluted with an equal amount of water before application. At the time of application, the base shall be in a moist condition. The protective coating of asphalt shall be maintained until the wearing surface is placed. If the condition of the protective coating is satisfactory, no additional prime coat will be required at the time of placement of the wearing surface.

Furnishing and placing asphalt will not be paid for separately, but full compensation therefor will be considered included in the contract unit price bid for Processing Cement Treated Base Course.

Finished portions of the roadway adjacent to construction that is traveled by equipment used in construction an adjoining section shall be protected by means satisfactory to the Engineer. If earth covering is used on fresh bases, straw, hay, building paper, or similar material shall be placed under the earth so that the covering may be removed without damage to the base.

307.04 Maintenance. The Contractor shall, within the limits of the Contract, maintain the treated base material in good condition until all work has been completed and accepted. Maintenance shall include immediate repairs of any defects that occur.

This work shall be done at no cost to the Owner and repeated as often as may be necessary to keep the area continuously intact. Faulty work shall be replaced to the full depth of treatment. The Contractor shall construct the plan depth of cement treated base in one homogeneous mass. The addition of thin treated layers to provide the minimum specified depth will not be permitted.

307.05 Seasonal and Temperature Limitations. Application of cement will not be permitted when the surface temperature is below 5° C (40° F), nor shall it be applied before April 1. Application of cement shall be terminated sufficiently early to give reasonable assurance that all mixing, spreading, rolling, and curing of the cement treated base course and the application of the subsequent asphalt courses can be complete on or before the following dates, except by written permission of the Engineer:

Asphalt Surface Treatment – Roadway	September 30
Asphalt Surface Treatment – Shoulders	October 31
ACHM Binder Course	October 31
ACHM Surface Course	October 31

307.06 Quality Control and Acceptance. Quality control and acceptance shall be according to the provisions of Section 306 except the minimum frequency of testing shall be based on a lot size of 10,000 sq m (12,000 square yards).

307.07 Method of Measurement and Payment. Cement Treated Base Course will be measured by the square meter (square yard) or by the metric station (station) for the depth specified. When measurement by the metric station (station) is specified, roadways in each direction of a divided highway will be measured, and additional areas outside the normal roadway will be converted to the normal measurement on an equivalent area basis.

Water, Portland cement and/or fly ash and asphalt will not be measured or paid for separately, but full compensation therefor will be considered included in the contract unit price bid for the item Processing Cement Treated Base Course.

The contract unit price mentioned above will be full compensation for furnishing, hauling, and placing materials; for pulverizing, watering, mixing, compacting, finishing, and applying asphalt; for performing quality control and acceptance sampling and testing; and for all labor, equipment, tools, and incidentals necessary to complete the work.

SECTION 401

PRIME AND TACK COATS AND EMULSIFIED ASPHALT IN BASE COURSE

401.01 Description. This item shall consist of a single application of asphalt material and blotter material, if required, applied to the completed and approved subgrade, to the base course, or on the existing asphalt or concrete surface in accordance with these specifications and in reasonably close conformity with the lines shown on the plans or as directed.

401.02 Materials. Materials shall conform with the requirements provided under Section 403. A medium curing cut-back asphalt or an asphalt penetrating prime will be used for prime coat and a rapid curing cut-back or an emulsified asphalt will be used for prime coat and a rapid curing cut-back or an emulsified asphalt will be used for tack coat. Emulsified asphalt conforming to grades SS-1, SS-1h, CSS-1, or CSS-1h shall be used for emulsified asphalt in base course. Dependent upon the texture of the base and the season of the year that work is being performed, the Engineer will select the particular grade of the type of asphalt material that will be used.

401.03 Construction Requirements. The methods employed in performing the work, and all equipment, tools, and machinery used in handling materials and executing any part of the work shall be subject to the approval of the Engineer before the work is started, and whenever found unsatisfactory, shall be changed and improved as required. All equipment, tools, and machinery used shall be maintained in a satisfactory working condition and shall meet the requirements of Section 403.

The surfaces of all structures shall be protected by some satisfactory method to prevent their being disfigured by the application of asphalt material. Objectionable asphalt discoloration, caused by the Contractor's operations, shall be removed from all roadway and bridge structures at no cost to the Owner.

(a) Cleaning. The surface to be treated with prime or tack coat shall be cleaned of dust, dirt, and loose or foreign material by sweeping with mechanical brooms immediately preceding the application of the prime or tack coat. Care shall be taken to clean but not loosen or dislodge the embedded aggregate in base courses. Patches of asphalt, dirt, or other material which do not form an integral part of the surface to be treated shall be removed. When directed, the surface shall be sprinkled with water and given an additional sweeping.

The cleaning operations shall be carried only far enough in advance of the application of the asphalt material to insure the surface being properly prepared by at the time of application. When the existing surface is an old concrete pavement, excess joint and crack filler shall be removed from the surface.

(b) Application of Prime Coat. After the surface to be treated has been prepared as outlined above, the asphalt material for the prime coat shall be sprayed uniformly over the surface by means of an approved mechanical pressure distributor at the rate of application indicated on the plans, or as directed.

Surplus asphalt material collected in surface depressions shall be removed.

Following the application of the prime coat, the road will be closed to traffic, if practicable, for a period of time sufficient to allow the proper curing of asphalt coating. Prime coat shall be allowed to cure a minimum of 3 days before any successive application of asphalt material. However, the minimum three day curing time may be waived when, in the opinion of the Engineer, the prime has sufficiently cured to allow successive courses of asphalt on detours and temporary construction. No material for a succeeding course shall be placed on a primed base course until the prime coat has cured sufficiently to prevent damage by hauling operations. When shown on the plans or directed by the Engineer, the prime coat shall be applied in half widths in order to allow free passage of public traffic at all times.

Prime coat shall not be applied when the air temperature is below 45 deg. F., nor shall it be applied to a surface having excess moisture, nor when general weather conditions, in the opinion of the Engineer, are not suitable. Special precautions shall be observed to insure a uniform distribution of the asphalt material. The distributor shall be so adjusted and operated as to distribute evenly the material being applied. Deposits of asphalt material upon the road surface in excess of the quantity specified, caused by stopping or starting the distributor, by overflow, leakage, or otherwise, shall be removed.

The asphalt material shall be applied at the temperature specified in Section 403. The distributor shall be operated at the pressure of not less than 30 nor more than 70 psi. The Contractor shall provide the necessary facilities for determining the temperature of the asphalt material in the heating equipment and in the distributor, for determining the rate of application, and for securing uniformity of distribution at longitudinal and transverse joints.

If the primed surface becomes damaged, such areas shall be cleaned or patched and re-treated at no cost to the Owner.

At the Contractor's option, Emulsified Asphalt in Base Course, constructed in accordance with subsections 401.02 and 401.03(d), may be substituted in lieu of Prime Coat. Payment for this substitution will be made as Prime Coat.

(c) Application of Tack Coat. When an asphalt course is to be laid on an asphalt or concrete surface, a tack coat shall be applied prior to placing the course. The tack coat shall be applied by means of a pressure distributor in the same manner as outlined above for the application of prime coat. When emulsified asphalt is used it shall be diluted with water as specified. The asphalt material shall be applied at the temperature specified in Section 403. The rate of application shall be from 0.03 gallon to 0.10 gallon per square yard as designated by the Engineer. The tack coat shall be applied sufficiently in advance of the asphalt course to allow the proper curing of the asphalt material but shall not be applied so far in advance as to lose its adhesiveness as a result of being covered with dust or foreign material. If the tack coat becomes damaged or covered with foreign material, such areas shall be cleaned as necessary and re-treated at no cost to the Owner.

(d) Application of Emulsified Asphalt in Base Course. Construction of the base course shall be in accordance with Division 300 for the applicable type of base course.

Emulsified asphalt shall be incorporated into the top 2" of the base course in a manner which will produce a uniform distribution of the asphalt at the plan designated rate. To facilitate uniform application and distribution, the emulsified asphalt may be added to water at a rate dictated by job conditions.

When an existing base course is to be treated, the top 2" of the existing material shall be scarified, treated as described above, and spread and compacted.

At the Contractor's option, prime coat, constructed in accordance with subsection 401.02 and 401.03(b), may be substituted in lieu of Emulsified Asphalt in Base Course on shoulders, driveways, turnouts, islands, detours, temporary roadways, and parking or small, irregular areas. Payment for this substitution will be made as Emulsified Asphalt in Base Course.

401.04 Blotter Course. (a) General. When directed, the fresh prime coat shall be covered by a blotter course in order to permit immediate use of the road by traffic without undue damage to the work or inconvenience to the traveling public.

(b) Material. The material for the blotter course may be an approved, clean, sandy material from a local source or may be a commercially processed sand. Material used shall be free from lumps, roots, sticks, or other foreign matter.

(c) Construction Requirements. Before the primed surface is opened to traffic, the blotter course shall be distributed evenly over the primed surface in such quantity as may be necessary to blot the surplus asphalt and prevent it from picking up under traffic. The surface shall then be dragged with an approved type of drag broom, supplemented as necessary by hand brooming, so as to distribute the material evenly.

401.05 Method of Measurement. Asphalt material will be measured by the gallon.

Blotter course material, applied at the direction of the Engineer, will be measured either by the cubic yard in vehicles or by the ton.

401.06 Basis of Payment. Work completed and accepted and measured as provided above will be paid for at the contract unit price bid per gallon for Prime Coat, Tack Coat, or Emulsified Asphalt in Base Course and per cubic yard or ton for Blotter Course Material, which price shall be full compensation for furnishing, preparing, hauling, diluting and applying asphalt material and blotter course material, when required; for cleaning or scarifying and compacting the surface; and for all labor, equipment, tools, and incidentals necessary to complete the work.

SECTION 403

MATERIALS AND EQUIPMENT FOR PRIME,

TACK, AND ASPHALT SURFACE TREATMENTS

403.01 Mineral Aggregate. The various classes of Mineral Aggregate shall conform to the grading requirements of subsection 403.02. Composition shall be as follows:

Class 1 shall be crushed stone or crushed gravel in which at least 98% by weight of the coarse aggregate particles have been produced from larger particles by crushing operations.

Class 2 shall be crushed or uncrushed gravel or crushed stone.

Class 3 shall be crushed stone or crushed gravel in which at least 90% by weight of the coarse aggregate particles have been produced from larger particles by crushing operations.

Class 4 shall be composed of material meeting the requirements for either Class 1 or Class 2 at the option of the Contractor.

Crushed stone shall consist of tough durable fragments of rock of uniform quality, free from an excess of soft particles. When subjected to 5 cycles of the Sodium Sulfate Soundness Test (AASHTO T 104) it shall have a loss not to exceed 12% and shall have a percent of wear by the Los Angeles Test (AASHTO T 96) not greater than 35.

Gravel shall consist of hard, durable aggregate free from an excess of soft particles and shall have a percent of wear by the Los Angeles Test (AASHTO T 96) not greater than 35.

Fine aggregate is that portion passing the #10 sieve, and shall consist of clean, sound, hard, and durable particles of natural sands, stone sand, and other inert substances of similar characteristics. Coarse aggregate is that portion retained on the #10 sieve.

All mineral aggregates shall be uniformly well graded from coarse to fine and free from lumps or foreign material. They shall also be free from adherent films of clay that will prevent thorough coating with asphalt material.

403.02 Aggregate Gradation. Requirements are given in percent passing by weight.

Class No.	¾	½"	3/8"	#4	#10	#16
1	100	90-100		0-15	0-3	
2		100	90-100		0-15	0-3
3			100	50-90	0-15	0-8
4	May be either Class 1 or Class 2 Aggregate					

Sieve analysis will be determined by AASHTO T 27.

The decantation loss as determined by AASHTO T 11 shall not exceed 1.5% for any class of mineral aggregate.

403.03 Asphalt Materials. Asphalt materials shall include cut-back asphalt, emulsified asphalt, and asphalt cement. Samples of asphalt material will be tested in accordance with applicable AASHTO or ASTM methods.

(a) Rapid Curing Cut-back Asphalt. Rapid Curing Cut-back asphalt shall conform to the requirements of AASHTO M 81.

(b) Medium Curing Cut-back Asphalts. Medium Curing Cut-back asphalt of the grade designated shall conform to the requirements of AASHTO M 82.

(c) Anionic Emulsified Asphalt. Anionic emulsified asphalt shall conform to the requirements of AASHTO M 140.

(d) Cationic Emulsified Asphalt. Cationic emulsified asphalt shall conform to the requirements of AASHTO M 208. In addition, CRS-2 shall have: (1) A minimum Saybolt Furol Viscosity at 122 deg. F at the point of manufacture and/or origin of 200 seconds, and a maximum Saybolt Furol Viscosity of 500 seconds. The Saybolt Furol Viscosity at 122 deg. F on destination field samples shall be within the limits of 100-500 seconds. If the asphalt being tested begins to drip at 122 deg. F test temperature, the test shall be repeated at 160 deg. F and shall be within the limits of 90-200 seconds, and (2) the minimum residue from distillation by weight shall be 68%.

(e) Polymer Modified Cationic Emulsified Asphalt. Polymer modified CRS-2P shall conform to the requirements of subsection 403.03(d) with the following additions:

(1) Upon standing undisturbed for a period of 24 hours, the CRS-2P shall show no white, milky colored substance on its surface, but shall be a homogeneous brown color throughout, and

(2) CRS-2P shall have a minimum ductility at 77 deg. F of 125 cm and a minimum ductility at 39 deg. F of 30 cm, and

(3) CRS-2P shall contain a minimum polymer content of 2.5% polymer solids by weight of asphalt cement, and

(4) CRS-2P shall conform to AHTD Test Method 401.

(5) Polymer addition shall be accomplished prior to or during the emulsification process.

(f) Asphalt Cement. Asphalt cement furnished shall conform to the requirements of AASHTO M 226. Specific physical requirements to be met are those set forth in Table II of AASHTO M 226, with the further provision that the ductility for all grades of asphalt cement shall be a minimum of 100 cm and all grades of asphalt cement shall have a negative spot as determined by the Spot Test. the grade to be used will be specified by the Engineer.

(g) Asphalt Penetrating Prime. This material shall be produced by fluxing asphalt base with suitable solvents. Penetrating prime shall conform to the following requirements:

Asphalt Penetrating Prime

	Min.	Max.
Flash Point, Pensky Martens, deg. F	100	---
Viscosity, Saybolt Furol at 122 deg. F, seconds	40	120
Distillation ASTM D 402:		
Over at 437 deg. F vol. percent total solvent	15	45
Over at 500 deg. F vol. percent total solvent	55	80
Over at 600 deg. F vol. percent total solvent	85	---
Residue from distillation to 680 deg. F, volume percent	50	---
Test of residue from distillation:		
Softening Point (R & B), deg. F	115	165
Penetration at 77 deg. F, mm/10	10	90

Base shall be asphalt refined from petroleum crude oil.

403.04 Application Temperatures. Asphalt material should be applied at the temperature which provides proper and uniform distribution and within practical limits avoiding higher temperatures than necessary. Satisfactory application usually should be obtained within the recommended ranges shown below. No material shall be heated above the following maximum allowable temperatures:

Type and Grade	Recommended Range deg. F	Maximum Allowable Deg. F
RC-70	80-150	175
RC-250	100-175	200
RC-800	160-225	250
RC-3000	200-275	290
MC-30, MC-70	80-150	175
MC-250	100-200	230
MC-800	185-260	275
MC-3000	225-275	290
RS-1, RS-2	125-185	185
MS-2	70-160	160
SS-1, SS-1H	70-160	160
CRS-1, CRS-2, CRS-2P	125-185	185
CMS-2H, CMS-2	70-160	160
CSS-1, CSS-1H	70-160	160
All Asphalt Cements	275-325	350
Asphalt Penetrating Prime	130-200	230

Note: Heating of asphalt materials (except emulsions) constitutes a fire hazard to various degrees. Proper precautions should be used in all cases and especially with rapid curing cut-backs, as the maximum allowable temperature may exceed the flash point.

403.05 Heating Equipment. Equipment for heating asphalt material in tank cars or storage tanks shall have adequate capacity to heat the material by steam coils, electricity, or other means such that no flame shall come in contact with the heating tank.

The heating equipment shall be provided with an accurate thermometer to indicate the temperature of the asphalt material in the unit to which heat is being applied. Heating equipment which agitates the material will be prohibited if, in the opinion of the Engineer, it injures or in any way changes the characteristics of the material. The introduction of free steam directly into asphalt material will not be permitted.

403.06 Pressure Distributors. Each pressure distributor used for applying asphalt material shall be equipped with the following listed appliances or devices:

(a) Tachometer devices registering traveling speed in feet per minute.

(b) A gauge, indicating pump pressure or output in gallons per minute passing through the nozzles.

(c) Thermometer well and accurate thermometer to indicate the temperature of the asphalt material in the distributor.

(d) Spray bars shall be of adjustable length and height and the distributor shall produce a 50% lap of the sprays from adjacent nozzles.

(e) A power unit and pump system that will supply a uniform pressure through the entire length of the spray bar to provide equal output from all nozzles.

(f) Calibrated metal measuring stick, marked in increments of not more than 10 gallons.

(g) Easily removable dome cover.

(h) Wind guard on ends of spray bars.

Calibration of the distributor will be checked by the Engineer before being used on the work. Distributors previously calibrated by the Department or by the manufacturer, and certified in writing, will be accepted. Distributors will be kept free from sludge or other residue and at any time there is evidence of inaccuracy, they will be subject to re-calibration. The Contractor shall provide, at no cost to the Owner, all necessary equipment, materials, and assistance for any required calibration.

403.07 Aggregate Spreaders. The mechanical spreader for mineral aggregate shall be self-propelled and capable of accurately and uniformly spreading the material.

Calibration of the spreader will be checked by the Engineer prior to the actual work, and as often as necessary, to assure that the openings are properly set to feed the aggregate at the designated application rate.

403.08 Rollers. (a) General. Rollers shall be equipped with approved devices to prevent adhesion of the surfacing material to the wheels.

Rollers shall be maintained in good mechanical condition and operated to produce a surface course with satisfactory aggregate orientation and interlock. Rollers shall be equipped with a self-contained power unit adequate to maintain dependable

forward and reverse working speeds. Rollers shall have a system for cleaning the tires for the full width of each tire.

(b) Pneumatic Rollers. Pneumatic rollers shall be mounted on 7 or more wheels, a minimum of 3 leading wheels and 4 drive wheels. The wheels shall be mounted at right angles to the axles, shall maintain this position through the full revolution, and shall afford a continuous and complete rolling width of not less than 60 inches. The tires shall have a smooth tread and minimum tire size shall be 7.50 x 15, 10 ply. All tires on an individual roller unit shall be of equal size and diameter and shall be so arranged that the gap between the tires of one axle is covered by the tires of the other axle. Tires shall be uniformly inflated so that the air pressure of the several tires shall not vary more than 5 psi.

Pneumatic rollers shall be capable of exerting a minimum ground contact pressure of 45 psi. The Contractor shall furnish to the Engineer charts or tabulations showing the contact area and contact pressure for the full range of tire inflation pressures and for the full range of tire loadings for each type and size compactor tire furnished. The tires shall be inflated and the roller loaded with ballast, as required, to obtain the average ground contact pressure necessary to obtain proper compaction.

(c) Steel Wheel Rollers. Steel wheel or combination steel wheel/pneumatic rollers may be either three wheel or tandem type and shall weigh not less than 200 pounds per inch width of roller and shall have a complete rolling width of not less than 36 inches.

SECTION 404

DESIGN AND QUALITY CONTROL OF ASPHALT MIXTURES

404.01 Design of Asphalt Mixtures. (a) General. This item will consist of the Contractor furnishing a mix design for each of the particular asphalt mixtures to be used.

The Engineer will not perform any pre-bid testing of materials. It will be the Contractor's responsibility to locate acceptable materials sources unless the sources are so noted in the plans or Special Provisions.

Each mix design shall be prepared by laboratory analysis in accordance with the requirements of the specifications. Each mix design will establish a mix gradation for the aggregates (based on the weight of material passing specified screen sizes), an optimum asphalt content (expressed as a percentage of the total mix weight), an optimum mixing temperature, and an optimum compaction temperature. Optimum mixing and compaction temperatures will be established based on temperature-viscosity curves of the asphalt to be used in the mix. These curves shall be supplied with the mix design. The optimum asphalt content shall be established by performing Marshall Method tests at a minimum of four different asphalt contents. Tests should be run on the basis of ¼ to ½ percent (0.25% to 0.5%) increments in asphalt content. At least one asphalt content shall be above the optimum content and at least one content shall be below the optimum. Graphical plots of the test results shall be made. These plots shall include: Stability vs. Asphalt Content; Flow vs. Asphalt Content; Unit Weight (Density) vs. Asphalt Content; Percent Air Voids vs. Asphalt Content; and Percent Voids in Mineral Aggregate (VMA) vs. Asphalt Content. Optimum asphalt content shall be based on the results of the Marshall Method tests. The maximum theoretical density computed from the specific gravity as determined by the Rice method (AASHTO T 209) shall be included in the mix designs. The mix design for each type of asphalt mix shall meet the design criteria for stability, flow, VMA, air voids, aggregate gradation, asphalt content, and retained stability.

To be acceptable, the mix design shall provide for the maximum mix tolerance for asphalt content without exceeding the specification limits for asphalt content, aggregate gradation, stability, flow, voids, and VMA specified for the particular mix. The Engineer may accept a mix design in which the tolerance for asphalt content is reduced by 0.1% from the specified tolerance; in such case, all mix produced shall conform to the reduced tolerance.

The Engineer may accept a mix design in which the tolerances for gradation are less than those shown in the applicable specifications; in such case, all mix produced

must comply with the reduced tolerances. The Engineer may accept a mix design with full tolerances for gradation even when such tolerances fall outside the master gradation limits provided that the mix design is shown by testing to meet all specified requirements for stability, flow, voids, and VMA at the extreme limits of the tolerance. The mix design gradations must fall within the master limits. The Contractor shall perform additional testing to verify compliance at the extreme limits of the tolerance. Such additional testing shall be at no cost to the Owner.

For each asphalt mix to be used, the Contractor shall submit the proposed mix design and copies of all results and design work papers to the Materials and Research Division for review. Both the company and the individual who performed the tests and prepared the mix design shall be identified in the documents submitted. In addition, the Contractor shall furnish to the Engineer a history of the aggregate gradations for each of the aggregate stockpiles that are proposed to be used in the production of the asphalt concrete hot mix. These gradations shall be used to develop the mix design.

Asphalt cement and additives shall be from approved sources as listed in the Department's Qualified Products List. Aggregates must have been tested for abrasion and soundness by the Department within the previous 12 months. If these tests have not been performed, at least 14 days must be allowed for abrasion and soundness testing before beginning the mix review process. At least five (5) days should be allowed for the review of the mix design.

Upon completion of the review process, the Engineer will accept or reject, in writing, the proposed mix design. If rejected, the Contractor shall develop a new mix design which shall be submitted for review as described above. When a mix design is accepted, it shall remain in effect for the duration of the project unless modified in writing by the Engineer.

If an acceptable pavement is not produced and it is determined that the accepted mix design is at fault, paving operations shall be stopped and the Contractor shall prepare a new mix design.

The processing of proposed changes or new designs shall follow the same procedures as the initial mix designs.

The mix design submitted for approval need not be prepared specifically for the project, but may be a previously accepted design which uses the same materials and meets the same design requirements.

Mix designs accepted for use under this section will become the property of the Department and may be accepted for use on other projects and/or by other contractors or by the Department.

(b) Testing Requirements. Binder and Surface Course Mixtures will be designed and tested in accordance with AASHTO T 245 and AHTD Test Method 455"

Water Sensitivity Test for Compacted Bituminous Mixtures" as applicable, with the requirements as specified for the particular mix. Copies of AHTD Test Methods are available from the Department.

(c) The laboratory shall be AASHTO accredited or AHTD approved.

404.02 Mixture Requirements. Binder and surface course mixtures will be designed and tested in accordance with AASHTO T 245 as applicable with the requirements as specified in Tables 406-1, 407-1, 408-1, and 408-2.

404.03 Mixture Substitutions. Substitutions will be allowed for mixtures as follows:

(a) ACHM Stabilized Base Course may be replaced with:
Type 1 Surface Course
Type 2 Surface Course
Type 1 Binder Course
Type 2 Binder Course

(b) Type 2 Binder Course may be replaced with
Type 1 Surface Course
Type 2 Surface Course
Type 1 Binder Course

(c) Type 1 Binder Course may be replaced with:
Type 1 Surface Course

(d) Type 2 Surface Course may be replaced with:
Type 1 Surface on shoulders, driveways, islands, and patching
Type 3 Surface on driveways, islands, and patching

(e) Type 1 Surface Course may be replaced with:
Type 2 Surface on driveways, islands, and patching
Type 3 Surface on driveways, islands, and patching

Mixture substitutions will be at the planned rate for the material for which the substitution is being made. Measurement for payment of all components of the mix will be based on the job mix formula for the type specified on the plans or on the job mix formula for the type used, whichever results in the lowest cost per ton of mix to the Department. If no job mix formula for the type specified on the plans is available, the mixture composition for payment will be based on the composition shown on the plans as the basis of estimate for the plan type or on the job mix formula for the mix actually used, whichever results in the lowest cost per ton of mix to the Department.

Arbitrary and intermittent substitutions of small quantities of mixtures will not be permitted without approval by the Engineer.

404.04 Quality Control of Asphalt Mixtures. (a) General. This item shall consist of the Contractor performing all applicable quality control sampling and testing of the asphalt mixtures used on the project.

The Contractor shall perform all applicable quality control sampling and testing required to insure that the completed asphalt pavement complies with all requirements of the specifications. Quality control sampling and testing shall be accomplished in a timely manner. Sampling and testing shall be planned and conducted so that a representative sample is obtained and tested.

Sampling and testing methods and the frequency of testing for each mixture shall be as shown below:

Characteristic	Minimum Test Frequency	Test Method
	All Mixes	
Aggregate Gradation	1 per 1000 Tons	AHTD 452, 303
Asphalt Content	1 per 1000 Tons	AHTD 450, 451, 499/499A
Density	1 per 300 Tons	AASHTO T 166, AASHTO T 168
Moisture Content	1 per 1000 Tons	AASHTO 255
	Binder and Surface, Type 1 and Type HT	
Stability	Note 1	AASHTO 245
	Binder and Surface, Type HT	
Air Voids	1 per day	AAHTD 453, 454
Water Sensitivity	Note 2	AHTD 455

NOTE 1: One per day for the first three days of production and one per day for the first three days of production if production has been interrupted for 30 calendar days or more or if the mix design has changed.

NOTE 2: One test during the first three days of production and one during the first three days of production if production has been interrupted for 30 calendar days or more or if the mix design has changed.

A quality control lot for aggregate gradation and asphalt content shall be 100 tons. A quality control lot for density shall be 300 tons. A new lot will begin whenever there is a new mix design or when production resumes after an interruption of 30 calendar days or more. The Engineer may designate a new lot whenever he detects a significant change in the work or when test results indicate that the work is outside the specified tolerances.

More frequent sampling and testing may be required whenever the test results indicate that the material is widely varying or consistently marginal. Copies of the applicable AHTD Test Methods are available from the Department.

All sampling and testing for acceptance and/or adjustments will be performed by the Department.

If either quality control or acceptance results indicate that the material is outside the specified tolerances, further evaluation of the work will be made, in accordance with subsection 410.09, to determine its acceptability.

The Contractor shall furnish a building for the use of the Department's plant inspector in accordance with subsection 409.03(h). This building shall be separate and independent of the Contractor's facilities and equipment for performing quality control sampling and testing.

The Contractor shall provide an opportunity for the Engineer to observe all quality control sampling and testing procedures.

The Contractor shall split all samples of aggregate, mix, or other material and provide on half of each sample to the Engineer. The Engineer will randomly test this portion of the samples for the purpose of checking the Contractor's procedures and results. The Contractor shall maintain a daily plot of all test results, and make the plots available to the Engineer. Upon completion of work on the item these plots shall be furnished to the Resident Engineer for inclusion in the project files.

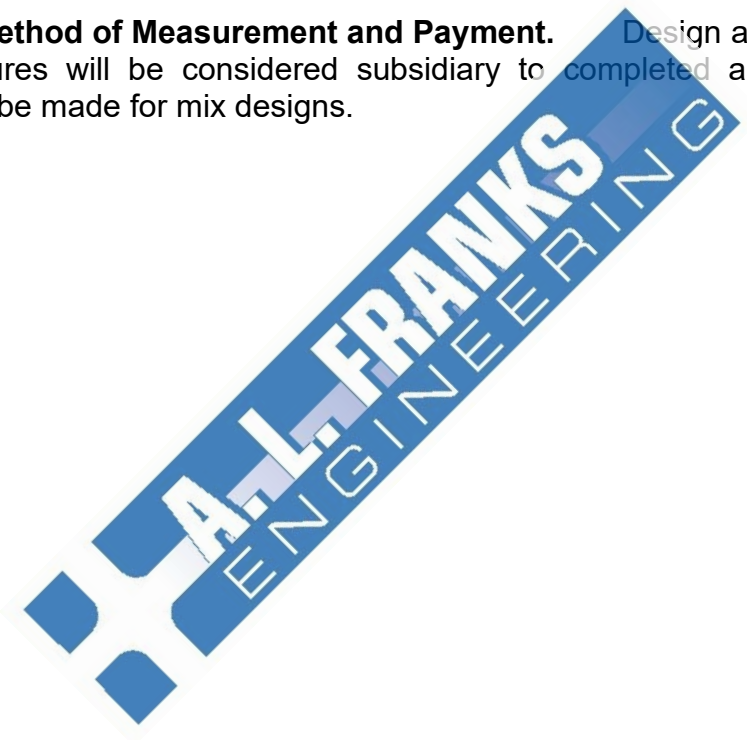
If the test results show that the material is outside the mix design limits, is widely varying, or is consistently marginal, corrective action shall be taken. The Department's asphalt plant inspector will be notified of all proposed corrective actions prior to their implementation. Corrective actions that require an adjustment of any one of the

aggregate cold feeds by more than ±5% will not be permitted. If excessive changes are required, production will be suspended and anew mix design will be developed in accordance with the applicable specifications.

The fluids resulting from the extraction process contain solvent and asphalt cement and are considered hazardous waste. The Contractor shall be responsible for the disposal or recycling of this waste in a manner approved by the Arkansas State Department of Environmental Quality.

Use of a nuclear asphalt content gauge is regulated by the Radiation Control and Emergency Management Programs of the Arkansas State Department of Health. If the Contractor elects to use a nuclear gauge in his quality control program, he shall be responsible for meeting and following all licensing and use requirements.

404.05 Method of Measurement and Payment. Design and Quality Control of Asphalt Mixtures will be considered subsidiary to completed asphalt. Separate payment will not be made for mix designs.



SECTION 407

ASPHALT CONCRETE HOT MIX SURFACE COURSE

407.01 Description. This item shall consist of an asphalt concrete surface course constructed on a completed and accepted course in accordance with these specifications and in reasonably close conformity with the lines, grades, compacted thickness, and typical cross sections shown on the plans.

407.02 Composition. The surface course shall be composed of mineral aggregate, asphalt cement, and any required additives proportioned to meet the requirements for design of asphalt concrete surface course mixtures as shown in Table 407-1.

The design and quality control of ACHM surface course mix shall be in accordance with Section 404. Acceptance sampling and testing will be performed by an approved testing laboratory and paid for by the Contractor. Test results will be provided to the Engineer.

The mineral aggregate in Type 1 Surface Course shall contain a mineral filler composed of limestone dust, Portland cement, or hydrated lime complying with the physical requirements of AASHTO M 17. The mineral aggregate in Type 2, 3, and 4 Surface Courses shall contain, if required by laboratory mix design, mineral filler complying with the physical requirements of AASHTO M 17. In addition, these mixes shall contain a heat stable anti-strip additive if required by laboratory mix design.

The exact quantities of these additives to be incorporated in the mixes will be as determined by the laboratory mix design.

407.03 Materials and Equipment. Materials and equipment used in this construction, in addition to the general requirements of these specifications, shall conform to the provisions of Section 409.

407.04 Construction Requirements. Construction requirements, in addition to the general requirements of these specifications, shall conform to the provisions of Section 410.

407.05 Method of Measurement. (a) Mineral aggregate will not be measured by the ton. Mineral filler will not be measured separately but will be considered as mineral aggregate.

(b) Asphalt cement hot mix surface course will be measured by the square yard.

TABLE 407-1

REQUIREMENTS FOR ASPHALT CONCRETE SURFACE COURSE

A. Design Requirements

Sieve	Type 1	Type 2	Type 3	Type 4	Maximum Mix Tolerance
	Percent Passing				
3/4"	100	100	--	--	
½"	85-100	85-100	100	100	
#4	55-80	55-80	60-80	95-100	+7
#10	35-60	35-60	40-60	75-95	+4
#20	22-45	22-45	22-47	45-62	+4
#40	15-35	15-35	15-40	30-55	+4
#80	8-22	8-22	8-24	15-30	+4
#200	2-8	2-8	2-8	5-12	+2
Asphalt Content	4.5-7.5	4.5-7.5	4.5-7.5	6.0-10.0	+0.4

	Type 1	Type 2	Type 3	Type 4
No. of Blows:	75	50	50	50
Minimum Marshall Stability, lbs.:	1750	1000	1000	750
Marshall Flow, 1/100":	7-16	7-16	7-16	---
% Air Voids: (AASHTO T 166 and T 209)	3.0-5.0	2.5-5.0	2.0-5.0	---
Minimum % VMA:	14	14	15	---
Minimum Water Sensitivity Ratio %: (as determined by AHTD Test Method No. 455)	75	70	70	
% Mineral Filler:	2-4			
% Anit-strip:	As required for all types			

B. Field Requirements

	Type 1	Type 2	Type 3	Type 4
Minimum Marshall Stability*, lbs:	1500	--	--	--
Minimum Density, % Theoretical:	92.0	92.0	92.0	92.0
Maximum Moisture, % (Roadway):	0.75	0.75	0.75	0.75

Gradation and asphalt content tolerances: As shown in design requirements or as specified in job mix.

*In accordance with AHTD Test Method 454.

407.06 Basis of Payment. Work completed and accepted and measured as provided above will be paid for as follows:

(a) Asphalt concrete surface course will be paid for at the contract unit price bid per square yard for Asphalt Concrete Hot Mix Surface Course of the particular type called for in the Contract.

The contract unit prices mentioned above shall be full compensation for furnishing materials; for heating, mixing, hauling, placing, rolling, and finishing; and for all labor, tools, equipment, and incidentals necessary to complete the work.

SECTION 409

MATERIALS AND EQUIPMENT FOR ASPHALT CONCRETE HOT MIX BINDER AND SURFACE COURSES

409.01 Mineral Aggregates. The mineral aggregates for Asphalt Concrete Hot Mix Binder Course, Asphalt Concrete Hot Mix Surface Course, Asphalt Concrete Hot Mix Binder and Surface Courses for Heavy Traffic, and Asphalt Concrete Cold Plant Mix shall consist of combinations of coarse aggregate, fine aggregate, and mineral filler proportioned as provided for the respective mixes.

The coarse aggregate is that fraction retained on the #10 sieve and shall consist of crushed gravel, crushed stone, or slag.

Fine aggregate is that fraction passing the #10 sieve, and shall consist of clean, hard, durable particles of natural or manufactured sand or combinations of the two. Natural sand shall meet the requirements of AASHTO M 145 except a maximum of 35 percent may pass the #200 sieve. If two or more materials are combined to produce a sand, each material must comply with this requirement.

The fine aggregate may contain a maximum of 2.0% coal and lignite by weight of the Fine Aggregate. When deemed necessary by visual observation, the amount of coal and lignite will be determined in accordance with AASHTO T 113.

Crushed stone shall consist of clean, hard, durable fragments of rock of uniform quality, free from an excess of soft particles. The stone shall have a percent of wear by the Los Angeles Test (AASHTO T 96) not greater than 40 and when subjected to 5 cycles of the Sodium Sulfate Soundness Test (AASHTO T 104) the loss shall not exceed 12%.

Crushed gravel shall consist of clean, hard, durable aggregate free from an excess of soft particles in which at least 98% of the particles retained on the #10 sieve have been produced from larger particles by crushing operations. The gravel shall have a percent of wear by the Los Angeles Test (AASHTO T 96) not greater than 40.

Mineral aggregates shall be clean and free of deleterious material and adherent films of clay that will prevent thorough coating with asphalt material. The fraction passing the #40 sieve shall have a plasticity index not greater than 4. For Asphalt Concrete Hot Mixes, a minimum of 65% of the total aggregate shall be produced from larger particles by crushing.

Unless otherwise specified, all surface courses serving as wearing courses in travel lanes and not covered with a friction course shall contain not more than 60%

limestone aggregate in the coarse mineral aggregate fraction. When limestone is the primary coarse mineral aggregate, crushed sandstone, crushed siliceous gravel, syenite, novaculite, or crushed slag shall be used as the remaining coarse mineral aggregate fraction. The portion retained on the #10 sieve shall have an insoluble residue of not less than 85% when tested in a 1:1 solution of hydrochloric acid and water in accordance with AHTD Test No. 135.

Mineral filler shall comply with the requirements of AASHTO M 17.

409.02 Asphalt Cement. Asphalt cement shall be in accordance with AASHTO M 226. Specific physical requirements to be met are those set forth in Table II of AASHTO M 226, with the further provision that the ductility for all grades of asphalt cement shall be a minimum of 100 cm and all grades of asphalt cement shall have a negative spot as determined by the Spot Test. The grade to be used will be specified by the Engineer.

If required, the asphalt cement shall contain a heat-stable anti-stripping additive. The additive shall be approved by the Engineer. It shall be added at the rate specified by the Engineer as determined by laboratory analysis and laboratory mix design procedures. The anti- stripping additive shall be added by an in-line blending process just prior to introduction of the asphalt cement to the mixer.

409.03 Mixing Plants. The plant used in the production of the mixture shall be of the separate weight batch type, the continuous mixing type, or the drum mixer type. If the drum mixing process is used, the drum mixer and auxiliary equipment shall have been specifically designed and constructed for this process and the mix produced shall conform to the requirements of these specifications. Such precautions shall be taken as are necessary to avoid damage to the asphalt cement in the drum mixer. If the asphalt cement is added through auxiliary equipment outside the confines of the drum, the mixing shall be sufficient to provide 100% coating of the aggregate.

The plant site shall have adequate storage facilities. Sufficient storage space shall be provided for separate stockpiles and the different aggregate sizes and types shall be kept separate until used. Stockpiles must be separated by at least 4' or bulkheads provided between stockpiles to separate the materials. The storage yard shall be maintained in a neat and orderly condition and the separate stockpiles shall be readily accessible for sampling.

Coarse aggregate stockpiles shall generally be constructed in layers or wedges not to exceed 4' in height. Stockpiles built in wedges shall not produce slopes greater than 30 degrees. Stockpiles shall contain a sufficient quantity of material to allow the Contractor to control the operation of the plant to produce a mix that meets the job mix formula. Aggregate shall be removed from stockpiles by front end loader in lifts which shall not exceed the vertical reach of the loader. When the course aggregate is separated into uniform sizes and stored in separate stockpiles, the requirements

concerning height of lifts, slopes, and method of removal from the stockpile shall not apply.

Although a required number of stockpiles is not specified, several graded stockpiles may be necessary, when using plants without screens, in order to consistently meet specification requirements.

All plants used for the preparation of asphalt mixtures shall conform to the following applicable requirements.

(a) Requirements for All Plants. (1) Uniformity. The plant shall be so designed, coordinated, and operated as to produce mixtures within the job mix tolerances fixed by the specifications.

(2) Storage Tanks and Heating Equipment for Asphalt Cement. Storage tanks shall be equipped to heat the asphalt, under effective and positive control at all times, to the temperature requirements set forth in the specifications. Heating shall be accomplished by steam or oil coils, electricity, or other means such that no flame shall come in contact with the heating tank. A circulating system for the asphalt shall be provided of adequate size to insure proper and continuous circulation during the entire operating period. Pipe lines and fittings shall be steam or oil jacketed or otherwise properly insulated to prevent heat loss. Provisions shall be made for sampling storage tanks.

(3) Cold Feed Bins and Feeder for Dryer. A minimum of 3 cold feed bins shall be used. The bins shall be of sufficient size to store the amount of aggregates required for continuous plant operation. Partitions between bins shall extend a minimum of 18" above the top of the material against the partition.

The unit shall have a mechanical feeder mounted under the cold bins with each bin compartment having an accurately controlled individual gate to form an orifice for measuring the material drawn from it. The orifice shall be rectangular, with one dimension adjustable by positive mechanized adjustment. An indicator shall be provided on each gate to show that the proper gate opening is maintained. Premixing to avoid separate feeding will not be permitted. Placing the separated aggregates into storage or moving the aggregates from storage to feeder shall be accomplished by any method which will not cause segregation degradation, or combinations of aggregates which fail to meet the specified requirements.

When mineral filler is required it shall be proportioned through a separate feeding unit.

(4) Dryer. The plant shall include a dryer or dryers which will continuously agitate the aggregate during the heating and drying process.

(5) Asphalt Control Unit. Satisfactory means, either by weighing or metering, or the taking of volumetric measurements, shall be provided to obtain the proper amount of asphalt material in the mix within the tolerance specified for the job mix. Suitable means shall be provided, either by steamjacketing or other insulation, for maintaining the specified temperature of asphalt material in the system.

(6) Thermometric Equipment. An armored automatic recording thermometer covering a range from 200 deg. F to 400 deg. F shall be fixed in the asphalt feed line at a suitable location near the discharge valve at the mixer unit.

Batch plants shall be further equipped with an approved automatic recording dial scale mercury thermometer, an electric pyrometer, or other approved thermometric instrument so placed as to register and record automatically the temperature of the heated aggregates.

At the close of each working day the temperature charts of both asphalt and aggregate shall be given to the Engineer.

(7) Control of Mixing Time. The plant shall be equipped with positive means to govern the time of mixing and to maintain a constant mixing time.

(8) Pollution Control Equipment. Asphalt mixing plants shall be so designed, equipped, and operated that the quality and quantity of pollutants emitted will conform to the requirements of applicable Federal, State, and local laws, ordinances, and regulations.

(9) Dust Return. If the asphalt plant is equipped with a baghouse dust collector, the fines, if elected to be reintroduced to the mixture, shall be added to the mixture at the approximate rate at which collected. Direct return from the baghouse to the hot elevator will be permitted only when it can be demonstrated that the flow can be controlled at a uniform rate. Intermittent feeding of baghouse fines into the mixture will not be permitted.

(10) Safety Requirements. Adequate and safe access to the mixer platform and guarded ladders to other plant units shall be provided for accessibility to plant inspection. Gears, pulleys, chains, sprockets, and other dangerous moving parts shall be thoroughly guarded and protected. Ample and unobstructed space shall be provided on the mixing platform. A clean and unobstructed passage shall be maintained at all times in and around the truck loading space. The space shall be kept free from drippings from the mixing platform.

(11) Anti-strip Additive Measuring System. An anti-strip additive measuring system shall be placed in the anti-strip additive line prior to introduction into the asphalt loading line. The meter shall be capable of handling the anti-strip additive at temperatures up to 160 deg. F and shall be capable of withstanding the corrosiveness of the anti-strip additive. Meters having working internal components exposed to the

additive shall not be composed of aluminum, brass, bronze, or cooper. Permanent provisions shall be made for checking the accuracy of the meter. The meter shall be designed so that the cumulative amount of anti-strip additive can be accurately determined.

The anti-strip additive pipe line shall be properly insulated.

(12) Storage Silos and Surge Bins. The Contractor may use storage silos or surge bins for storing asphalt concrete mixtures provided it is not detrimental to the quality of the mix placed on the roadway.

The system shall be capable of conveying the hot mix from the plant to the silo by means of a drag-slat conveyor system or other approved system. The conveyor may be enclosed and heated to prevent a drop in the mix temperature; however, hot air shall not be blown on the mix. The conveyor shall be of a continuous type designed to prevent spillage and to remove the mix from the plant as fast as it is produced. In no case shall the conveyor or drag-slat be operated at a speed or in a manner as to segregate the mixture entering the storage bin. The mixture entering the storage bin shall be controlled in sequence with the tonnage produced so as not to segregate the mixture.

When the mixture is placed into the bin through a surge device, an automatic warning system shall be provided which will automatically warn the operator of a malfunction of the gates.

When heated, the silo shall be insulated and may be heated electrically or with hot oil or hot air.

The atmosphere within the silo may be air or inert gas. The storage silo heating system shall be capable of maintaining the mix temperature without localized heating (hot spots). If inert gas is used, the inert gas system must be capable of purging the silo with an oxygen free (inert) atmosphere and then sealing the silo to prevent the loss of the inert gas.

The maximum allowable storage time of the hot mix in the heated storage silo shall be as follows:

	Storage Time-Hours	
	Fine Mix (¾" Max. aggr. size)	Coarse Mix (1½" Max. aggr. size)
Air in bin	36	18
Inert gas in bin	144	72

All asphalt treated with an approved silicone from the Department's Qualified Products List at a rate as specified by the Engineer.

The storage silo or surge bin shall be loaded to approximately 1/3 of its capacity prior to discharging into trucks. The storage silo or surge bin unloading gates shall not cause segregation or be detrimental to the mixture in any way.

All trucks shall be loaded front, back, and middle, with a minimum of three drops. When the operation of the silo or bin produces segregation, the Contractor shall take immediate corrective action.

(13) Scales. All approved plant and truck scales shall be furnished by the Contractor in accordance with subsection 109.01(f).

(b) Additional Requirements for Batch Plants. (1) Bins. The plants shall include storage bins of sufficient capacity to supply the mixer when it is operating at full capacity. Hot Bins shall be divided into at least three compartments unless otherwise specified and arranged to insure separate and adequate storage of appropriate fractions of the aggregate. Each compartment shall be provided with an overflow pipe that shall be of such size and at such location as to prevent any backing up of material into other bins.

(2) Proportioning Equipment. Mineral aggregate shall be proportioned by weight. Weighing equipment for proportioning mineral aggregate shall be of such design and construction that each batch can be quickly and accurately weighed. Excessive vibration of the weighing assembly will not be permitted. The weighing unit shall consist of one hopper or weigh box large enough to hold one batch without running over or without requiring manual placement. The weigh box or hopper shall be supported on fulcrums and knife edges so constructed that they will not be easily thrown out of alignment or adjustment. Edges, ends, and sides of weighing hoppers must be free from contact with supporting rods or columns or other equipment that will affect proper functioning of the hopper. Also, there must be sufficient clearance between the hopper and supporting devices to prevent accumulation of foreign materials. The discharge gate of the weigh box shall be so hung that the aggregates will not be segregated when dumped into the mixer. The gate shall not be segregated when dumped into the mixer. The gate shall close tightly when the hopper is empty so that no material will be allowed to leak into a batch in the mixer during the process of weighing the next batch.

(3) Scales. Scales for weigh box or hopper shall be of the digital or springless dial type and shall be of standard make and design, sensitive to $\pm$0.5% of the maximum load that may be required, and equipped with a tare beam. The capacity of the dial shall not exceed twice the full capacity of the mixer. The dial shall be of compounding type having full complements of index pointers. Pointers so placed as to give excessive parallax errors shall not be used. Weight indicators shall be plainly visible and easily read by the operator.

The Contractor shall provide at least one 50 pound standard test weight for each 400 pounds of aggregate scale capacity.

Scale indicators placed at locations other than the mixer platform shall be operated by a satisfactory electronic system. A mechanical arrangement such as cables and pulleys for operating the scale indicators will not be permitted.

Asphalt shall be measured by weight in a heated bucket suspended from a springless dial scale. Scales for weighing asphalt shall conform to the specifications for the scales for aggregate, and shall read to the nearest pound.

In lieu of plant and truck scales, the Contractor may provide an approved automatic printer system which will print the weights of the material delivered, provided the system is used in conjunction with an approved automatic batching and mixing control system. Such weights shall be evidenced by a weigh ticket for each load.

(4) Mixer Unit. The plant shall include a batch mixer of an approved twin pugmill type, steamjacketed and capable of producing a uniform mixture within the job mix tolerances.

The mixer shall be so constructed as to prevent leakage of contents before the batch is discharged. The clearance of blades from fixed and moving parts shall not exceed ¾", except that when mixing Hot Mix Asphalt Stabilized Base Course or Crushed Stone Asphalt Concrete Base Course the blade clearance may be adjusted to prevent excessive pugmill blade and liner wear.

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 of the mixer gate 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. The dry mixing period is defined as the interval of time between the opening of the weight box gate and the start of introduction of asphalt material. The wet mixing period is the interval of time between the start of introduction of asphalt material and the opening of the mixer gate. The time control shall be capable of being set at intervals of not more than 5 seconds.

(c) Special Requirements for Batch Plants with Screens. The plants shall be provided with vibrating screens which will remove all particles larger than the maximum size permitted and will separate the material into at least three sizes.

The screens shall have a normal capacity slightly in excess of the full capacity of the mixer. Screen opening shall be such that in no case shall more than 50% be used from any one bin. No less than 15% shall be used from any one bin unless the plant is equipped with more than three hot bins. For Type 4 Surface, only 1 bin will be required.

(d) Additional Requirements for All Plants Without Screens. (1) Cold Feed Control. Prior to commencing production of the specified mixture, the Contractor shall establish cold feed limits and proportions established shall be such that the material produced will meet the specified hot mix asphalt materials and job mixture limits.

As part of the cold feed control, provisions shall be made for the Engineer to safely obtain cold feed samples of the combined aggregates from the belt prior to entering the dryer.

Cold feed belt samples will be taken on a daily random basis. Results of these tests may be used by the Contractor as a basis of making any adjustments to individual aggregate cold feeds, which may be necessary due to changing moisture conditions, minor gradation fluctuations, etc., in order to maintain the desired mixture gradation. The cold feed control shall be considered acceptable when the results of tests conducted on these cold feed samples indicate that the individual aggregates have been combined within the allowable tolerances for job mixture limits.

(2) Cold Feed Bins and Feeder for Dryer. The plant shall be equipped with a minimum of 4 cold feed bins. The bins shall be of sufficient size to store the amount of aggregates required for continuous operation of the plant. partitions between bins shall extend a minimum of 18" above the top of the material against the partition.

The unit shall have a mechanical feeder control mounted under the cold feed bins with each compartment having an accurately controlled individual gate to form an orifice for measuring the material drawn from it. The orifice shall be rectangular, with one dimension adjustable by positive mechanized adjustment. An indicator shall be provided on each gate to show that the proper gate opening is maintained. Premixing to avoid separate feeding will not be permitted. Placing the separated aggregates into storage or moving the aggregates from storage to feeder shall be accomplished by any method which will not cause segregation, degradation, or combination of aggregates which fail to meet the specified requirements.

(3) Scalper Screen. A scalper screen of the dimensions necessary to remove oversize aggregates shall be located between the cold feed bins and the dryer opening.

(4) An automatic plant shutoff shall be provided to operate when an aggregate bin becomes empty or flow is interrupted. the asphalt storage system shall be provided with signal devices and controls which will warn of low levels if the asphalt storage level is lowered to the point of exposing the feed end of the asphalt suction line.

(e) Special Requirements for Batch Plants Without Screens. Single Bin Discharge. The discharge into the weigh hopper shall be made from 1 bin only, which shall discharge into the center of the weigh hopper. The amount of material

stored in the bin at any one time shall not be in excess of one batch and shall be such that sloughing or segregation is minimized.

The Engineer may permit modification of these requirements provided that satisfactory results are obtained.

(f) Additional Requirements for Drum Mixer Plants. The system shall provide a positive weight measurement of the cold aggregate feed by use of belt scales or other devices which will allow regulation of feed gates and permit correction for variations in load.

The asphalt feed control shall be interlocked with the total aggregate weight measuring device in such manner as to automatically vary the asphalt feed rate as required to maintain proper asphalt content in the mixture. The weighing system shall be accurate within ±0.5%.

Means shall be provided for diverting aggregate into trucks, front end loaders, or other containers for checking the accuracy of the belt weigher.

(g) Additional Requirements for Continuous Mixing Plants. (1) Gradation Control Units. The plant shall include means for accurately proportioning aggregate from each bin.

The unit shall include a mechanical feeder mounted under the compartment bins. Each bin shall have an accurately controlled individual gate to form an orifice for volumetrically measuring the material from each bin compartment. The orifice shall be rectangular, its dimensions adequate to provide a positive feed without bridging, with one dimension adjustable by positive mechanical means provided with a lock. An indicator shall be provided on each gate to show that the proper gate opening is maintained. Means shall be provided to indicate when material in any bin is below fixed level so that proper proportions can ben maintained.

(2) Weight Calibration of Aggregate Feed. The plant shall include a means for calibration of gate openings by weighing test samples. The materials fed out of the bins through individual orifices shall be bypassed to suitable test boxes, each compartment material being confined in a separate box section. The plant shall be equipped to handle conveniently such test samples weighing up to 800 pounds each and to weigh them on accurate platform scales.

The system shall provide a positive weight measurement of the cold aggregate feed by use of belt scales or other devices which will allow regulation of feed gates and permit corrections for variations in load.

Means shall be provided for diverting aggregate into trucks, front end loaders, or other containers for checking the accuracy of the belt weigher.

(3) Proportioning of Asphalt Cement. Asphalt cement shall be proportioned by volume in an approved asphalt metering pump. The pump shall deliver the asphalt to the pugmill at a uniform rate which shall not vary more than 2% by weight from the required quantity. The asphalt shall be introduced into the pugmill in a manner which will result in a thoroughly uniform distribution of the asphalt in the final mixture at the end of the mixing operation.

The asphalt feed control shall be interlocked with the total aggregate measuring device in such manner as to automatically vary the asphalt feed rate as required to maintain proper asphalt content in the mixture. The weighing system shall be accurate within ±0.5%.

(4) Mixer Unit. The plant shall include a continuous mixer of an approved twin pugmill type, steam jacketed, and capable of producing a uniform mixture within the job mix tolerances. It shall be quipped with a discharge hopper with dump gates which will permit rapid and complete discharge of the mixture. The paddles shall be adjustable for angular position on the shafts and reversible to retard the flow of the mix. The mixer shall carry a manufacturer's plate giving the net volumetric contents of the mixer at the several heights inscribed on a permanent gauge and also giving the rate of feed of aggregate per minute at plant operating speed.

Unless otherwise required, determination of mixing time shall be by weight method under the following formula:

$$\text{Mixing time seconds} = \frac{\text{pugmill dead capacity in lbs.}}{\text{pugmill output in lbs. per sec.}}$$

The weights shall be determined for the job by tests made by the Engineer.

(h) Plant Inspection. For the verification of weights or proportions and character of materials, and determination of temperatures used in the preparation of the mixture, the Engineer shall have access to all parts of the plant.

The Contractor shall provide and maintain an approved building for the exclusive use of the Engineer. This building shall be located at the plant site. The building shall provide not less than 140 square feet of floor space with the width being not less than 7.5 feet. A work counter approximately 30" high shall be built in along one side wall and along one end wall. The total length of work counter shall be approximately 20 feet. A single sink, with approximate dimensions of 20" x 20", with outside drain, and suitable for washing samples shall be installed in the end section of the work counter. A water supply shall be provided with not less than 50 gallons storage discharging through a faucet mounted above the sink. An adequate supply of clean water shall be maintained at all times when work is in progress. Adequate shelves and/or cabinets shall be provided for storing testing equipment. A 24" x 36" desk shall be provided, which may be built-in, with at least two drawers 13" x 13" x 18" long for storing records.

Each building shall be provided with facilities for electric lights and power outlets arranged as directed by the Engineer. In cold weather each building shall be provided with adequate vented space heating facilities and fuel for heating. In hot weather each building shall be equipped with adequate air conditioning units. Heating and cooling utility service will be furnished at no cost to the Owner.

The building shall contain a completely enclosed vented compartment that is suitable for housing the extraction and heating equipment. The compartment shall be a minimum of 66" wide and 26" deep with the approximate door opening being 60" wide and 36" high. The bottom of the compartment shall be approximately 30" above the floor of the building. The interior surfaces shall be covered with approved fire resistant materials. This compartment shall be equipped with a rheostatically controlled exhaust fan capable of exhausting in one minute a volume of air at least 1 1/2 times the volume of the laboratory. The fan shall be located near the center of the compartment and no higher than 12" from the bottom. provision shall be made for drainage of solvent from the extraction equipment to a sheltered container outside the laboratory.

When Type 1 Binder or Type 1 Surface Course is specified, the laboratory shall be provided with a 30" square concrete base which extends from the ground to the floor level of the laboratory and shall provide satisfactory support for the asphalt compactor and pedestal.

The field laboratory for asphalt mixing plants will not be paid for directly, but shall be considered as part of the asphalt mixing plant.

409.04 Mechanical Spreading and Finishing Equipment. Mechanical spreading and finishing equipment shall consist of a self-powered paver, capable of spreading and finishing the mixture true to line, grade, and cross section without the use of side forms or side supports. the paver shall be capable of laying a uniform mixture to the full width being laid.

The paver shall be equipped with mechanical devices such as equalizing runners, straightedge runners, evener arms, or other compensating devices to adjust the grade and confine the edges of the mixture to true lines without the use of stationary side forms. The paver shall be equipped with hoppers and distributing screws of the reversing type adequate to place the mixture evenly ahead of the screed for the full width being laid.

Pavers used for shoulders and similar construction shall be capable of uniformly spreading and finishing courses of asphalt material to the full width being laid. The paver shall be equipped with a receiving hopper and distribution system to place the mixture uniformly across the entire width of the screed.

The term "screed" shall include any strike-off device, operated by cutting, crowding, or other practical action which effectively places and spreads the mixture

without tearing, shoving, gouging, or segregating. Screeds shall be adjustable to crown and grade and shall have an indicating level attached.

The paver shall be equipped with blending or joint leveling devices for smoothing and adjusting all longitudinal joints between adjacent strips. Suitable and adequate heating equipment shall be provided to preheat the screed.

The paver shall be equipped with an automatic screed control system for the control of grade and slope. The sensor for grade control may be operated from a reference stringline, from a ski-type grade reference system, from a sensor shoe sliding over an adjacent mat, or by any other appropriate method which will produce the desired results.

Final approval of spreading and finishing equipment will be based upon satisfactory performance during actual construction. If equipment becomes unsatisfactory, it shall be replaced before proceeding with the work.

409.05 Rollers. Compaction of asphalt base, binder, and surface courses shall be obtained by self-propelled rollers. No roller will be permitted on the work which is not in good mechanical condition. Rollers shall have a system for moistening the full width of each roller and devices for cleaning the tires and/or drums.

Rollers to accomplish the requirements for pneumatic rolling shall have sufficient number of axles and tires or be operated in such a manner as to provide tire contact over the full width of the mat being placed.

Trench rollers shall be equipped with a leveling mechanism to maintain the axis of the compacting roller in a horizontal plant while compacting surfaces below the edge of the old pavement. The compacting rollers shall have not less than 15" tread width. The weight applied by any compacting roller shall be not less than 200 pounds per inch of tread width.

SECTION 410

CONSTRUCTION REQUIREMENTS FOR ASPHALT CONCRETE HOT MIX BINDER AND SURFACE COURSES

410.01 General. The methods employed in performing the work and the equipment, tools, and plant machinery used in executing the work shall be subject to the approval of the Engineer before the work is started. When found unsatisfactory they shall be changed and improved as required. Equipment, tools, and plant machinery must be maintained in a satisfactory working condition. The plant and equipment shall comply with the requirements of Section 409.

410.02 Preparation of Mineral Aggregate. Coarse and fine aggregates shall be fed into the dryer through the cold aggregate bins in such a manner that a uniform and constant flow of materials in the required proportions will be maintained. The aggregate shall be dried and heated to the temperature necessary to produce a mixture having the desired temperature within the range specified. The burners on the dryers shall be adjusted so that the fuel is completely burned.

When the Contractor elects to use a batch plant, immediately after heating, the aggregate shall be screened into three or more approximately equal fractions and conveyed into separate bins ready for batching and mixing with asphalt cement except when Type 4 Surface Course is specified. Screens shall never be loaded to such an extent that they will not separate the aggregate efficiently.

410.03 Preparation of Mixture. Each size of hot aggregate, the mineral filler, and the asphalt cement shall be measured separately and accurately in the proportions in which they are to be mixed. In batch mixing, the hot aggregate and mineral filler shall be mixed in the pugmill for at least 10 seconds before application of the asphalt cement. The dry mixing requirements may be waived for binder or hot mix stabilized base course when clean uncoated aggregate is used. The dry mixing time for surface course may be decreased from the minimum 10 seconds, upon approval of the Engineer, when the aggregates being used in the mix are such that dry mixing is considered detrimental to the mixture. The reduced mixing time will be specified by the Engineer. The asphalt cement shall be introduced in such manner as to spread evenly over the mixture. The time required to add the asphalt cement shall not exceed 15 seconds. The time required for adding asphalt and completing the wet mixing shall be not less than 30 seconds. The mixing time may be increased above the minimum specified if necessary to produce a homogeneous mixture with a uniform distribution of the asphalt cement throughout the aggregate and complete coating of the aggregate particles. The mixture shall not show an excess or deficiency of bitumen, injury or damage due to burning or overheating, or an improper combination of aggregates.

410.04 Preparation of Subgrade. Unless the course is to be placed on an existing base or pavement, the subgrade shall be prepared in conformity with the provisions of Section 212, and shall conform to the typical cross section as shown on the plans, and primed if specified. Additional material obtained from preparing the subgrade shall be bladed to the shoulders and evenly spread, with excess material being distributed evenly on the slopes.

410.05 Preparation of Existing Base or Surface. Newly constructed base courses shall be prepared as set forth in the specification item covering such base courses.

Prior to placing asphalt base, binder, or surface courses, all required corrections of the existing pavement or old base, such as filling pot holes, sags, and depressions, or alterations of the existing pavement crown, shall be made. Such corrections shall be accomplished by placing asphalt binder or surface course mixtures at the location and in a manner as directed by the Engineer. Asphalt material used for wedging or leveling courses, or for filling holes, may be placed by hand, blade grader, or mechanical spreader methods. The mixture shall be feathered to a smooth and even surface around the edges of these areas. Prior to placing asphalt material, the base or existing surface shall be primed or tacked as applicable.

Excessive joint or crack filler on existing pavement surface shall be removed. No direct payment will be made for cleaning the surface of existing pavement unless provided for in the plans.

Prior to arrival of the mixture on the work, the prepared surface, primed or tack coated as specified, shall be cleaned of all loose and foreign materials. The mixture shall not be placed on a surface which shows evidence of free moisture.

Contact surfaces of curbing, gutters, manholes, and other structures shall be painted with a thin coating of rapid curing cutback asphalt or emulsified asphalt. No direct compensation will be made for this work.

For foreign material, or when the time lapse between courses is in excess of 72 hours, the earlier course shall be cleaned and given a tack coat prior to placing the succeeding course. When directed, the tack coat shall be applied and paid for in accordance with Section 401. If directed by the Engineer, a tack coat shall be used even though the lapsed time has been less than 72 hours.

410.06 Transporting. The mixture shall be transported from the mixing plant to the work in vehicles with clean tight beds.

When the mixture is being hauled more than 15 miles or when the mixture is being placed between November 1 and April 1, the beds of the vehicles shall be suitably insulated and covered with canvas or other suitable material to retard loss of heat. The insulating material shall be at least ¾" thick and shall cover ends, sides, and bottom of

the truck bed. The cover shall extend at least 12" over the sides and ends of the truck bed and shall be securely fastened. When the mixture is being hauled less than 15 miles the cover shall be stored on the truck at all times to be utilized when overtaken by sudden rains.

No loads shall be sent so late in the day as to interfere with spreading and compacting the mixture during daylight hours unless adequate artificial lighting is provided.

Sufficient haul vehicles and plant production rate shall be maintained to the project to provide a continuous operation on the roadway.

Only approved non-petroleum release agents shall be used in haul trucks. The release agent shall be one listed on the Department's Qualified Products List.

410.07 Spreading and Finishing. The mixture shall be placed on an approved surface, spread , and struck off to the line, grade, and elevation established. the mixture shall be placed only on a base which shows no evidence of free moisture, and only when weather conditions are suitable. The Engineer may, however, permit work of this character to continue when overtaken by sudden rains to utilize materials which may be in transit from the plant at the time, provided the mixture is within the temperature limits specified and provided the finished pavement otherwise meets specification requirements.

The mixture from all types of plants should be delivered to the paver within the recommended compaction temperature range as shown on the approved job mix design. These recommended temperatures should be used in placing and compacting the material.

Surface and binder course mixtures shall not be placed on the roadway at a temperature lower than 250 deg. F.

The longitudinal joint in one layer shall offset that in the layer immediately below by approximately 6", however, in general, the joint in the top layer shall be at the centerline of the pavement if the roadway comprises two lanes in width, or at lane lines if the roadway is more than 2 lanes in width. General casting back of material or hand raking material onto the surface will not be permitted. Hand spreading will be permitted only in areas inaccessible to the paver.

On roads under traffic, the mixture shall be spread and finished in full lane widths where practicable. The paver shall alternate between the lanes with such frequency that the adjacent lane shall be laid the next working day after the first lane is laid.

The paver shall uniformly distribute and compact the mixture in front of the screed for the full width being paved. The finished surface shall be smooth and of uniform texture.

The screed or strike-off assembly shall effectively produce a finished surface of the required evenness and texture without tearing, shoving or gouging the mixture.

When laying mixtures, the paver shall be operated at forward speeds consistent with satisfactory laying of the mixture. The speed of the paver shall be matched with the plant production rate and number of hauling units. Stop and go operation of the paver is to be avoided.

The edge of the Binder or Surface Course shall be established by a string or chalk line for a distance of not less than 500' ahead of the spreading operation.

410.08 Rolling and Density Requirements and Joints. The mixture, after being spread, shall be thoroughly compacted by rolling as soon as it will bear the weight of the rollers without undue displacement.

An optimum rolling pattern that will produce the maximum density possible shall be established for each mix design at the beginning of paving operations by the placement of a test strip approximately 500' in length. A sufficient number of coverages of the entire mat by the rollers proposed to be used by the Contractor during production paving operations shall be made to achieve the maximum density possible. The densities for the establishment of the optimum rolling pattern will be determined by the Engineer using a nuclear density gauge. The Contractor may continue with paving operations while the optimum rolling pattern is being determined. Whenever a change in the job mix formula occurs or the compaction method or equipment is changed or unacceptable results occur, a new strip shall be constructed and tested in order to establish a new optimum rolling pattern.

Except for the intermediate rolling requirements with a pneumatic roller, the number, weight, and type of rollers, and the optimum rolling pattern shall be such that the specified density and surface requirements are consistently attained whiled the mixture is in a workable condition. Final approval of the rollers and the rolling pattern will be based upon satisfactory performance and the ability to compact the mixture to the specified density and surface requirements. Rollers which produce excessive crushing of aggregate particles will not be permitted.

Following the breakdown rolling operation and as soon as the mat will support the roller without displacement, each layer of base, binder, or surface mix shall receive a sufficient number of passes with a pneumatic roller to knead and seal the entire mat being placed.

When using vibratory rollers, the Contractor shall exercise due caution to prevent any deterioration of the material caused by excessive rolling or vibration. Vibratory rollers shall not be used on courses less than 1 1/2" thick. Vibratory rollers shall be operated in such a manner that overlap of adjacent passes shall be held to a minimum.

Rolling shall start longitudinally at the low edge and proceed toward the higher portion of the mat. When paving in echelon or abutting a previously placed lane, the longitudinal joint shall be rolled first followed by the regular rolling procedure. Alternate passes of the roller shall be terminated at least 3' from any preceding stop. Rolling on superelevated curves shall progress from the low side. Rollers shall not be stopped perpendicular to the centerline of the traveled way.

The speed of the roller shall be slow enough to avoid displacement of the hot mixture and in no case, more than 3 mph. The roller shall be operated in such a manner that no displacement of the mat will occur. Rolling shall proceed continuously until all roller marks are eliminated and the required density attained. To prevent adhesion of the asphalt mixture to the rollers, the rollers shall be kept moist for the full width of the rollers, but an excess of water will not be permitted.

Upon completion of the rolling operations, the surface shall be smooth and of uniform texture.

The maximum theoretical density will be determined by the Rice Method, AASHTO T 209, as shown on the accepted job mix design for the optimum asphalt content. If the asphalt content varies from the optimum, the maximum theoretical density will be adjusted accordingly. If production of the mix is discontinued for a period of thirty days or more, or if other conditions warrant, the Engineer may redetermine the maximum theoretical density.

Rollers shall not pass over the unprotected end of a freshly laid mixture. Transverse joints shall be formed by cutting back on the previous run to expose the full depth of the course. A brush coat of asphalt material shall be used on contact surfaces of transverse joints just before additional mixture is placed against the previously placed material.

410.09 Acceptance of the Pavement and Adjustments. (a) Acceptance of the Pavement. The minimum frequency of sampling and testing for acceptance will be in accordance with the Department's "Manual of Field Sampling and Testing Procedures." Investigation of and adjustments for non-complying work will be based on the quality control lot. All sampling and testing for acceptance and/or adjustment will be performed by the Department.

(1) Asphalt Content and/or Gradation. Acceptance of the pavement mixture with respect to asphalt content and/or aggregate gradation will be based upon the results of extraction tests or nuclear gauge results and belt or dray batch gradations.

When the results of either quality control or acceptance tests indicate that the mixture is outside the specified tolerances, further evaluation of the mixture will be made to determine its acceptability by dividing the quality control lot into three equal sub-lots and taking a sample from each sub-lot. The sample shall be obtained by the Contractor at locations selected by the Engineer, and at no cost to the Owner. The

sample shall be obtained using any tool suitable for removing a sample of compacted pavement for the full depth of the course or courses. An impact chisel, a diamond blade pavement saw, or a diamond bit core drill are suitable for this purpose. The holes made in taking the samples shall be repaired by the Contractor at no cost to the Owner, other than for materials. The results of the extraction tests on these samples will be used in the evaluation of the individual sub-lot.

If extraction test results for a sub-lot are within the specified tolerances the sub-lot will be accepted. If extraction test results for a sub-lot are outside the specified tolerances, two additional samples shall be taken from the sub-lot near the location of the original sample. If the test results for both samples are within the specified tolerances, the sub-lot will be accepted. If the test results for either of these samples are outside the specified tolerances, the sub-lot will be considered non-complying. When a sub-lot is found to be non-complying, but within the limits specified in 410.09(c), it may be left in place at a reduced cost to the Owner. The cost adjustment will be determined in accordance with 410.09(c) using the test results of all three samples. The number of deviations for the cost adjustment will be calculated by summing the maximum deviation of each of the samples and dividing the sum by the number of complying and non-complying samples. Any adjustment will be for entire quantity of the sub-lot.

In the event non-complying material is found to be unacceptable relative to asphalt content or aggregate gradation and it is determined that the pavement must be removed, the area to be removed shall be isolated by taking additional cores at 50' intervals, beginning 25' each direction from the location of the failing samples, until complying specimens are obtained. The minimum area to be removed will be 50 linear feet of the width paved. Replacement of the pavement shall be accomplished using a paver.

(2) Density. Acceptance of the pavement with respect to filed density will be based on the density determined for each lot placed.

If non-complying densities are obtained during the establishment of the optimum rolling pattern, the mix placed while using the unsatisfactory rolling pattern will be considered as a separate lot(s) for testing and evaluation purposes.

A sample for density determination shall be taken in each lot on the day following placement. The pavement shall be cut by the Contractor at locations selected by the Engineer, and at no cost to the Owner. The sample shall be obtained using any tool suitable for removing intact a sample of compacted pavement for the full depth of the course or courses. An impact chisel, a diamond blade pavement saw, or a diamond bit core drill are suitable for this purpose. The hole made in taking the samples shall be repaired by the Contractor at no cost to the Owner, other than for materials. Each lot of the compacted mix will be accepted when the density of the sample obtained from the lot is equal to or greater than the minimum specified density.

If a field density determination is below the minimum specified value, two additional samples shall be taken from the quality control lot near the location of the original sample. If the average value of these three samples equals or exceeds the minimum specified value, the lot will be accepted. If this average is below the minimum specified value, the lot will be considered non-complying. When a lot is found to be non-complying, but within the limits specified in 410.09(c), it may be left in place at a reduced cost to the Owner. The cost adjustment will be determined in accordance with 410.09(c) using the average density of the three samples. Any adjustment will be for the entire quantity of the lot.

In the event non-complying material is found to be unacceptable relative to density and it is determined that the pavement must be removed, the area to be removed shall be isolated by taking additional cores at 50' intervals, beginning 25' each direction from the location of the failing samples, until complying specimens are obtained. The minimum area to be removed will be 50 linear feet of the width paved. Replacement of the pavement shall be accomplished using a paver.

(3) Segregation. Visual inspection of the compacted pavement will be made to determine the extent of any segregation. Pavements exhibiting objectionable segregation will be further investigated to determine compliance. Test results from routine samples taken from the roadway and/or from additional samples taken in objectionable areas will be utilized to determine if the material complies with the specifications; i s non-complying but deemed reasonably acceptable, in accordance with subsection 105.04, and may be left in place at a reduced cost to the Owner; or if the material must be removed and replaced.

In the event the material is found unacceptable relative to segregation and it is determined that the material must be removed, the area(s) of segregation shall be removed full depth of the course paved. Replacement of material by dumping and spreading by hand or motor grader will be permitted on base and binder courses for areas less than 50' in length. Replacement in larger areas of base and binder courses and replacement in any surface course will be accomplished with a paver. The minimum area to be removed and subsequently replaced with a paver shall be 50 linear feet of the width paved.

(b) Unacceptable Pavement. Removal and replacement of any Base, Binder, or Surface Courses that are found to be unacceptable relative to asphalt content, gradation, density, or segregation shall be at no cost to the Owner.

(c) Adjustments. Adjustments will be made by reducing the contract cost of the items used in the lot or sub-lot in accordance with the schedules below. Adjustments will be applied to all components of the course for the entire quantity of the lot or sub-lot. Adjustments will be accomplished by Change Order and will be shown on progress and final estimates as a separate item deduction. When the number of deviations for asphalt content, aggregate gradation, or density exceeds the maximum specified below, or when an accumulation of deviations results in a reduction of the

contract cost of the work greater than 50%, that lot or sub-lot will not be accepted. **Continuous production of material not qualifying for 100% payment will not be allowed.**

(1) For asphalt cement content, the contract cost of all items in the mix will be reduced by 10.0% for each deviation outside the specified tolerance, up to a maximum of 4 deviations. One deviation is 0.1%.

(2) For aggregate gradation on sieves above the #200, the contract cost of all items in the mix will be reduced by 5.0% for each deviation outside the specified tolerance up to a maximum of 8 deviations. One deviation is 1%.

(3) For aggregate gradation on the minus #200 material, the contract cost of all items in the mix will be reduced by 2.0% for each deviation outside the specified tolerance up to a maximum of 20 deviations. One deviation is 0.1%.

(4) For field density on all asphalt concrete courses, the contract cost of all items in the mix will be reduced by 2.0% for each deviation outside the specified range up to a maximum of 20 deviations. One deviation is 0.1%.

(d) Pavement which is determined to be non-complying for any reason other than asphalt content, aggregate gradation, or field density will be evaluated in accordance with subsection 105.04. The Engineer will determine whether the non-complying pavement must be corrected or removed and replaced or may be left in place at a reduced cost to the Owner. Cost reductions in accordance with subsection 105.04 will be in addition to the cost reductions, if any, determined for asphalt content, aggregate gradation, and/or field density. If the total cost reduction is determined to be greater than 50% for any lot or sub-lot, that lot or sub-lot will not be accepted.

410.10 Surface Tests. The finished surface, when checked with a 10' straightedge operated parallel to the centerline, shall show no variation more than 3/16" for binder courses and not more than 1/8" for surface courses when the profile grade line is shown on the plans. If the profile grade line is not shown on the plans, the variations shall be not more than ¼" for binder courses and not more than 3/16" for surface courses. When surface tests indicate surface tolerances do not meet these requirements, corrections to the pavement and/or changes to the paving operations will be made before beginning the next day's operations.

All transverse joints shall be straightedged immediately following rolling of the joint. Paving will not continue until the transverse joint meets the applicable surface tolerances shown above.

The Engineer will test the finished surface of each course on main lanes and ramps with a rolling straightedge immediately following the final rolling as conditions permit. All testing will be made in a longitudinal direction and at least one pass shall be made for the full length of each lane.

Areas not meeting the above surface test requirements for all except the final surface course may be corrected by skin patching, featheredging, or other methods which would provide the required smoothness.

Areas not meeting the above surface test requirements for the final surface course shall be corrected in such a manner as to maintain a quality pavement having the same uniform texture and appearance as the adjoining surface. Skin patching will not be permitted. Featheredging will be permitted only at the beginning and the end of the job.

All corrective work and material necessary to correct surface tolerance deficiencies for both binder and surface course shall be at no cost to the Owner.

410.11 Widening and Overlay Operations. When pavement construction results in vertical differentials at the lane lines or at the edge of the traveled lanes, the Contractor shall comply with the requirements of subsection 603.02(c).

When asphalt hot mix material is to be placed in a trench for widening an existing pavement and the trench is inaccessible to normal rolling operations, compaction both of the subgrade and of the asphalt material shall be accomplished by means of a trench roller or by other approved methods.

410.12 Seasonal and Temperature Limitations. Hot mix asphalt materials shall not be mixed or placed when the surface temperature is below 40 deg. F, or when there is frost in the base or subgrade, or at any other time when weather conditions are unsuitable for the type of material being placed. It is further provided that ACHM Stabilized Base Course or ACHM Binder Course shall not be placed after December 1, nor prior to March 15. All ACHM Binder Course previously placed on the project shall be covered with ACHM Surface Course by December 20. However, during the period between December 1 and March 15, substitutions may be made in accordance with subsection 404.03 except that Binder Course may not be substituted for ACHM Stabilized Base Course.

When a substitution is made, payment shall be in accordance with the provisions of subsection 404.03.

SECTION 501

PORTLAND CEMENT CONCRETE PAVEMENT

501.01 Description. This item shall consist of construction a pavement composed of portland cement concrete, with or without reinforcement as specified, constructed on a prepared subgrade or base course 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.

501.02 Proportions. The concrete shall be composed of portland cement, water, fine aggregate, and coarse aggregate of the gradation, quality and proportions hereinafter specified. unless otherwise provided, the air content of the fresh concrete, as determined by AASHTO T 152, shall be 6% ±1 ½%. The air entrainment shall be accomplished by adding to the mixing water the proper amount of an air entraining agent in solution.

The minimum cement content shall be 517 pounds (5.5 sacks) of cement per cubic yard of concrete. The water-cement ratio shall not exceed 5.5 gallons of water, including the free moisture content of the aggregate, per sack of cement. The quantity of water will be determined by the Engineer and shall not be varied without his consent. The minimum 28 day compressive strength shall be 4000 psi when tested in accordance with AASHTO T 22. Test specimens will be made and cured in accordance with AASHTO T 23 or T 126 as applicable.

Fly ash may be used as a partial replacement not exceeding 25% by weight for the cement. Mixtures with fly ash shall meet the same requirements as mixtures without fly ash. Fly ash will not be allowed as a substitute for high early strength or blended cements.

When the Contractor elects to use fly ash as a partial replacement for the cement, the mix designs proposed by the Engineer shall be tested by trial batches using the specific materials, including admixtures, that are intended for use on the job. The Contractor shall prepare a batch of at least 2 cubic yards. This batch will be sampled and tested by the Engineer for compliance with the specifications for slump, air content, and compressive strength. A mix design may be approved, with respect to compressive strength, when test cylinders show the minimum required strength value at any age between 7 days and 28 days, inclusive.

In lieu of the above procedure, the Contractor may prepare trial batches in a laboratory in accordance with AASHTO T 126. The trial batches shall be accomplished

by the Contractor under the observation of the Engineer. Sampling and testing will be conducted by the Engineer.

With the approval of the Engineer, the Contractor may retain an independent laboratory or a Registered Professional Engineer to prepare and test trial batches. In this case, trial batch information and laboratory results shall be furnished to the Engineer along with a statement certifying that the testing was conducted in accordance with the specifications.

All trial batches required by these specifications are subject to the review and approval of the Engineer of Materials and Research.

If a current mix design utilizing the same materials the Contractor proposed to use on the project is on file with the Materials and Research Division, that mix design may be approved for use on other projects with the same design requirements. Transfer of a mix design may be permitted if the mix design is certified by an independent laboratory to meet these specifications and is supported by mix design information and actual quality control test results.

Fine and coarse aggregate shall be added only in such proportion that satisfactory plasticity, workability, and consistency of the mix shall be maintained, with the further provision that the ratio of the fine aggregate to cement, based on dry and rodded measure, shall be not less than 1.5 nor more than 2.5.

The mixed concrete shall have a uniform consistency with a slump, as determined by AASHTO T 119, of not more than 2 inches.

The specified ratio of water to cement shall not be exceeded and the desired workability, plasticity, and consistency shall be attained either by increasing the cement content while using the maximum allowable water-cement ratio, or by decreasing the water-cement ratio while using the minimum allowable cement content.

The proportions to be used in the mix, based upon the gradation of the fine and coarse aggregate to be used, will be determined by the Engineer and will be stated in terms of the number of parts of dry and rodded measure of such aggregate.

When a mix design has been established utilizing the materials provided, the mix design will be submitted to the Contractor for his review.

The Contractor may submit to the Engineer an alternate mix design. If this mix design is within the required specifications and meets all the design criteria, the Engineer will accept the mix design proposed by the Contractor. If plant production must be stopped due to a material change or depletion of material sources, the Engineer will design a new mixture. At this time, the Contractor will have one opportunity to propose an alternate to the new mixture. When a mix design is

considered marginal, and the Contractor elects to use the mixture, he shall acknowledge in writing that he is aware of the marginal condition.

Prior to producing any concrete mixture, the Contractor shall have a mix design which has been approved by the Engineer. Acceptance by the Contractor will be documented before production begins.

501.03 Materials. The materials used shall conform to the requirements as set out herein. No materials shall be used containing foreign matter, frost, or lumps or crusts of hardened substances.

(a) Water. Water used in mixing or curing shall be clean and free from injurious amounts of oil, salts, or other deleterious substances and shall not contain more than 1000 parts per million of chlorides.

Water from municipal supplies approved by the State Health Department will not require testing but water from other sources shall be sampled and tested before use in concrete.

Tests will be made in accordance with AHTD Test Method 576.

Where the Source of water is relatively shallow, it shall be maintained at such depth and the intake so enclosed as to exclude silt, mud, grass, or other foreign materials.

(b) Cement. Portland cement shall conform to AASHTO M 85, Type 1, unless otherwise specified.

Cement shall be furnished in bulk. The use of cement salvaged from spillage will not be allowed, nor will the mixing or alternate use of different brands of cement be permitted. Cement placed in storage shall be suitably protected. Loss in quality occurring during the storage period will be cause for rejection.

(c) Chemical Admixtures. The air-entraining agent shall comply with the requirements of AASHTO M 154, and shall be added to the mixing water in solution. The Contractor shall submit evidence based on tests made in a recognized laboratory to show that the air-entraining admixture conforms to the requirements of AASHTO M 154 for 7 and 28 day compressive and flexural strengths and resistance to freezing and thawing, except as provided in the following paragraph. Tests for bleeding, bond strength, and volume change will not be required. A "recognized" laboratory in any State Highway, Federal Highway Administration, or cement concrete laboratory regularly inspected by the Cement and Concrete Reference Laboratory of the National Bureau of Standards. Tests may be made upon samples taken from a quantity submitted by the Contractor for use on the project or upon samples submitted and certified by the manufacturer as representative of the admixture to be supplied.

An exception to the requirements in the preceding paragraph is the case of admixtures which are manufactured by neutralizing Vinsol resin with caustic soda (sodium hydroxide). When the Contractor proposes to use such an admixture, he shall submit a certification concerning the admixture in the following form:

> "This is to certify that the product (trade name) as manufactured and sold by the (company) is an aqueous solution of Vinsol resin that has been neutralized with sodium hydroxide. The ratio of sodium hydroxide to Vinsol resin is one part of sodium hydroxide to (number) part of Vinsol resin. The percentage of solids based on the residue dried at 105 deg. C is (number). No other additive or chemical agent is present in this solution.

The Contractor may request, in writing, to use admixtures that are water-reducing, set-retarding, set-accelerating, or combinations thereof. Admixtures shall conform to the requirements of AASHTO M 194 and approval for their use shall be obtained from the Engineer prior to their being incorporated into the mix.

When the Contractor proposes to use an air-entraining admixture which has been previously approved, he shall submit a certification stating that the admixture is the same as that previously approved. If an admixture offered for use is essentially the same (with only minor differences in concentration) as another previously approved material, a certification will be required stating that the product is essentially the same as the approved admixture and that no other admixture or chemical agent is present.

Chemical admixtures shall be from the Department's Qualified Products List.

Either prior to or at any time during construction, the Engineer may require that the admixture selected by the Contractor be further tested to determine its effect upon the strength of the concrete. Admixtures failing to meet the applicable requirements of AASHTO M 154 or M 194 will be rejected.

(d) Coarse Aggregate. The coarse aggregate shall consist of crushed stone or gravel. A coarse aggregate consisting of a combination of crushed stone and gravel shall be used only when specifically approved by the Engineer.

Crushed stone shall consist of clean, hard, durable fragments of rock of uniform quality. The stone shall have a percent of wear by the Los Angeles Test (AASHTO T 96) not greater than 40, and when subjected to 5 cycles of the Soundness Test (Sodium Sulphate, AASHTO T 104), shall have a loss not to exceed 12%.

Gravel shall consist of clean, hard, durable, uncoated aggregate, crushed or uncrushed, having a percent of wear by the Los Angeles Test (AASHTO T 96) not greater than 40.

When determined necessary by visual observation, the amount of deleterious substances will be tested by laboratory methods and will not exceed the following limits:

	Maximum Permissible Percentage by Weight
Removed by decantation (AASHTO T 11)	1
Coal and Lignite (AASHTO T 113)	0.25
Clay lumps (AHTD Test Method 302)	0.25
Soft fragments (AHTD Test Method 302)	5
Total Deleterious substances	5

The maximum percentage by weight removed by decantation (AASHTO T 11) from crushed stone coarse aggregate may be increased to 1.5% provided the percent loss (AASHTO T 11) from the fine aggregate does not exceed 1%.

Coarse aggregate shall be reasonably well graded from coarse to fine and shall conform to the following grading requirements when tested in accordance with AASHTO T 27;

Sieve	**Percent Passing**
1½"	100
¾"	35-75
3/8"	10-30
#4	0-5

Coarse aggregate from any one source shall not vary as to maximum size and shall be uniform to a reasonable degree in gradation with the representative sample submitted by the Contractor, with the further provisions that aggregate furnished from any one source having a variation in fineness modulus greater than 20 points either way from the fineness modulus of the representative sample submitted by the Contractor will require a new mix design.

(e) Fine Aggregate. The fine aggregate shall consist of clean, hard, durable particles of natural sand or other approved inert material with similar characteristics.

When determined necessary by visual observation, the amount of deleterious substances will be tested by laboratory methods and will not exceed the following limits:

	Maximum Permissible Percentage by Weight
Removed by decantation (AASHTO T 11)	2
Clay lumps (AHTD Test Method 302)	0.50
Coal and lignite (AASHTO T 113)	0.25
Soft and flaky particles (AHTD Test Method 302)	2

All fine aggregate shall be free from injurious amount of organic impurities.

Aggregates shall be subjected to testing in accordance with AASHTO T 21. Should AASHTO T 21 produce results which indicate that the sand may possibly contain injurious organic compounds, mortar strength test specimens shall be tested in accordance with AHTD Test Method 530.

Fine aggregate shall be reasonably well graded from coarse to fine and shall conform to the following grading requirements when tested in accordance with AASHTO T 27:

Sieve	Percent Passing
3/8"	100
#4	95-100
#8	70-95
#16	45-80
#30	20-60
#50	5-30
#100	0-5

Fine aggregate from any one source shall be uniform to a reasonable degree in gradation with the representative sample submitted by the Contractor with the further provision that aggregate supplied from any one source having a variation in fineness modules greater than 20 points either way from the fineness modules of the representative sample submitted by the Contractor will require a new mix design.

(f) Fly Ash. Fly ash for use with portland cement shall conform to the requirements of ASTM C 618, Class C or Class F. Mixing of Class C and Class F fly ashes will not be permitted.

(g) Reinforcing Steel and Dowel Bars. Reinforcing steel, dowel bars, and other steel bars shall meet the requirements of subsection 502.02.

(h) Joint Materials. (1) Materials for filling and sealing expansion joints shall be as shown on the plans and shall conform to the following requirements, as applicable:

a. Type 1 joint filler shall be a uniform mixture of sawdust and asphalt material in the proportion of one part asphalt to four parts sawdust, by volume. Asphalt material used shall be either MC-250 or SS1 in accordance with subsection 403.03. When this material is specified, the joint shall be filled to within 1" of the pavement surface. The top 1" shall be sealed with a material complying with the requirements of AASHTO M 173.

b. Type 2 joint filler shall be preformed, non-extruding, and resilient type, meeting the requirements of AASHTO M 153 Type I (sponge rubber) or Type III (self-expanding cork), except that the Type III (self-expanding cork) shall have a minimum expansion of 135% and be within ±0.1" of the specified plan thickness.

(2) The material for filling and sealing longitudinal, warping, contraction, and other specified joints shall be as shown on the plans and shall conform to the following requirements:

a. Backer rod filler for Types 3, 4, and 5 joint shall be of resilient material approximately ⅛" larger in diameter than the width of the joint to be sealed. The rod shall be compatible with the sealant or any component of the joint sealant system. No adverse reaction shall occur between the backup material, sealant, and primer. No bond shall occur between the backup material and the sealant system for Types 3 and 4 joint sealer.

b. Type 3 joint sealer shall be a one part silicone formulation which does not require a primer for bond to concrete. The compound shall be compatible with concrete. Acetic acid cure sealants are not acceptable. The material shall be one listed on the Department's Qualified Products List.

c. Type 4 joint sealer shall be a one part silicone formulation which does require a primer for bond to concrete. The compound shall be compatible with concrete. Acetic acid cure sealants are not acceptable. The material shall be one listed on the Department's Qualified Products List.

d. Type 5 joint sealer shall be a hot poured elastomeric joint sealant. The material shall meet the requirements of AASHTO M 282 (ASTM D 3406). The appendix of that specification shall be considered a part of this specification. The material shall be one listed on the Department's Qualified Products List.

e. Type 6 joint sealer shall be a 2 component cold poured, synthetic polymer, meeting the requirements of ASTM D 1850 with the exception of penetration which shall not exceed 100 and resilience (both original cured sample and oven aged) which shall

be a minimum of 70%. The material shall be one listed on the Department's Qualified Products List.

f. Type 7 joint filler shall be a hot poured elastic type meeting the requirements of AASHTO M 173.

(i) Curing Materials. Curing materials shall conform to one of the following types:

(1) Polyethylene-burlap mats meeting requirements of AASHTO M 171. Polyethylene-burlap mats shall consist of one 9 ounce per square yard thickness of burlap, impregnated on one side with one opaque 4 mil thickness of polyethylene, and free from visible defects.

(2) Membrane curing compound meeting requirements of AASHTO M 148. Membrane curing compound shall consist of a transparent blend of oil, waxes, or resins, and finely ground white pigment held in solution or suspension in a volatile vehicle and shall not settle out hard on continuous standing.

(3) Polyethylene sheeting meeting requirements of AASHTO M 171. Polyethylene sheeting shall be 4 mil minimum thickness, uniform in appearance, and free from visible defects.

(4) Copolymer/synthetic blanket meeting performance requirements of AASHTO M 171. Copolymer/synthetic blankets shall be a composite of a copolymer membrane material coated over a layer of absorbent nonwoven synthetic fabric weighing at least 6 ounces per square yard, uniform in appearance and free from visible defects.

(5) Other approved sheeting materials meeting performance requirements of AASHTO M 171.

501.04 Construction Requirements. General. Equipment, tools, and machinery used on mainlane and ramp pavements shall be specifically designed for placing, consolidating, and finishing portland cement concrete pavement and shall be maintained in a satisfactory working condition. the methods employed in performing the work and all equipment, tools, and machinery used for handling materials and executing any part of the work shall be subject to the approval of the Engineer. Either the slip form paver or side form method may be used.

(a) Subgrade. The subgrade shall be prepared in conformity with the provisions of Section 212.

(b) Handling and Storage of Materials. The handling and storage of concrete aggregates shall be such as to prevent segregation and contamination with foreign materials.

Coarse and fine aggregates shall be separated by bulkheads or stored in separate stockpiles sufficiently removed from each other to prevent the material at the edges of the piles from becoming inter-mixed. Coarse aggregate stockpiles, not confined by bulkheads or bins, shall be built up in layers or wedges not to exceed 4' in height and each layer shall be completely in place before beginning the next. Coning or building up of stockpiles by depositing material in one place will not be permitted.

Coarse aggregates secured from different sources shall be unloaded into separate stockpiles and proportioned through separate storage bins. The Contractor will be required to furnish such additional storage bins and auxiliary equipment as may be necessary to combine and proportion the aggregate for the mix specified by the Engineer.

There shall be adequate aggregate stockpiled to allow representative sampling sufficiently in advance of any placement to determine its acceptability, with the minimum amount being that required to adequately complete the planned placement. The stockpiles shall be large enough to insure that the moisture content of any class of aggregates will remain sufficiently uniform to allow the accurate control of the amount of water entering into the concrete.

Cement shall be stored in suitable weatherproof buildings or silos which will protect the cement from dampness. Provision for storage shall be ample.

(c) Measuring Materials. (1) General. Batch plants shall be equipped to proportion aggregates and bulk cement by weight by means of automatic and interlocking proportioning devices of approved type.

Measuring devices shall be operated in a manner which will consistently allow the exact weight of cement within ±1%, individual aggregates within ±2%, and total weight of aggregate within ±2% of the required weight. Measuring devices shall be so designed and plainly marked that the weights can be accurately and conveniently verified for the quantities of each component actually being used.

(2) Aggregates. Aggregates shall be measured separately and accurately by weight.

The batch plant shall include batcher bins, of either the stationary or mobile type, with adequate separate compartments for fine aggregate, each compartment designed to discharge efficiently and freely into the weighing hopper or hoppers. Means of control shall be provided in each case so that as the quantity desired in the weighing hopper is being approached, the material may be added slowly in small quantities and shut off with precision. Means of removing any overload of any one of the several materials shall be provided.

In the type where more than one aggregate is weighed into one hopper, each aggregate shall be held in a separate compartment, so arranged that an overload of any aggregate can be removed. Hoppers shall be constructed so as to eliminate accumulations of tare materials and to fully discharge without jarring the scales. Partitions between compartments, both in bins and in hoppers, shall be ample to prevent spilling under any working condition. Batch plant structures shall be maintained properly leveled within the accuracy required by the design of the weighing mechanism.

The scales for weighing aggregates and cement may be the horizontal beam, the springless dial, or the electronic type, designed as an integral unit of the batch plant, of rugged construction to withstand hard usage due to working conditions, with a maximum allowable error of ½% of one net load. When beam type scales are used, provisions such as a "tell-tale" dial, shall be made for indicating to the operator that the required load in the weighing hopper is being approached, which device shall indicate at least the last 200 pounds of load. A device on weighing beams shall indicate critical position clearly. Poises shall be designed for locking in any position and to prevent unauthorized removal. The weigh beam and the "tell-tale" device shall be in full view of the operator while charging the hopper. The operator shall have convenient access to all controls.

Clearance between scale parts, hoppers, and bin structures shall be such as to avoid displacement of or friction between parts due to accumulations, vibration, or other causes. Pivot mountings shall be designed so none of the parts will jar loose and so as to assure unchanging spacing of knife edges. Scales shall be so designed that all exposed fulcrums, clevises, and similar working parts may readily be kept clean. Scales shall be constructed of non-corrosive materials, excluding material softer than brass. Ten 50 pound weights shall be made available by the owner for checking, when necessary. Weight beams shall have leveling lugs, and weighing parts of other types shall be provided with means for precision adjustment. Scales shall be satisfactory to the Engineer and shall be inspected, adjusted, and certified by a registered scale mechanic in accordance with subsection 109.01(f).

(3) Cement. Cement shall be proportioned on the basis of 94 pounds to the cubic foot and shall be measured by weight on scales as specified above.

Pneumatic charging of the weigh hopper shall be so arranged that the measurement will not be affected by air pressure in the supply line.

(4) Water. The mixer shall be equipped with an automatic water measuring device which shall be within a range of error of not over 1% and shall be so arranged that the measurement will not be affected by variations of pressure in the water supply line and will be accurate under all construction conditions encountered. Water may be measured either by volume or by weight.

(5) Admixtures. The mixer shall be equipped with an approved automatic dispenser for adding to the mixing water the desired amount of admixtures.

The dispenser shall be constructed and connected so that the inspector can make ready determination of the amount of admixture entering into the mixing water.

(d) Mixing Concrete. Concrete shall be mixed in accordance with subsection 802.08 except as follows:

Concrete shall be delivered and discharged from the truck mixer or agitator into the paver or forms within one hour after the introduction of the mixing water to the cement.

(e) Cold Weather Concreting. Concreting operations will not be permitted when a descending air temperature falls below 40 deg. F nor resumed until an ascending air temperature reaches 35 deg. F without specific authority from the Engineer. When operations are authorized under such conditions or when it is anticipated that the air temperature will fall below 40 deg. F before the concrete has taken its final set, the concrete surface shall be covered with suitable material and to such depth as to prevent freezing. The covering shall remain in place until the slab has thoroughly cured. Under no circumstances will the placing of concrete on a frozen subgrade be permitted.

(f) Protection Against Rain. In order that concrete may be properly protected against the effects of rain before the concrete is sufficiently hardened, the Contractor shall have available at all times materials for the protection of the edges and surface of the unhardened concrete. Such protective materials shall consist of standard metal forms or wood planks having a nominal thickness of not less than 2" and a nominal width of not less than the thickness of the pavement at its edge for the protection of the pavement edges, and covering material such as burlap or cotton mats, or plastic sheeting material for the protection of the surface of the pavement. When rain appears imminent, all paving operations shall stop and all available personnel shall begin protection of the sides of the pavement and covering the surface of the unhardened concrete with the protective covering.

(g) Dowel and Tie Bars. The Contractor shall establish the location of all dowel bars and tie bars and place them as shown on the plans. The dowel bars shall be held in position parallel to the surface and centerline of the slab by a metal assembly of sufficient strength to prevent displacement during the paving operations. Tie bars may be placed by mechanical equipment contingent upon satisfactory performance and the Engineer's approval.

Dowel bars extending across transverse joints shall be of the type and size shown on the plans. Each bar shall be coated with a film of epoxy, plastic, epoxy paint, zinc chromate primer, or tar paint from one end for a distance of 2" greater than the half length of the bar. The coated portion of the bar shall be field coated with an approved grease. Each bar across expansion joints shall be capped on the coated end with a close-fitting, non-compressible paper, plastic, or metal expansion sleeve of approved design, approximately 6" long, which shall extend 1" beyond the end of the bar and shall

carry a stop of compressible material so as to provide space for subsequent movement of the bar.

Tie bars extending across and through the longitudal center joint shall be deformed round bars of the type and size shown on the plans. The center 6" of tie bars shall be coated with a film of liquid or emulsified asphalt, or other approved anti-rust material.

Other types of ties and load transfer devices may be used when shown on the plans or approved in writing by the Engineer.

(h) Placing Reinforcement. Reinforcing steel shall be clean and free from foreign material and scaling rust. Reinforcing mats shall be handled carefully and kept straight and free from bends and warps. They shall be placed parallel to the finished surface and to the depth shown on the plans.

When the concrete is placed in one course, mechanical or vibratory equipment shall be used to place the mesh fabric reinforcement in position. The reinforcement shall be placed immediately behind the first strike-off and followed immediately by the finishing machine in order to erase all marks made by the insertion of the reinforcing fabric in the concrete. Use of equipment for the insertion of wire mesh will be contingent upon satisfactory performance and the Engineer's approval.

When reinforced concrete pavement is placed in two layers, the entire width of the bottom layer shall be struck off and consolidated to such length and depth that the sheet of mesh fabric may be layered full length on the concrete in its final position without further manipulation. The reinforcement shall then be placed directly upon the concrete before initial set of the concrete has occurred. the top layer of the concrete shall then be placed, struck off and screeded to the required thickness and crown. Sleds, chairs, or other devices supporting the mesh fabric reinforcing steel, with the consequent depositing of the concrete through the steel, will not be permitted.

(i) Plain Concrete. Concrete shall not be placed on a soft, muddy, or frozen subgrade. The subgrade shall be moistened immediately prior to placing concrete unless a waterproof subgrade or base course material is specified. Moistening shall not be excessive to the point of forming mud or pools.

No concrete shall be placed without the approval of the Engineer.

The concrete shall be deposited on the subgrade in such manner as to require as little re-handling as possible. Spreading required shall be done by means of an approved mechanical spreader supplemented by hand shoveling as required. Spreading by rakes will not be allowed.

(j) Joints. (1) General. The Contractor shall establish the location of all joints in concrete pavement. Longitudinal and transverse joints shall be

located as shown on the plans in relation to the dowel or tie bars. Longitudinal and transverse joints shall be constructed to conform with the types, dimensions, and other details shown on the plans.

Longitudinal joints include the longitudinal joint between lanes, lanes and shoulders, and longintudinal construction joints between placements in sequence or placements against existing pavement. Transverse joints include expansion joints, contraction joints, warping joints, and construction joints.

All longitudinal and transverse joints shall be constructed, finished, filled, and sealed with joint material as shown in the plans. The joint grooves shall be thoroughly clean and dry when joint material is placed.

Sawed joints shall be formed by cutting the groove in the hardened concrete with an approved concrete saw capable of cutting the joint to the specified dimensions and true to line within the allowable variation.

Joints shall be sawed as soon as the concrete has hardened to the extent that tearing and raveling will not occur, but prior to development of any random cracking. A standby machine and a sufficient supply of saw blades shall be available at all times. Should any procedure result in premature and uncontrolled cracking, the Contractor shall immediately revise the method and/or sequence of cutting the joints. Any curing media removed during sawing shall be immediately replaced.

All joints shall be construed so that the plane of the finished joint is perpendicular to the surface of the pavement and shall be uniform and not deviate more than ½" from the planned alignment within any 24' segment. In addition, all transverse joints shall be perpendicular to the centerline of the pavement.

The following methods shall apply for longitudinal, contraction, and warping joints when Type 3, 4, 5 or 6 joint sealer is used:

Within 15 minutes after sawing, the joints shall be flushed with water under sufficient pressure to remove all slurry and residue left by the sawing operation. After flushing, the joints shall be blown out with compressed air to remove excess water.

Joints shall not be filled and sealed for a minimum of 6 days following placement of the concrete except that when High Early Strength Concrete Pavement is specified, the period may be reduced to 18 hours.

When the joints are thoroughly dry and just prior to sealer placement, both vertical faces shall be thoroughly cleaned by sandblasting with a nozzle attached to an aiming device which directs the sand blast at approximately a 45 deg. angle and a maximum of 2" from the face of the joint. Each joint face shall be sandblasted individually. After sandblasting, the joints shall be blown out with compressed air that

has been filtered and is completely free of oil and moisture. The joints shall be thoroughly dry before sealer is placed.

All joints shall be filled and sealed the same day of the final sandblasting. Cleaned joints left open overnight shall be recleaned by sandblasting before filling and sealing.

In the event freshly cleaned joints become contaminated before they are sealed, they shall be re-cleaned as specified above.

Backer material shall be installed in a manner that will result in the planned depth and shape for the sealant. If primer is required, the primer shall be applied before installing the backer material.

Joint sealer shall be applied by an approved mechanical device from inside the joint in a manner which causes it to wet the joint surfaces. Joint sealer application will not be permitted when the pavement surface temperature at the joint is less than the application temperature specified by the manufacturer.

In Type 3 and 4 joint sealant, the surface shall be tooled, using the appropriate tool, to produce a slightly concave surface as shown on the plans. Tooling shall be accomplished before a skin forms on the surface. The use of soap or oil as a tooling aid will not be permitted.

Failure of the joint material in either adhesion or cohesion will be cause for rejection. Removal, re-cleaning and replacement of the failed material shall be at no cost to the Owner.

(2) Expansion Joints. Standard transverse expansion joints shall be placed at or near the ends of bridges, unless otherwise specified, and at other points designated on the plans. Special expansion joints shall be placed at all structures projecting through, into, or against the pavement such as drop inlets, junction boxes, etc. Unless otherwise specified, joints at such projecting structures shall be ½" in width and shall be filled with material conforming with subsection 501.03(h) Type 2.

Transverse expansion joints shall extend for the full cross section of the pavement and shall be formed by a template or as shown on the plans. The template shall be securely staked or fastened in place prior to placing the concrete and in a manner to insure the joint and dowel bars will remain in their proper position after finishing operations have been completed.

(3) Contraction and Warping Joints. Contraction and warping joints shall be constructed in accordance with the spacing and dimensions shown on the plans. The joints shall extend continuously across the full width of the concrete surface.

(4) Construction Joints. Transverse construction joints shall be constructed when there is an interruption in the concreting operations of more than 30 minutes. Time may be adjusted, due to weather conditions, as directed by the Engineer. No transverse joint shall be constructed within 10' of an expansion joint, contraction joint, or place of weakness. If sufficient concrete has not been mixed at the time of interruption to form a slab at least 10' long, the excess concrete back to the last preceding joint shall be removed.

The header may be made of wood or metal and shall have openings for the dowel bars. The header may be of one or two pieces and shall be rigid and accurately set to grade perpendicular to the centerline and surface of the pavement.

(5) Longitudinal Joints. Longitudinal joints shall be constructed along the center line of two lane pavements and approach slabs, between lanes of multiple lane pavements and approach slabs, between pavements (new or existing) and added concrete lanes or concrete shoulders, and between approach slabs and approach gutters.

(k) Consolidating and Finishing. (1) Mechanical Methods. After the concrete has been deposited and spread it shall be consolidated by means of a mechanical vibrating machine of approved type and design. The vibrating machine may be mounted either on the mechanical spreader or operated as a separate unit on an individual carriage. Vibrators for full width vibration of concrete paving slabs shall be the internal type with either immersed 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 joint, load transfer devices, subgrade, or side forms. The frequency of the internal type shall not be less than 5,000 impulses per minute for tube vibrators and not less than 7,000 impulses per minute for spud vibrators.

When spud type internal vibrators, either hand operated or attached to spreaders or finishing machines, are used adjacent to forms, they shall have a frequency of not less than 3,500 impulses per minute.

If, for any reason, equipment previously approved becomes unsatisfactory, it shall be replaced before proceeding with the work.

Vibration shall extend over the entire pavement area and the vibrating machine shall satisfactorily consolidate the mixes required for this type of construction and shall not displace the reinforcement, side forms, joints, or dowel bar assemblies. the concrete shall be deposited, spread, and vibrated in a manner that will insure minimum segregation and develop a maximum density and strength in the finished pavement.

After vibratory consolidation, the concrete shall be struck off by means of an approved power driven, mechanical finishing machine equipped with double screeds adjusted to strike-off to the required crowned section on tangents and to the plane section on curves as shown on the typical cross section. The finishing machine shall be

operated with a roll of concrete in front of each screed sufficient to fill depressions and leave the top of the slab smooth and even with the desired crown and at the proper elevation.

(2) Hand Methods. At intersections and turnouts, and on additional widths or other irregular sections not readily accessible to conventional equipment, the concrete may be spread and struck off by hand methods as approved by the Engineer. Over all such areas, however, consolidation shall be accomplished through use of a suitable and approved mechanical vibrator unit.

When striking-off and consolidating by hand methods is permitted, the work shall be done in the following manner:

After the concrete has been deposited, it shall be leveled and then struck-off to such depth above the finished grade specified that when properly consolidated the surface shall conform to the line and grade desired. Before striking-off, the concrete shall be thoroughly consolidated by means of a mechanical vibrator unit. The strike-board shall be moved forward with a combined longitudinal and transverse motion, so manipulated that neither end is raised from the side forms during the striking-off process.

A slight excess of material must be kept in front of the cutting edge at all times. Additional concrete shall be added to low places and porous spots and the striking and consolidating continued until the entire pavement has a uniform, even surface.

Strike-boards used must be straight, free from warp, shod on the striking surface with a strip of steel, shaped to the required crown, and have sufficient weight and rigidity to accomplish the purpose desired.

(3) Floating. After the concrete has been struck off and consolidated, it shall be further smoothed and consolidated by any approved method of mechanical floating, either longitudinal or transverse, which will satisfactorily finish the pavement to the required cross section, elevation, and surface smoothness. The use of mechanical floating equipment will be contingent upon satisfactory results.

Excess water, laitance, or foreign materials brought to the surface during the course of the floating operations shall not be reworked into the pavement but shall be removed immediately upon appearance by means of a squeegee or straightedge drawn from the center of the pavement toward either edge.

In general, the addition of water to the surface of the concrete to assist in finishing operations will not be permitted. If the application of water to the surface is permitted, it shall be applied as a fog spray by means of approved spray equipment.

(4) Straightedging. After the longitudinal floating has been completed and the excess water removed, but while the concrete is still plastic, the slab surface

shall be checked by the Contractor in both directions for trueness, using a straightedge. For this purpose an accurate 10' metal straightedge shall be used, swung from a handle longer than one-half the width of the slab. Additional floating may be necessary to eliminate all irregularities. The straightedge shall be held in successive positions parallel to the pavement centerline in contact with the surface and the surface checked for the full width of the slab.

Progression along the pavement shall be in successive stages of not more than one-half the length of the straightedge. Depressions found shall be immediately filled with freshly mixed concrete, struck-off, floated, and refinished. High areas shall be cut down and refinished. Straightedge testing and surface correction shall continue until the entire surface conforms to the required grade and section.

(5) Final Finish. Following the straightedging and after all excess moisture has disappeared, the surface of the concrete pavement shall be given a final finish with a drag followed by grooving. The drag shall consist of a seamless strip of damp burlap, cotton fabric, or artificial turf which shall produce a uniform surface of gritty texture after dragging longitudinally along the full width of pavement. For pavement 16' or more in width, the drag shall be mounted on a bridge and moved along the surface by mechanical means. The dimensions of the drag shall be such that s trip at least 2' wide is in contact with the full width of pavement surface while the drag is used. A burlap or fabric drag shall consist of not less than 2 layers with the bottom layer approximately 6" wider than the upper layer. The drag shall be maintained in such condition that the resultant surface is of uniform appearance and reasonably free from grooves over 1/16" in depth. Drags shall be maintained clean and free from encrusted mortar. Drags that cannot be cleaned shall be discarded and new drags furnished.

The final finish shall be produced by using the drag finish as described above along with the further application of a metal tine finishing device. The tines shall be approximately 0.032" by 0.125" steel flat wire, 2" to 5" in length and spaced on ½" to 3/4" centers. the grooves produced in the concrete shall be substantially from ⅛" to 3/16" in depth. The grooves shall be transverse to the centerline of the pavement. On main lanes the metal tine device shall be operated by an approved mechanical means. Manual methods may be used on ramps, connections, and miscellaneous sections when approved by the Engineer. Texturing equipment, other than the tine device, may be approved by the Engineer provided it produces a texture equivalent to that produced by the metal tine.

(6) Finishing Joints and Edging. Longitudinal and transverse joints, where required, shall be so constructed as to allow the normal finishing operations to be executed and completed over the joint. After the final finish, but before the concrete has taken its initial set, the edges of the pavement along each side of each slab, and on each side of transverse expansion joints and formed joints, shall be worked with an approved tool and rounded to a ¼" radius. A well defined and continuous radius shall be produced and a smooth, dense mortar finish obtained. The surface of the slab shall not be unduly disturbed by tilting the tool during use.

At joints, tool marks appearing on the slab adjacent to the joints shall be eliminated by brooming the surface. In doing this, the rounding of the corner of the slab shall not be disturbed. Concrete on top of the joint filler shall be completely removed.

Joints shall be tested with a straightedge before the concrete has set. Corrections shall be made if one side of the joint is higher or lower than the other.

(l) Curing. Immediately after 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:

(1) Polyethylene-Burlap Mats. The mats used shall be of such length or width that as placed they will extend at least twice the thickness of the pavement beyond the edges of the slab. The mat shall be placed so that the entire surface and both edges of the slab are completely covered. Prior to being placed, the mats shall be saturated thoroughly with water. The mats shall be so placed and weighted down as to cause them to remain in intimate contact with the surface covered, and the covering shall be maintained fully wetted and in position for 5 days after the concrete has been placed unless otherwise specified.

(2) Polyethylene Sheeting or Copolymer/Synthetic Blanket. When this type of curing is used, the sheeting shall be so placed and weighted down as to cause it to remain in intimate contact with the surface covered. The sheeting as prepared for use shall have such width that each unit as placed will extend beyond the edges of the slab at least twice the thickness of the pavement. Unless otherwise specified, the covering shall be maintained in place for 5 days after the concrete has been placed.

(3) Membrane Curing (White Pigmented). The entire surface of the pavement shall be sprayed uniformly with white pigmented curing compound immediately after the finishing of the surface and before the set of the concrete has taken place, or, if the pavement is cured initially with an alternate method, it may be applied upon removal of the covering. The curing compound shall not be applied during rainfall.

Curing compound shall be applied using pressure sprayers at the rate of 1 gallon to not more than 125 square feet. The spraying equipment shall be of the fully atomizing type equipped with a tank agitator. At the time of use, the compound shall be in a thoroughly mixed condition with the pigment uniformly dispersed throughout the vehicle. During application, the compound shall be stirred continuously by effective mechanical means. Hand spraying of odd widths or shapes and concrete surfaces exposed by the removal of forms will be permitted. Curing compound shall not be applied to the inside faces of joints to be sealed.

The curing compound shall be of such character that the film will harden within 30 minutes after application. Should the film become damaged from any cause within the required curing period, the damaged portions shall be repaired immediately with additional compound.

Upon removal of side forms, when used, the sides of the slabs exposed shall be protected immediately to provide a curing treatment equal to that provided for the surface.

(m) Surface Evenness and Testing. The finished pavement surface shall have a maximum profile index of 8" per mile (±0.1" blanking band) for each 0.1 mile section, or portion thereof, for mainlane pavement and 14" per mile for each 0.1 mile section, or portion thereof, for ramps. A profile will be taken near the center of each traffic lane or ramp using a Rainhart profilograph. The profiles shall being 25' back onto the previous day's pavement or an existing structure, and shall run continuously to within 25' of an existing structure or existing pavement, or the end of the pavement. The finished surface of the 25' sections adjacent to an existing structure shall not show surface deviations in excess of ⅛" in 10' when tested with a 10' rolling straight edge.

For the first day's run, profiles will be taken utilizing a Rainhart profilograph in accordance with AHTD Test Method 575, as soon as the hardness of the concrete is sufficient for proper testing. Should the day's run not meet the profile index of 8" or less per mile, the paving operations shall be discontinued until better methods and equipment are obtained or until the present equipment is properly adjusted. The second day's run will be profiled to again determine the ability of the equipment to finish the pavement within the specified tolerance. If the second day's operation fails to produce a finished surface having a profile index of 8" or less per mile, the Contractor shall produce new methods and/or equipment which will obtain the specified results. The new methods and/or equipment will be given trials runs as indicated above for the original equipment.

For the duration of the work every reasonable effort will be made to test smoothness within 5 working days after each day's run. Scheduling and testing will be arranged by the Engineer. The Contractor will be responsible for traffic control associated with this testing operation.

The cross slope of the pavement shall vary no more than ⅛" in 10' from the straightedge.

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 covering shall be properly replaced by the Contract after testing.

Grinding shall be performed, if necessary, to reduce the profile index as determined by the profilograph 8" per mile or 14" per mile, as appropriate, in any 0.1 mile section on all profiles, including the trial run. The grinding equipment shall be

power driven and specifically designed to smooth and texture portland cement concrete by means of diamond blades. Areas that have been ground shall be re-grooved, by grooving in accordance with subsection 802.20 for Class 7 surface finish, to provide a uniform texture equal in roughness to the surrounding unground pavement. However, if the ground area is at least 50' in length and full width of the pavement lane, re-grooving will not be required.

In addition to the above requirements for profile indices, areas representing high points having deviations in excess of 0.3" in 25' as determined by the profilograph or ⅛" in 10' as determined by the rolling straightedge, shall be reduced by grinding until such deviations as indicated by retest do not exceed the above limits.

Areas showing low spots of more than ¼" in 10' in the longitudinal direction shall be corrected by grinding or shall be removed and replaced in accordance with Section 508 to an elevation that will not show surface deviations in excess of ⅛" in 10 feet.

(n) Shoulder Construction. In the construction of the shoulders, the base course material shall be placed directly on the shoulder area between the pavement edge and the outer shouldering limits indicated on the typical section. Material shall not be deposited on the surface of the pavement during placing. Care shall be exercised by the Contractor in manipulating and shaping of the material on the shoulders to assure a minimum amount of littering with base material on the pavement surface. Any littering of the surface of the pavement with base material shall be corrected by brooming.

(o) Core Drilling. The finished pavement will be core drilled and any deficiencies in thickness will be made a factor for adjustment before final payment is rendered. The core drill will be furnished and operated at the expense of the Department. The concrete for backfilling core holes will be furnished and placed by the Department.

(p) Opening Pavement to Traffic. All traffic shall be excluded from newly constructed pavement by the Contractor until the concrete is found, by suitable tests of representative cylinders prepared at regular intervals and subjected to the same curing conditions as the pavement, to have a compressive strength of not less than 3000 psi. The pavement shall not be opened to traffic in less than 7 days, except that the minimum time for opening the pavement to traffic shall be reduced from 7 days to 24 hours when High Early Strength Pavement is specified and the requirements of subsection 501.07 are met. Before opening the pavement to public or construction traffic, all joints shall be cleaned and sealed, and the surface of the pavement cleaned of foreign substances.

501.05 Slip Form Paver. When a slip form paver is used, the following requirements shall apply:

(a) Conditioning of Subgrade or Foundation Course. After the subgrade or base has been placed and compacted to the required density, the area which will

support the slip form paving machine and the area on which pavement is to be constructed shall be brought to the proper profile and cross section by means of a properly designed electronic or automatic screed control system for the control of grade and slope and recompacted to the prescribed density. The foundation course shall be graded to a stringline tolerance of 0" high and ½" low. No hauling will be allowed on the finished subgrade or base course except for dumping the concrete. Suitable temporary construction crossovers may be constructed when approved by the Engineer. The subgrade shall be prepared for a distance of not less than 500' in advance of the paver or the entire remaining distance when within 500' of the end of the paving or bridge end. The subgrade or base course shall be checked and corrected immediately ahead of the placing of the concrete.

(b) Placing and Finishing. The slip form paver shall be designed to spread, consolidate, screed, and finish the freshly placed concrete in one complete pass of the machine in such manner that a minimum of hand finishing will be necessary to provide a dense and homogeneous pavement in conformance with the plans and specifications. The paver shall be self-propelled.

Final approval of spreading and finishing equipment will be based upon satisfactory performance during actual construction. If, for any reason, equipment previously approved becomes unsatisfactory, it shall be replaced before proceeding with the work.

The machine shall vibrate the concrete for the full width and depth of pavement being placed. This vibration shall be accomplished by means of satisfactory internal vibration in each course of concrete placed. The sliding forms shall be rigidly held together laterally to prevent spreading of the forms. Hand finishing shall be kept to a minimum. If the machine is of the trailing form type and hand finishing is required, it must be done within the length of the trailing forms.

(c) Uniform Consistency and Progress. The concrete shall have a uniform consistency. The slip form paver shall be operated with a continuous forward movement and all operations of mixing, delivery, and spreading concrete shall be so coordinated as to provide a 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. No tractive force shall be applied to the machine except that which is controlled from the machine.

(d) Surface Test. The surface tolerance of the finished pavement shall meet the requirements of subsection 501.04(m). Any slump of the pavement edge in excess of ¼" shall be corrected before the concrete has hardened.

501.06 Stationary Side Forms. (a) General. Side forms shall be made of metal, of an approved section, with a height and base width not less than the edge thickness of the pavement. Each section of forms shall be reasonably straight and

free from warp. The method of connecting form sections shall be such that a joint is formed free from play or movement in any direction. The forms when set to line and grade shall have a tolerance of ¼" for alignment and ⅛" for grade and shall be of such strength and so secured as to resist, without springing or settlement, the pressure of the concrete when placed and the impact and vibration of the finishing machine. The minimum length of section of metal forms used on tangents shall be 10 feet. Metal or wooden forms may be used on short radius curves where sections of less than 10' are required to produce the circular arc effect desired. When used, side forms of wood shall conform to the requirements for metal forms as to lines, grade and height.

Forms shall be cleaned before being set to line and grade and shall be oiled prior to placing reinforcing steel and dowels in the vicinity of the forms.

After the forms have been set to correct grade, the subgrade under and about them shall be thoroughly tamped by means of a mechanical form tamper so constructed that each side of the form will be tamped simultaneously. Hand tampers, or other means, shall be used to supplement the mechanical tamper as necessary to obtain an unyielding support for the forms. On treated bases, the forms may be supported by approved shimming methods.

The alignment and grade of forms shall be checked and must be approved immediately before placing the concrete. Forms which show a variation in excess of the surface tolerance requirements specified shall be removed.

(b) Removing Forms. Unless otherwise provided, forms shall not be removed from freshly placed concrete until it has set for at least 12 hours, except auxiliary forms used temporarily in widened areas. Forms shall be removed carefully so as to avoid damage to the pavement. Immediately after the forms have been removed, the side of the slab shall be cured by one of the approved methods. Honeycombed areas will be considered as defective work and shall be repaired or replaced, as directed.

501.07 High Early Strength Concrete Pavement. When High Early Strength Concrete Pavement is specified and used, it shall be made with the use of high early strength portland cement meeting requirements of AASHTO M 85, Type III cement, in lieu of AASHTO M 85, Type I cement. Upon written permission of the Engineer, the Contractor may, at his option, substitute standard portland cement with a cement factor of 25% in excess of that specified for Portland Cement Concrete Pavement for the high early strength cement in the High Early Strength Concrete Pavement. No additional compensation will be allowed above the price bid for High Early Strength Concrete Pavement for the 25% additional cement if standard portland cement is used. All other requirements specified for Portland Cement Concrete Pavement shall be applicable to High Early Strength Concrete Pavement.

501.08 Repair of Defective Pavement Slabs. Broken slabs, random cracks, nonworking contraction joints, major honeycombed areas, and spalls shall be

replaced or repaired in accordance with Sections 507, 508, and/or 509, as appropriate at no cost to the Owner.

501.09 Tolerance in Pavement Thickness. The pavement shall be constructed in accordance with the thickness required by the typical cross section shown on the plans.

Cores will be drilled in the finished pavement on the basis of at least one core for each 5,000 square yards of pavement or fraction thereof, but sufficient cores shall be taken so that in no case shall two or more separated areas be represented by the same core.

For the purpose of determining the thickness of the pavement as constructed, the project will be considered in consecutive sections of 5,000 square yards, the initial section to be regarded as a full section of 5,000 square yards, starting from either end of the project.

Where not constructed in accordance with the planned thickness, the following procedure for adjustment of payment will govern:

When any core is more than ½" less than the specified thickness, additional cores will be taken at random, on cross sections on the same slab of the pavement, measured parallel to the centerline, 10' back and 10' ahead of the station of the original core. If both of these cores are within ½" of the specified thickness, no further special corings for this individual zone of deficiency need be made. If either or both of these cores are not within ½" of the specified thickness, additional cores will be taken at random on cross sections of the slab in question, 25', 50', 100', and 200' ahead and back of the original core, and thereafter, at 200' intervals, until a thickness within the ½" tolerance is found in each direction. The Contractor may request additional cores to be drilled within the deficient area. The cost of drilling any additional cores the Contractor may designate shall be at no cost to the Owner.

No payment will be made for any section of pavement which is more than ½" deficient in thickness. The length of such section will be the sum of the distances measured in both directions, parallel to the centerline, from the deficient core to the nearest core which shows a thickness not more than ½" deficient. In all cases deductions will be made for the full width of the slab of which the cores are represented (normally 2 traffic lanes placed simultaneously).

When a deficiency in thickness of any portion of pavement slab in excess of ½" may seriously impair traffic service of the pavement, the Contractor will be required to remove such deficient slab and to replace it with a slab of satisfactory quality and thickness which, when accepted, will be included for payment. The Contractor shall receive no compensation for any cost incurred in the original placement and subsequent removal of the deficient slab.

In removing pavement that is deficient in thickness, the pavement shall be removed from the edge to a longintudinal joint, or between longitudinal joints and on each side of any deficient area until no portion of the exposed section is more than ½" deficient, except that in no instance shall there be less than 10 linear feet of pavement removed. If in meeting the above requirement, there remains less than 10' of acceptable pavement between the section that has been removed and a transverse plane of weakness, then the Contractor shall remove the pavement to the plane of weakness at no cost to the Owner. The Contractor shall then replace all the pavement that has been removed with satisfactory acceptable pavement in accordance with the requirements of Section 507 and the details of the Department's applicable Standard Drawings for PCCP Patching. If the plane of weakness is a contraction, expansion, or construction joint, the joint shall be replaced with a joint of the same design as the one removed. If the plane of weakness is a warping joint, the new joint shall be formed to comply with subsection 501.04(j)(3).

The thickness of the pavement of each section will be computed from the average of the thickness of the core(s) taken from that section, and the thickness of the pavement of the entire project will be computed from the average of the thickness determined for each section, except that sections, or parts thereof, found more than ½" deficient in thickness will not be considered in such computation.

Should the thickness of the pavement as constructed, in any section, exceed the thickness shown on the plans, the actual thickness as constructed, not to exceed ¼" in excess of the thickness shown on the plans, will be used in computing the thickness of the pavement for that section. No additional payment over the contract unit price will be made for any pavement in excess of the thickness specified.

Payment for pavement deficient in thickness, not in excess of ½" will be made at an adjusted unit price.

The adjusted unit price to be paid shall bear to the contract price per square yard of pavement the same ratio that the square of the average thickness, as computed above, bears to the square of the required thickness shown on the plans.

501.10 Constructing Pavement in Half Widths. When the pavement is placed in half widths, a longitudinal center joint with tie bars, as provided for by the plans and specifications, shall be used.

Where the pavement is being constructed in half widths, the Contractor shall maintain a safe passageway in accordance with the provisions of Section 603.

501.11 Method of Measurement. Portland Cement Concrete Pavement and High Early Strength Concrete Pavement will be measured by the square yard. The width for measurement will be the width as constructed in accordance with the plans and typical cross sections or as directed by the Engineer.

501.12 Basis of Payment. Work completed and accepted under this item and measured as provided above will be paid for at the contract unit price bid per square yard for Portland Cement Concrete Pavement or for High Early Strength Concrete Pavement, as the case may be, of the thickness or type specified, which price shall be full compensation for preparing the subgrade or base and shaping the shoulders unless otherwise specified; for furnishing, transporting, and placing materials, including steel bars for joints and all other joint materials; for the preparation and processing of materials; for mixing, spreading vibrating, finishing, and curing; for sawing, cleaning, filling, and sealing joints; for half width construction; and for all labor, equipment, tools, and incidentals necessary to complete the work; provided, that for such square yardage as is deducted for deficiency in thickness, only the adjusted price will be paid as heretofore specified in subsection 501.09. No payment will be made for pavement deficient in thickness in excess of ½", even though the deficient pavement may be allowed to remain in place, nor for repair as specified in subsection 501.08.

SECTION 502

REINFORCING STEEL FOR PAVEMENT

502.01 Description. This item shall consist of reinforcing steel of the type and size designated in the plans and in conformity with the details shown on the plans for Portland Cement Concrete Pavement.

502.02 Materials. Reinforcing steel, dowel bars, and other steel bars shall conform to the requirements of the following specifications:

Deformed billet Steel Bars for Concrete Reinforcement ASTM A 615

Welded Steel Wire Fabric for Concrete Reinforcement ASTM A 185

Tie bars which are bend and later straightened to facilitate construction shall conform to ASTM A 615, Grade 40. Bars used for longitudinal members in continuously reinforced concrete pavement shall conform to ASTM A 615, Grade 60.

502.03 Construction Requirements. Reinforcing steel for pavement shall be placed in accordance with Section 501 or Section 503, as applicable.

502.04 Method of Measurement. Reinforcing steel placed and accepted will not be measured.

502.05 Basis of Payment. Work performed and accepted under this item will not be paid for but will be included in the price bid per square yard of portland cement concrete pavement, which shall be full compensation for furnishing and placing materials and for all labor, equipment, tools, and incidentals necessary to complete the work.

DIVISION 600
INCIDENTAL CONSTRUCTION

SECTION 601
MOBILIZATION

601.01 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 the Contractor's offices, buildings, and other facilities necessary to undertake the work on the project.

This item shall also include other work and operations that must be performed, or for expenses incurred, before beginning work on the various Contract items on the project site. It shall also include pre-construction costs which are necessary direct costs to the project and are of a general nature rather than directly attributable to other pay items under the Contract.

601.02 Measurement and Payment. Mobilization will be measured as a complete unit and will be paid for at the contract lump sum price bid. In computing the allowable partial payments from the schedule below, the percentage of the original Contract earned will be based on all items exclusive of the item Mobilization and any materials estimates paid. Payment for Mobilization at any of the listed stages of completion will be made on the basis of the percentage of the item allowed less all payments made.

PARTIAL PAYMENT SCHEDULE

Percentage of Original Contract Amount Earned	Percentage of Bid Price for Mobilization Allowed
First Progress Estimate	25
10	50
25	100

This item will be paid for on regular estimates. Payments on percentages of the original Contract amount other than those set out above will not be considered. No adjustment in the amount bid for this item will be made for additional quantities or items of work required to satisfactorily complete the Contract.

IN NO CASE SHALL THE AMOUNT BID FOR THE ITEM OF "MOBILIZATION" EXCEED 5% OF THE TOTAL CONTRACT AMOUNT FOR ALL OTHER ITEMS LISTED IN THE PROPOSAL. Should the amount entered in the Proposal for this item exceed 5%, the Engineer will reduce it to the maximum allowed amount to determine the correct total bid.

Nothing herein shall be construed to limit or preclude partial payments otherwise provided for by the Contract.

Payment will be made under:

Pay Item	**Pay Unit**
Mobilization	Lump Sum

SECTION 603
MAINTENANCE OF TRAFFIC AND TEMPORARY STRUCTURES

603.01 Description. This item shall be accomplished according to the plans, this specification, Subsections 104.05 and 107.07, and the MUTCD. It is also applicable to the furnishing, installing, maintaining, and removal of Temporary Culverts and Temporary Bridge Structures and to those traffic control devices and operations required to delineate temporary hazards that are a result of the Contractor's operations and which are not otherwise specified on the plans.

The Contractor shall maintain the existing roads, including shoulders, bridges, and culverts, within the limits of the project from the date work is begun until the project has been completed and accepted. This maintenance of existing roads, including shoulders, bridges, and culverts, is the ordinary day to day maintenance, including minor repairs. Major repairs or reconstruction of existing roads, including shoulders, ridges, and culverts, will be the responsibility of the State, County, or City, unless such are made necessary by the Contractor's operations.

The Contractor shall provide, under the item of Maintenance of Traffic, those traffic control devices and operations required to delineate temporary hazards that are a result of Contractor operations. When the pay item of Maintenance of Traffic is not included in the Contract, the Contractor shall perform operations according to Subsection 104.05 and this Section. Full compensation for this work will be considered included in the contract unit prices bid for the various items of the Contract.

The Contractor shall provide a competent traffic control supervisor for the project. When the pay item Traffic Control Supervisor is not included in the Contract, the work required will not be paid for separately, but full compensation therefor will be considered included in the contract lump sum price bid for Maintenance of Traffic, or, if Maintenance of Traffic is not included in the Contract as a pay item, included in the contract unit prices bid for the various items of the Contract.

Speed limits through construction zones will be determined by the Department.

603.02 Construction Requirements. (a) Maintenance of Traffic. Maintenance of Traffic shall be accomplished by the

Contractor in an expeditious manner to preserve the integrity of the traveled way and shoulders and to protect traffic from temporary hazards created by Contractor operations.

The delineation of temporary hazards shall include the placement of any traffic control devices that are necessary for the protection from, and/or delineation of, such objects as open trenches or holes, stationary objects, drop-offs, parked equipment, stockpiled materials, fresh oil, etc. These traffic control devices shall be placed at locations where they will provide adequate warning to the traffic, including side roads that enter the work limits. All traffic control devices used shall comply with the applicable requirements of Section 604.

Traffic control plans for detours, lane closures, lane width reductions, shoulder closures, and other alterations to the original traffic pattern shall not be placed in operation more than 72 hours before the work begins which requires the traffic control changes.
After a traffic control plan is placed in operation, if progress on the work that required such plan is interrupted by more than 72 continuous hours, the original traffic operations must be restored as conditions allow, unless otherwise directed by the Engineer. Removal and restoration of traffic control devices to restore original traffic operations, and the subsequent reinstallation of the traffic control modifications will be at no additional cost to the Department.

Passageways for traffic shall be maintained dust free by the application of water or other approved material.

The Contractor shall make judicious use of pilot vehicles or properly attired and trained flaggers or sentinels, as necessary, to safely and conveniently guide traffic through the work limits.

On unpaved traveled ways or shoulders, the Contractor shall keep the surface smooth and stable by blading, ditching, etc.

Shoulder material shall be maintained to closely match the grade of the existing pavement.

(b) Traffic Control Supervisor. When the pay item Traffic Control Supervisor is included in the Contract, the traffic control supervisor shall be certified as a worksite traffic supervisor by either the American Traffic Safety Services Association (ATSSA) or the Arkansas Associated General Contractors, and shall be someone other than the Contractor's

superintendent. The name, address, and telephone number of the traffic control supervisor shall be furnished to the Engineer at the pre-construction conference. The Contractor shall advise the Engineer of any changes to the contact information for the traffic control supervisor or changes in person designated as the traffic control supervisor.

The traffic control supervisor shall:

- Perform or supervise the performance of the inspections required in Section 604;
- Prepare, sign, and submit to the Engineer the certification of inspection required in Section 604;
- Train and supervise flaggers and pilot car operators, as needed;
- Review the project for additional traffic control measures needed to delineate hazards due to the Contractor's operations;
- Correct all traffic control deficiencies;
- Provide emergency maintenance of traffic control devices as needed.

Emergency maintenance shall consist of maintenance, repair, or replacement of traffic control devices that have been damaged, vandalized, or otherwise rendered ineffective to the extent that a serious hazard exists. The traffic control supervisor, or a designated alternate, shall begin such emergency work within two (2) hours after being notified. When emergency maintenance is required during non-working hours, devices that are classified as "unacceptable" according to ATSSA *Quality Standards for Work Zone Traffic Control Devices* may be used in emergency maintenance provided the devices are effective in reducing the existing hazard and further provided that they are replaced not later than the next business day. The traffic control supervisor shall keep the Resident Engineer informed of the name, address, and telephone number of the individual responsible for performing emergency maintenance.

(c) Detour or Stage Construction. Where shown on the plans for the maintenance of traffic, the Contractor shall construct and maintain detours or stage roadway sections to provide for the construction of the roadway, culverts, bridges, or miscellaneous items.

Any temporary culvert shall be of sufficient length to provide the specified roadway width, but in no case be less than that required to provide a minimum 20' (6 m) traveled way, and

shall have a minimum design capacity of H15 (M13.5) loading.

Any temporary bridge structure, regardless of type or centerline roadway lengths, shall have a minimum 20' (6 m) bridge roadway width and a minimum design capacity of H15 (M13.5) loading, unless otherwise specified.

Except as provided herein, a layout and working drawings shall be submitted to the Engineer for informational and record purposes for all temporary bridges and drainage structures, except standard pipe culverts. The layout submitted shall show the length and type of spans, and the type of substructure. Working drawings shall show all dimensions and details necessary to construct the structure, and the type and condition of all materials that will be used. The Contractor shall construct the temporary structures according to these drawings, or shall submit revised drawings if changes become necessary.

The Department's plans will, as appropriate, include temporary bridge details. The Contractor may elect to use these temporary bridge details, or use an optional design. If an optional design is used, the Contractor shall submit a layout and working drawings signed by a Registered Professional Engineer and a certification by a Registered Professional Engineer that the design and working drawings meet all the requirements of the plans, specifications, and the design requirements of the current edition of the AASHTO Standard Specifications for Highway Bridges with interim Specifications, except as modified herein. The rail and curb system for an optional design shall be at least equal in strength to that shown on the Department's temporary bridge details. If the Department's temporary bridge details are used, only a layout and a listing of the type and condition of materials to be used will be required for submittal. When an optional design is used, file copies of the design calculations shall be maintained by the Contractor until final acceptance of the project.

No work other than the driving of test piles shall be performed on a temporary bridge until the Contractor has submitted the layout, working drawings, and any required certifications to the Engineer.

Materials used in temporary bridges and temporary drainage structures, whether Department design or Contractor design, may be new or used and in good condition. Materials and workmanship shall comply with the requirements of the applicable sections of the specifications covering the items.

Timber used in the substructure or superstructure may be untreated unless treatment is specified on the plans. Lumber and timber materials and construction shall comply with Section 817 except that 1) the preservative requirements for used material shall be a minimum of 50% of that required for new material, and 2) the differential of two adjacent planks in the finished deck surface shall not exceed 1/4" (6 mm). Timber flooring shall be installed in a transverse direction.
Longitudinal runners will not be permitted.

Unless otherwise specified, the Contractor has the option of using timber, steel, or concrete piling. If timber piling is used, the piling shall be peeled as specified in Subsection 818.02. Untreated piling may be used unless treatment is specified on the plans. If treated timber piling is specified, the preservative requirements for used timber piling shall be 50% of that required for new material.

Pile driving shall be according to the provisions of Subsections 805.06 through 805.09 except that painting of steel piles is not required. Safe bearing values shall be determined by Method A, Empirical Pile formula.

Before the temporary structure is open to traffic, the Contractor shall submit a certification that the structure was built according to the submitted layout, working drawings, and materials. The certification will be required whether the Department's temporary bridge details are used or the Contractor's optional design is used.

The materials and completed drainage structure shall be maintained in good serviceable condition that will safely accommodate traffic using the facility for the duration of the work.

Temporary pipes in detour or stage construction shall be as shown on the plans or shall be approved before installation. No additional payment will be allowed if a bridge type structure is furnished in lieu of a temporary culvert at the Contractor's request.

Construction of approaches to temporary culverts or bridge structures, or other roadway construction shown on the plans as part of detour or stage construction, shall conform to the lines, grades, cross sections, and typical sections shown on the plans or established by the Engineer. Materials used in detour or temporary roadway construction, and the maintenance thereof, shall comply with the requirements of the applicable sections of the specifications covering the items.

The detour or temporary roadway shall be maintained in a condition to allow the safe and convenient passage of vehicles. When the plans do not provide for a dust free surfacing, the passageway shall be maintained dust free by the application of wateror other approved material to the roadway itself or to adjacent areas of construction activity that are the source of dust.

Temporary culverts or bridge structures shall be removed when the new facility has been completed and opened to traffic.

Materials from temporary culverts or temporary bridge structures shall remain the property of the Contractor. Materials used on detours and in stage construction and not incorporated into the permanent work, shall be salvaged to the extent practicable and used for base on other detours, drives, approaches, islands or shoulders, or stockpiled as directed. Non-salvageable materials shall be disposed of by the Contractor according to Section 201.

(b) Projects on Existing Roadways. Shoulder material shall not be cut away from the edge of the pavement on both sides of any section open to traffic. Unless otherwise specified, the total length of work areas on the entire project having vertical differences greater than 4" (100 mm) adjacent to the edge of traveled lanes shall be limited to 5,280 linear feet (2 km) in advance of backfill.

Where detour or stage construction is specified, traffic control shall be accomplished as shown on the plans or as modified by the Engineer.

The Contractor shall provide the Engineer with a minimum of three full business days advance, written notification of any non- emergency lane closure or lane width restriction. The first full business day shall commence at midnight on the first business day following written notification to the Engineer. This advanced notification is required to allow adequate notice for the issuance of over width load permits by the Department.

Where any operations result in a vertical differential at the centerline, lane lines, or edge of pavement, the Contractor shall immediately place traffic control devices or install a positive barrier according to the plans. Traffic control devices shall be maintained until the planned typical section is completed or until temporary shoulders are constructed.

In addition to the above requirements, when pavement

construction in lanes open to traffic results in a vertical differential at the centerline, lane lines, or edge of pavement, then backfill or adjacent pavement construction shall be accomplished as soon as practicable but in all cases no later than the following:

Vertical Differential		Location	Time Limitation
(1" or less)	25 mm or less	centerline, lane lines, and/or edge of pavement	None
(1" to 3")	25 to 75 mm*	centerline and/or lane lines	Next working day
(1" to 4")	25 to 100 mm	edge of pavement	30 calendar days
(greater than 4")	greater than 100 mm	edge of pavement	**

*No vertical differential greater than 3" (75 mm) will be permitted at centerline or lane lines.

**Traffic control devices shall be installed according to the plans. However, shoulder work in conjunction with overlay projects shall be accomplished within 7 business days.

Where temporary shoulder construction is utilized, the shoulder material shall closely match the grade at the edge of the pavement, but not necessarily conform to the planned typical section. The temporary material shall be stable, but specification density will not be required. Caution shall be exercised in temporary shoulder construction to prevent damage to the pavement. The Contractor will be required to maintain the temporary shoulder in a safe condition until the planned typical shoulder section is constructed.

The Contractor may utilize the planned shoulder material for the temporary shoulder or, at Contractor option, may use other materials approved by the Engineer. Any temporary material that does not comply with the requirements of the planned shoulder material shall be removed by the Contractor before constructing the planned shoulder. There will be no additional payment for constructing, maintaining, or removing temporary shoulders.

Where Contracts do not include shoulder work, the

Contractor shall coordinate work with the State, County, or City forces that will be performing the shoulder work. In this case, the State, County, or City will be responsible for placing and maintaining the required "Low Shoulder" signs. The Contractor will be responsible for all other construction signs until completion of the Contract.

Temporary culverts or bridge structures required in detour or stage construction shall be according to Subsection 603.02(c).

The Contractor shall schedule all work in a manner that will allow the routing of traffic over the permanent pavement as quickly as practicable.

When the plans do not show a detailed sequence of construction or planned detour, the Contractor shall provide a safe and convenient two-way passage throughout the entire length of the work. The Contractor shall perform the work and operate equipment in a manner that will permit the safe, continuous flow of two-way traffic through the work at all times, except when blasting or other potentially hazardous construction operations are actually in progress and where the unregulated movement of traffic would be unsafe. In such sections, the Contractor shall provide a safe and convenient passageway for traffic either by means of one-way passage on the roadway, with traffic controlled by flaggers or signal lights, or by means of short, two-way temporary detours within the right-of-way. Such sections shall be limited to approximately 1500' (500 m) in length. If traffic conditions warrant, the length of such sections may be increased or decreased as directed or approved by the Engineer.

The Contractor shall utilize, and store when directed, material available within the project, including existing surfacing, which is suitable for surfacing temporary portions of the grading for use as passageways for traffic. Gravel or crushed stone may be used for temporary surfacing if other suitable materials are not available within the project limits.

If it is determined that the Contractor's performance of the work was not completed in an efficient, workmanlike manner, making it necessary to use temporary surfacing materials for maintaining traffic, the Contractor shall provide the necessary temporary surfacing material at no cost to the Department.

The Contractor shall maintain access for the safe and convenient use of the adjacent property owners/occupants. The Contractor shall maintain all existing highway, street, and

county road regulatory, warning, guide, and informational signs in an effective location at all times for the duration of the work and shall install them at the correct location upon completion of the work. Any signs damaged by the Contractor shall be replaced at no cost to the Department.

(e) Projects Constructed on New Location. When projects on new location sever existing public or private roads or the access to premises, the Contractor shall schedule and perform the various items of construction to provide a safe and convenient passageway for traffic at all times according to Subsections 603.02(a), (b), (c) and (d).

603.03 Method of Measurement. (a) Maintenance of Traffic will be measured by the lump sum.

(b) Traffic Control Supervisor will be measured by the lump sum.

(c) The construction and subsequent removal of Temporary Culverts will be measured by the linear foot (meter) measured parallel to the flow line of the culvert. For multiple pipes, the measured length will be the sum of the lengths of the individual barrels. No measurement or payment will be made for lengths in excess of that required to provide the roadway width specified on the plans or as directed by the Engineer for the particular location.

The construction and subsequent removal of Temporary Bridge Structures, of the specified width, will be measured by the linear foot (meter) of bridge structure actually constructed, not to exceed the length specified on the plans for the particular location. No additional measurement or payment will be made for widths or lengths in excess of those shown on the plans or as directed by the Engineer for the particular location.

(d) Materials designated on the plans or authorized by the Engineer to be used for the maintenance of traffic, for repairs to the existing roadway within the limits of the work, for temporary bases and surfaces directed to be used during stage construction and reconstruction, and for the construction and maintenance of detours will be measured according to the specifications for the particular item used. Materials required for maintenance of traffic due to negligence of the Contractor or failure of the Contractor to construct and maintain the work in proper sequence will not be measured or paid for.Materials removed from detours or temporary passageways and placed as directed will be measured under the item of Common Excavation, Unclassified Excavation, or Removing and Replacing Base Course and Asphalt Surfacing, as appropriate.

603.04 Basis of Payment. (a) Work completed and accepted under the item of Maintenance of Traffic and measured as provided above will be paid for at the contract lump sum price bid for Maintenance of Traffic, which price shall be full compensation for furnishing, placing, maintaining, and removing traffic control devices; for ordinary maintenance of the existing roads, bridges, and culverts; for the application of water or other approved materials to alleviate dust conditions on passageways; for furnishing flaggers, pilot vehicles, and sentinels, as necessary; for maintaining a smooth and stable passageway; for maintaining and re-erecting all existing highway, street, and county road signs; and for all materials, labor, equipment, tools, and incidentals necessary to safely maintain traffic during the construction period.

(b) Work completed and accepted under the item Traffic Control Supervisor and measured as provided above will be paid for at the contract lump sum price bid for Traffic Control Supervisor, which price shall be full compensation for providing the traffic control supervisor and for all materials, additional labor, equipment, tools, and incidentals necessary to accomplish the specified work.

(d) Work completed and accepted under the item Temporary Culverts and/or Temporary Bridge Structures and measured as provided above will be paid for at the price bid per linear foot (meter) for _ " (_ mm) Temporary Culvert and/or at the price bid per linear foot (meter) for Temporary Bridge Structure (′ [m] Roadway Width), which price shall be full compensation for the preparation of necessary design details and/or Registered Professional Engineer certifications; the construction, maintenance, and subsequent removal of the structures; and for furnishing all materials, labor, equipment, tools, and incidentals necessary to complete the work. The Contractor may substitute temporary culverts of different sizes and shapes from those specified on the plans, provided that the minimum specified waterway opening is obtained for the particular location. Payment will be based on the culvert size specified for the particular location. Materials furnished and used for the maintenance of traffic and measured as provided above will be paid for at the contract unit price bid for the particular items used, which price shall be full compensation for furnishing all materials; for removal, if applicable; and for all labor, equipment, tools, and incidentals necessary to complete the work. Advanced payment for stockpiled materials will not be allowed for any of the pay items in this Section.

(e) Traffic control devices required for temporary hazard delineation as a result of the Contractor's operations; for those operations required to provide smooth and dust free traffic passageways; for flaggers, pilot vehicles, and/or sentinels required to safely and conveniently guide traffic through the work limits; and for maintaining and re-erecting all existing highway, street, and county road signs will not be paid for separately, but full compensation therefor will be considered included in the contract unit price bid for Maintenance of Traffic.

(f) Periodic payments will be made for Temporary Culverts, Temporary Bridge Structures, Maintenance of Traffic, and Traffic Control Supervisor.

The periodic payments for Temporary Culverts and Temporary Bridge Structures will be limited to the following percentages of the total price bid for each culvert or structure:

Temporary Culverts	**Temporary Bridge Structures**
Installation - 80%	Substructure -
30% Removal and Disposal - 20%	
	Superstructur
e - 50%	
	Removal and Disposal - 20%

The periodic payments for the items Traffic Control Supervisor and Maintenance of Traffic will be in proportion to the percent of the total work performed on the Contract.

Payment will be made under:

Pay Item	**Pay Unit**
Maintenance of Traffic	Lump Sum
Traffic Control Supervisor	Lump Sum
__" (___mm) Temporary Culvert	Linear Foot (Meter)
Temporary Bridge Structure (___′ [__m] Roadway Width)	Linear Foot (Meter)

SECTION 604
TRAFFIC CONTROL DEVICES IN CONSTRUCTION ZONES

604.01 Description. This item consists of furnishing, installing, maintaining, moving from one location to another, and removing traffic control devices as specified on the plans according to this Section, Subsections 104.05 and 107.07, and the MUTCD. Traffic control devices shall include, but not be limited to: traffic cones, signs, vertical panels, barricades, barrier units, traffic drums, advance warning arrow panels, portable changeable message signs, pavement markings, and removal of pavement markings.

604.02 Materials. (a) General. All work zone traffic control devices used on the project, including sign supports, barricades, traffic drums equipped with flashing lights, crash cushions, and impact attenuators shall comply with the requirements of National Cooperative Highway Research Program (NCHRP) Report 350 or the Manual for Assessing Safety Hardware (MASH).

604.03 The Contractor shall furnish a certification of such compliance from the manufacturer or supplier of all work zone traffic control devices prior to using the devices on the project. The certification shall state the device meets the requirements of NCHRP 350 or MASH and include a copy of the Federal Highway Administration's (FHWA) approval letter with all attachments for each device. Devices shall be fabricated and installed in accordance with the plans and with the crash testing documentation provided in the FHWA approval letter, which is available at: http://safety.fhwa.dot.gov/roadway_dept/policy_guide/road_hardware/.

The 2lb. (0.9 kg) minimum channel post or 4" x 4" (100 mm x 100 mm) wood post sign support systems, installed in accordance with the plans (direct buried), have been previously tested and accepted, and, therefore, do not require certification. No direct payment will be made for fulfilling the requirements of this Specification, but full compensation will be considered included in the contract unit prices bid for the various traffic control devices.

Traffic control devices will be accepted based on a visual inspection according to ATSSA *Quality Standards for Work Zone Traffic Control Devices* as to their effectiveness and

condition. At the time of initial setup, 100% of all traffic control devices shall be classified as "acceptable". Maintenance, repair, and replacement operations shall be conducted so that at least 75% of each type device in use are maintained in the "acceptable" classification, with the remaining devices classified as "marginal". Traffic control devices that are classified as "unacceptable" shall be removed from the project and replaced within 12 hours after notification.

Used signs, vertical panels, barricades, drums, traffic cones, precast concrete barrier, advanced warning arrow panels and portable changeable message signs will be allowed provided such devices comply with the requirements set out herein and on the plans.

(b) Signs, Vertical Panels, Barricades, Drums, and Traffic Cones. Materials for signs, vertical panels, and barricades required under this subsection shall comply with materials requirement of the plans, specifications and the MUTCD for the construction of signs using ASTM D 4956 for Type VIII or IX sheeting furnished according to the QPL. All orange signs must meet requirements for Fluorescent Orange.

Sign messages, symbols, borders, and backgrounds shall be of the size, type, and/or color shown on the plans. All colors for signs shall match the colors specified by the MUTCD. All sign messages designating project lengths in miles shall be carried only to the nearest mile.

All letters and numerals shall be standard Series C, D, E, E modified, and F as specified in the current edition of *Standard Highway Signs*.

All letters, numerals, symbols, and borders shall have a regular outline, be clean-cut and sharp, and have a continuous stroke and border.

The letters, numerals, arrows, symbols, borders, and other features shall be produced on the retroreflective sheeting of the sign field by a silk screen process approved by the Engineer. Sign messages and borders of a color darker than the sign field shall be applied to the retroreflective sheeting by direct process. Sign messages and borders of a color lighter than the sign field shall be produced by the reverse process in which the message and border are outlined by applying darker transparent color to the retroreflective sheeting of the sign field. Transparent colors, inks, and paints used in the silk screen process shall be of the type or quality recommended by the manufacturer of the retroreflective sheeting and shall conform

to the colors shown in the current editions of the MUTCD and *Standard Highway Signs*. Precut letters, symbols, and numerals, when applied according to the manufacturer's recommendation, will be permitted.

The Contractor shall submit a certification to the Engineer stating that the retroreflective sheeting complies with the requirements of the specifications.

Traffic cones used for night work or which will be used for delineation during nighttime hours shall be reflectorized with retroreflective sheeting meeting the requirements of ASTM D 4956 for Type III or IV with the additional requirements for Reboundable Sheeting. All traffic cones shall meet the requirements of the MUTCD.

(c) Precast Concrete Barrier. Materials for precast concrete barrier shall comply with the applicable requirements of the plans.

The Contractor shall certify to the Engineer, in writing, that the materials and the design used in the construction of the barrier comply with the requirements of the plans and specifications and that the barrier was constructed according to the details of the plans.

(d) Construction Pavement Markings. (1) Asphalt Surfaces. Construction pavement marking material shall consist of an adhesive backed retroreflective tape that can be applied to the pavement. As an alternate, painted markings complying with Section 718 may be used. Markings shall be yellow for centerlines and inside edge lines, white for lane lines and outside edge lines, and have straight, unbroken edges.

For all markings that are to be removed, paint will not be allowed on the final roadway surface or on any pavement surface that will not be resurfaced or obliterated unless otherwise authorized in writing by the Engineer. The Contractor may, at Contractor expense, use painted markings on the final surface as a primer for permanent thermoplastic markings.

(2) Portland Cement Concrete Surfaces. Construction pavement markings for Portland cement concrete surfaces shall comply with the requirements for removable pavement markings as specified in Subsection 604.02(f). As an alternate, painted markings complying with Section 718 may be used. Markings shall be yellow for centerlines and inside edge lines and white for lane lines and outside edge lines, and shall have straight, unbroken edges.

For all markings that are to be removed, paint will not be allowed on the final roadway surface or on any pavement surface that will not be resurfaced or obliterated unless otherwise authorized in writing by the Engineer. Paint may be used as a primer for thermoplastic markings.

(e) Interim Pavement Markings. For interim pavement markings, the Contractor may use paint or tape as specified above for Construction Pavement Markings. Retroreflectorized raised pavement markers complying with Section 721 may be used in lieu of paint or tape specified above. Three raised pavement markers shall be installed, equally spaced, in the place of the 4' (1.2 m) stripe. The markers shall be retroreflectorized in the direction(s) facing traffic and shall be the color required for tape or paint.

In lieu of raised pavement markers complying with Section 721, the Contractor may use Construction Raised Pavement Markers (CRPM) listed on the QPL.

(f) Removable Construction Pavement Markings. Removable markings shall meet the requirements of Section 720 for Type 4.

(g) Certification for Construction and Interim Pavement Markings. The Contractor shall submit a certification to the Engineer stating that the construction and/or interim pavement markings used comply with the requirements of the specifications.

(h) Advance Warning Arrow Panel. Advance warning arrow panels shall meet the requirements of the MUTCD.

(i) Portable Changeable Message Signs. Portable changeable message signs shall meet the requirements of the MUTCD.

604.04 Construction Requirements. (a) General. Traffic control devices shall be installed and maintained in good condition and in compliance with the plans, this specification, and the MUTCD. The Contractor shall certify weekly to the Engineer that all traffic control devices in use have been inspected on at least a daily basis and that any devices failing to comply with the requirements set out herein or on the plans were corrected. The certification for inspection of traffic control devices shall be documented on the attached "Traffic Control Device Inspection Checklist", which is to be completed in its entirety, as applicable, on a daily basis. The Traffic Control Device Inspection Checklist form is available on the Department's website at:

http://www.arkansashighways.com/construction_division/Traffic ControlDeviceInspectionForm.

At least one inspection weekly shall be performed at night. The work involved in performing the required inspections and furnishing the certification will not be paid for separately, but full compensation therefor will be considered included in the contract unit prices bid for other items of the Contract.

Traffic control devices shall be constructed according to the plans. The Contractor shall be responsible for properly locating the traffic control devices according to the plans, or as directed.

The Contractor shall accomplish the items of work required for traffic control through construction zones in a logical sequence throughout the duration of the project. Any item constructed prematurely will not be accepted until the item is required for its intended use.

All traffic control devices shall be constructed and maintained in such manner that the devices will be fully visible, intact, and erect for the entire duration of their intended use and shall be removed from the project when their use is no longer required. All devices shall remain the property of the Contractor unless otherwise specified.

(b) Signs. Regulatory, warning, and guide signs, and vertical panels of a permanent nature, shall be placed and maintained in a vertical position as shown on the plans or as directed. Each device will be considered as a unit, including the sign and support assembly as shown on the plans.

After the project has been declared substantially complete by the Engineer, the Contractor shall either cover or remove the advance warning signs. In the event that work is required after the project is declared substantially complete, the Contractor will uncover the advanced warning signs or provide appropriate signs and traffic control devices needed to perform the work. Additional signs or traffic control devices required for such work will not be measured or paid for separately, but full compensation therefor will be considered included in the contract unit price bid for Maintenance of Traffic.

(c) Barricades. Type III barricades and assemblies used on detour signing and signing required to close off all or part of a roadway shall be placed as shown on the plans or as directed.

(d) Traffic Drums. Traffic drums shall be placed as shown on the plans or as directed.

(e) Precast Concrete Barrier. Precast concrete barrier shall be placed as shown on the plans or as directed.

(f) Pavement Markings. At the end of each day's operations, pavement markings, either permanent, construction, or interim, shall be in place on all roadways open to traffic. Work shall not continue or commence until the required pavement markings are in place. Before opening a detour or stage roadway to traffic, pavement markings, either permanent or construction, shall be in place.

Conflicting pavement markings shall be removed to prevent confusion to drivers. Removal of pavement markings shall leave a minimum of pavement gouging. Unless otherwise specified, painting over conflicting markings as a means of line removal will not be allowed.

(1) Classification of Markings. Pavement markings are classified as follows:

a. Permanent Pavement Markings. Permanent pavement markings are those markings that will be left in place upon completion of the project. Permanent pavement markings shall comply with the requirements of Sections 3A and 3B of the MUTCD and Section 718, 719, or 720, as specified on the plans or in the Contract. Skip lines shall be placed on a 40' (12 m) cycle (10' [3 m] stripe, 30' [9 m] skip) for white lane lines and for yellow centerlines where passing is permitted. No-passing zones shall be marked with solid yellow lines. Edge lines shall be white solid lines for both edges of the pavement on two-way traffic roadways. On divided multi-lane roadways, edge lines shall be white solid lines on the outside edge and solid yellow on the inside edge. Unless otherwise specified, all lines shall be broken only for street and/or ramp intersections.

b. Construction Pavement Markings. Construction pavement markings are those markings that will be removed, replaced with permanent markings, or covered with a pavement course before the completion of the project. Construction pavement markings shall comply with the requirements of Sections 3A and 3B of the MUTCD and shall be the same pattern as Permanent Pavement Markings. Unless otherwise specified, edge lines will not be required. The Contractor shall

replace all markings that become ineffective, as determined by the Engineer, at no cost to the Department.

c. Interim Pavement Markings. Interim pavement markings are those that may be used for a short period of time until it is practical and possible to place either permanent or construction pavement markings. Interim pavement markings shall be replaced with permanent or construction markings or covered with a succeeding course of paving within three (3) calendar days on high- volume roads or fourteen (14) calendar days on low- volume roads. (Day 1 of the 3- or 14-day period is the first calendar day that it becomes practical and possible to place permanent or construction pavement markings.) If interim markings are not covered or replaced with permanent or construction markings within the specified time period, no work on the project shall continue or commence until either permanent or construction pavement markings are in place. High-volume and low- volume roads will be designated on the plans.

Except as noted below for divided multi-lane roadways, interim pavement markings shall consist of white lane lines and yellow centerlines placed on a 40' (12
m) cycle (4' [1.2 m] stripe, 36' [10.8 m] skip). When interim markings are used and unless otherwise specified, all two- and three-lane, two-way traffic roadways shall be marked with a single 4" (100 mm) wide yellow skip line on the centerline so as to operate as two-lane roadways. Four lane two-way traffic roadways shall be marked with double 4" (100 mm) wide yellow skip lines on the centerline and a single 4" (100 mm) wide white skip line on lane lines in each direction so as to operate as four-lane roadways. On all roadways with existing turn lanes (either continuous or dedicated), the existing striping pattern shall be maintained with the interim markings. The center turn lane shall be marked with double 4" (100 mm) wide yellow skip lines on each side of the turn lane and a single 4" (100 mm) wide white skip line shall be used on lane lines in each direction. On multi-lane divided roadways, a 4"

(100 mm) wide white skip line 10' (3 m) long on a 40' (12 m) cycle shall be installed on the lane line(s) in each direction.

In conjunction with interim pavement markings on roadways marked for two-way traffic, no-passing zones shall be marked with signs. DO NOT PASS signs (R4-1) shall be placed at the beginning of no-passing zones and the PASS WITH CARE sign (R4-2) shall be placed at the end of no-passing zones. When the length of the no- passing zone exceeds 1/2 mile (800 m) in length, or when the alignment of the roadway warrants, supplemental DO NOT PASS signs shall be placed at 1/2 mile (800 m) intervals, or more frequently if necessary, to provide adequate warning to the public. The signs shall be mounted as shown on the plans.

Construction Raised Pavement Markers, when used, shall be securely attached to the surface in such manner that the surface will not be damaged and the device will remain in place for the time required for its use. Markers that become detached from the surface, are damaged, are coated with asphalt, or otherwise lose their effectiveness shall be replaced or repaired by the Contractor at no cost to the Department.

(2) Application of Markings. Pavement markings shall be applied as follows:

a. Final Surfaces. Permanent or construction markings, as specified in the Contract, shall be in place on the final surface at the end of each day's operations on all lanes open to traffic. Unless otherwise specified, edge lines will not be required. The Contractor may, at Contractor option and expense, use interim pavement markings as follows:

High volume roads. On roadways designated on the plans as high volume, interim pavement markings may be used for not longer than 3 calendar days. All centerline and lane line permanent markings shall be placed within the three-day period.

Low volume roads. On roadways designated on the plans as low volume, interim pavement markings may be used for

not longer than 14 calendar days. All centerline and lane line permanent markings shall be placed within the 14 day period.

The Contractor shall carefully place all interim markings to avoid any overlapping by the permanent pavement markings. Interim pavement markings shall be removed from the final surface as soon as possible after the placement of permanent markings. Any voids caused by the removal of interim markings shall be repaired immediately at the Contractor's expense. For all markings that are to be removed, paint will not be allowed on the final surface unless otherwise authorized in writing by the Engineer.

On roadways open to traffic, if interim pavement markings are used, they shall be removed only after permanent pavement markings are in place.

b. Intermediate Surfaces. On all except the final surfaces, construction pavement markings shall be in place at the end of each day's operations on roadways open to traffic. Unless otherwise specified, edge lines will not be required. The Contractor may, at Contractor option and expense, use interim pavement markings under the same conditions and time limits as specified for final surfaces. When CRPM are used on an intermediate surface before a final surface of ACHM and when the final ACHM surface course will not completely cover the CRPM, the CRPM shall be removed immediately in advance of the paver placing the final surface course. Removal of the CRPM shall be at the Contractor's expense.

c. Detours and Stage Construction. On detours and stage construction, construction pavement markings, including edge lines when required as shown on the plans, shall be in place before opening the roadway to traffic.

d. Asphalt Surface Treatment. When the final surface is asphalt surface treatment, pavement markings shall not be placed until the asphalt has set, the aggregate firmly embedded, and loose aggregate removed from the surface. No-passing zones shall be marked with signs as specified under interim pavement markings above. Permanent or

construction pavement markings shall be placed within 14 calendar days after placement of the final surface.

(g) Removable Construction Pavement Markings. The tape, pavement, and ambient air temperature shall be 50° F (10° C) and rising and the pavement surface shall be free of moisture at the time of placement. If weather conditions prohibit placement of removable construction pavement markings and the Engineer determines that pavement markings must be placed due to the sequencing of the work, the Contractor shall place and remove painted markings. The placement and removal of painted markings in this case will be measured and paid for at the contract unit price bid for removable construction pavement markings. No payment will be made for removable construction pavement markings that do not properly adhere to the pavement.

On jointed concrete pavement, the tape shall be cut at all joints. On all other pavements, the tape shall be cut at approximately 40' (12 m) intervals.

(h) Referencing No-Passing Zones. On two-way traffic roadways, the Contractor shall reference the locations of all no- passing zones with standard DO NOT PASS and PASS WITH CARE signs before obliteration of the existing pavement markings. On detours, new construction, and when construction significantly changes the horizontal or vertical alignment of an existing roadway, the Department will establish the locations of no-passing zones for referencing by the Contractor. Signs used to mark no passing zones shall remain in place until installation of permanent markings or final acceptance of the project, whichever is earlier.

On unpaved or unmarked roadways, the Contractor shall mark the locations of no-passing zones with signs immediately after the Department establishes the locations of the zones. If permanent or construction pavement markings are placed immediately after zoning is completed, the marking of no-passing zones with signs will not be required.

(i) Advance Warning Arrow Panel. Advance warning arrow panels shall be placed as shown on the plans or as directed, and shall remain in place for the time specified by the Engineer. The Engineer will specify the mode of operation to be used.

(j) Portable Changeable Message Signs. Portable changeable message signs shall be installed at the locations shown on the plans or as directed by the Engineer. The

Engineer will specify the message(s) to be displayed and the mode of display. The sign shall be maintained operational in the specified location until the Engineer directs that it be removed.

(k) Traffic Cones. Traffic cones shall be placed as shown on the plans or as directed.

604.05 Method of Measurement. Traffic control devices designated on the plans or authorized by the Engineer will be measured by the square foot (square meter), linear foot (meter), each, or day. The maximum quantities of traffic control devices, other than pavement markings, authorized for payment will be the maximum amounts of each, shown on the plans or authorized by the Engineer, that may be required to be in place at any one time during the construction period.

The various traffic control devices will be measured according to the following:

(a) Signs, Vertical Panels, Traffic Drums, Barricades, and Traffic Cones. The actual amount of signs, vertical panels, traffic drums, barricades, and traffic cones, furnished and in place, up to the maximum amount that is authorized to be in place at any one time, will be measured by the square foot (square meter), each, each, linear foot (meter), and each, respectively. No additional payment will be made for moving these devices from one location to another or for maintenance or repair.

(b) Precast Concrete Barrier. (1) Furnishing and Installing Precast Concrete Barrier. The actual amount of precast concrete barrier, furnished and installed, up to the maximum amount that is authorized to be in place at any one time, will be measured by the linear foot (meter).

(2) Relocating Precast Concrete Barrier. The actual amount of precast concrete barrier, previously furnished and installed, which is relocated within the project limits will be measured by the linear foot (meter) for each authorized relocation.

(c) Pavement Markings. Permanent pavement markings will be measured and paid for under Sections 718, 719, or 720, as applicable.

Construction Pavement Markings will be measured by the meter (linear foot). Construction Pavement Markings (Words), (Arrows), and (Railroad Emblems) will be measured by the unit. One railroad emblem unit will consist of both R's, the X, the transverse lines, and the stop line near the tracks.

Interim pavement markings will not be paid for separately, but full compensation therefor will be considered included in the contract unit prices bid for other items of the work.

Markings that become ineffective for any reason other than normal wear shall be replaced by the Contractor at no cost to the Department. Replacement of markings that become ineffective due to normal wear will be measured by the meter (linear foot) or unit.

Removal of Permanent Pavement Markings and Removal of Construction Pavement Markings will be measured by the linear foot (meter) of marking removed. Removal of Permanent and Construction Pavement Markings (Words), (Arrows), and (Railroad Emblems) will be measured by the unit. One railroad emblem unit consists of both R's, the X, the transverse lines, and the stop line near the tracks. Removal of interim pavement markings, including RPM and/or CRPM, will not be paid for separately, but full compensation therefor will be considered included in the contract unit prices bid for other items of the work.

When any pavement marking is removed in conjunction with the removal, scarification, milling, or grinding of the pavement, or is covered by a succeeding pavement course, the removal of the marking will not be measured for payment.

There will be no payment for removal of Removable Construction Pavement Markings.

Signs used to mark no-passing zones will be measured by the square (square meter) according to Subsection 604.04(a). Each sign will be considered as a unit, including the sign and the support assembly as shown on the plans.

(d) Advance Warning Arrow Panels and Portable Changeable Message Signs. Advance Warning Arrow Panels and Portable Changeable Message Signs furnished will be measured for payment by the number of days each panel or sign is required and authorized by the Engineer. Payment for a full day will be made for any portion of a day that the panel or sign is used, but the measurement shall not exceed one per panel or sign in any calendar day. When Advance Arrow Warning Panels or Portable Changeable Message Signs are required after the contract time has expired and liquidated damages are being assessed, the Contractor shall furnish such panels and/or signs at no cost to the Department.

604.06 Basis of Payment. Traffic control devices

completed and accepted and measured as provided above will be paid for at the contract unit price bid per square foot (square meter), each, linear foot (meter), or day, as applicable for the particular item, according to the following:

(a) Signs, Vertical Panels, Traffic Drums, Barricades, and Traffic Cones. The unit prices bid for these items shall be full compensation for all materials, labor, equipment, tools, and incidentals necessary for installation, moving from one location to another, and for maintenance, repair, and removal.

(b) Precast Concrete Barrier. (1) Furnishing and Installing Precast Concrete Barrier. The unit price bid for this item shall be full compensation for all materials, labor, equipment, tools, and incidentals necessary for the initial furnishing and installation of the barrier on the project; for maintenance and repair; and for final removal of the barrier upon completion of the work.

(2) Relocating Precast Concrete Barrier. The unit price bid for this item shall be full compensation for all materials, labor, equipment, tools, and incidentals necessary for each relocation of the barrier that was initially furnished and installed on the project and that is authorized to be used at other locations within the project limits.

The maximum unit bid price for Relocating Precast Concrete Barrier shall not exceed 25% of the unit price bid for Furnishing and Installing Precast Concrete Barrier. Any unit bid price submitted in an amount more than the specified maximum will be automatically adjusted by the Engineer downward to the specified maximum to determine the correct total bid. This adjustment to the specified maximum will be automatically made, without any counter- adjustments in prices for other items.

(c) Pavement Markings. The contract unit prices bid for these items shall be full compensation for installing and maintaining markings; for removing pavement markings; and for all materials, labor, equipment, tools, and incidentals necessary to complete the work.

Replacement of construction pavement markings, when required due to normal wear, completed and accepted and measured as provided above, will be paid for at the contract unit price bid for construction pavement markings.

Signs used to mark no-passing zones will be paid for under Subsection 604.05(a).

(d) Advance Warning Arrow Panel. The contract unit

price bid for this item shall be full compensation for furnishing, installing, moving, and maintaining the panel; and for all labor, equipment, tools, and incidentals necessary to complete the work.

(e) Portable Changeable Message Sign. The contract unit price bid for this item shall be full compensation for furnishing, installing, moving, and maintaining the sign; and for all labor, equipment, tools, and incidentals necessary to complete the work.

(f) Payment for replacing traffic control devices that are damaged beyond use by traffic or vandalism will be made at 75% of the actual measurement of the items being replaced if their continued use on the project is required. The damaged devices will be inspected by the Engineer and marked for disposal before payment for replacement. The replacement device shall be classified as "acceptable" according to ATSSA *Quality Standards for Work Zone Traffic Control Devices*. The Department reserves the right to seek any and all recovery of the amount of any such payment from the parties responsible for the damage.

No payment will be made for repair or replacement of Advanced Warning Arrow Panels or Portable Changeable Message Signs. No payment will be made for replacing any traffic control device that has been stolen or has been damaged due to the negligence of the Contractor.

Payment will be made under:

Pay Item	**Pay Unit**
Signs	Square Foot (Square Meter)
Vertical Panels	Each
Traffic Drums	Each
Barricades	Linear Foot (Meter)
Furnishing and Installing Precast Concrete Barrier	Linear Foot (Meter)
Relocating Precast Concrete Barrier	Linear Foot (Meter)
Construction Pavement Markings	Linear Foot (Meter)
Construction Pavement Markings (Words, Arrows, Railroad Emblems)	Each
Removal of Permanent Pavement Markings	Linear Foot (Meter)
Removal of Permanent Pavement Markings (Words, Arrows, Railroad Emblems)	Each
Removal of Construction Pavement Markings	Linear Foot (Meter)

Removal of Construction Pavement Markings (Words, Arrows, Railroad Emblems)	Each Removable Construction Pavement Markings
	Linear Foot (Meter)
Advance Warning Arrow Panel	Day Portable Changeable Message Sign Day
Traffic Cone	Each

SECTION 607
PRECAST REINFORCED CONCRETE BOX CULVERTS

607.01 Description. This item shall provide for the substitution of precast reinforced concrete box culverts as an equal alternate to cast in place box culverts, as further detailed below.

607.02 Materials. The manufacturer shall furnish design drawings for each project sufficiently in advance of casting operations to allow for review by the Engineer. Precast units shall bear evidence that the component materials have been tested and approved and the construction methods have been inspected by an inspector approved by the Engineer.

607.03 Design. (a) Load and Resistance Factor Design. When a cast in place box culvert has been designed meeting the AASHTO Load and Resistance Factor Design (LRFD) Bridge Design Specifications, current edition, with current interims, the precast box culvert proposed for substitution shall be designed to meet the LRFD Bridge Design Specifications noted above. The design shall be certified by a Professional Engineer, who is registered in any of the United States.

The manufacture and furnishing of precast reinforced concrete box culverts meeting these design specifications shall be according to ASTM C 1577. The manufacturer shall furnish a certification to the Engineer that the units comply with ASTM C 1577 and that all steel materials incorporated in the units comply with Subsection 106.01.

(b) Alternate Design. When a cast in place box culvert has not been designed meeting AASHTO LRFD Bridge Design Specifications, , the precast box culvert proposed for substitution may be designed to meet the AASHTO Standard Specifications for Highway Bridges, 16th Edition, with interims or the AASHTO LRFD Bridge Design Specifications noted above. The design shall be certified by a Professional Engineer, who is registered in any of the United States.

The manufacture and furnishing of precast reinforced concrete box culverts shall be according to AASHTO M 259 or M 273, or ASTM C 1577, as applicable. The manufacturer shall furnish a certification to the Engineer that the units comply with AASHTO M 259 or M 273, or ASTM C 1577, as appropriate, and that all steel materials incorporated in the units comply with Subsection 106.01.

607.04 Construction Requirements. Excavation and backfill shall be according to the requirements of Section 801. The Department will perform acceptance sampling and testing of the compacted backfill material in accordance with Subsection 210.10 at the frequencies established in the Department's *Manual of Field Sampling and Testing Procedures*.

Precast reinforced concrete box culvert units shall be bedded on a foundation of firm and stable material, accurately shaped to conform to their base. When required by the plans, special bedding material shall be provided.

Joints and joint materials shall comply with the requirements of Section 606.

Lifting holes shall be filled with mortar or concrete and cured as directed.

When precast boxes are used to form multiple barrel structures, they shall be placed in conformance with the details shown on the plans. Material required between barrels shall be as shown on the plans.

Connections of precast boxes to cast-in-place boxes or to any required headwalls, wingwalls, riprap, or other structure shall comply with the details shown on the plans.

Headwalls, wingwalls, and footings shall be according to the details of the plans, except that the overall widths of the headwalls and footings shall be modified to fit the finished width of the various structures.

607.05 Method of Measurement and Basis of Payment. Precast Reinforced Concrete Box Culverts will not be measured and paid for directly.

Measurement and payment for precast culverts will be made on the same basis as for a cast in place culvert under Sections 802 and 804 for the length and size of culvert specified.

SECTION 609
DROP INLETS AND JUNCTION BOXES

609.01 Description. This item shall consist of the construction of drop inlets, yard drains, junction boxes, and drop inlet extensions with rings and covers or grates and frames, according to these specifications, of the type, size, and dimensions shown on the plans, and in conformity with the locations, lines, and grades shown on the plans, or as directed.

609.02 Materials. (a) The concrete shall comply with Section 802 for Class A Concrete. The Department will perform all acceptance sampling and testing at the frequencies shown for Contractor acceptance testing in Subsection 802.06.

(b) Reinforcing steel shall comply with Section 804.

(c) Steel for welded steel grates and frames shall comply with AASHTO M 270, Grade 36 (250).

(d) Iron castings for rings and covers, grates and frames, and other appurtenances, shall comply with AASHTO M 105, Class 35B. Bearing surfaces between rings and covers or grates and frames shall be cast or machined with such precision that uniform bearing shall be provided throughout the perimeter area of contact.

(d) Paint shall comply with Section 638.

(e) Precast concrete units of the type, size, and designation shown on the plans may be used in lieu of cast-in-place concrete units and shall be subject to the requirements of AASHTO M 199 or ASTM C 913 as applicable, and shall be furnished from sources listed on the Department's QPL. Units so manufactured must bear evidence that the component materials have been tested and approved and that the construction methods have been inspected by an Inspector approved by the Engineer. Joint materials shall comply with Subsection 606.02(b)(4).

(f) Curing Materials. Curing materials shall comply with Subsection 501.02(i).

(g) Pipe culverts for yard drains shall comply with Subsection 606.02.

609.03 Construction Requirements. Drop inlets, junction boxes, and drop inlet extensions shall be constructed with either reinforced or non-reinforced concrete, as shown on the plans. The Engineer may adjust the plan locations of drop inlets and junction boxes to avoid the necessity of cutting pipe

or to avoid utility lines provided such adjustment does not move the drop inlet out of a low point in the gutter line or into a curb radius.

Concrete shall not be placed until the Engineer has inspected the forms and the placement of reinforcing steel and rings or frames.

Round monolithic drop inlets may have the floors cast monolithically with the walls. All other concrete floors shall be placed at least 24 hours before beginning construction of the walls. A longer period of time may be required if weather conditions make it necessary.

When completed, the concrete shall be cured as specified in Subsection 501.05(l).

Walls shall be constructed to form a tight joint with the floor and around the inlet and outlet pipes. Pipes shall be cut flush with the inside surfaces of the wall. Utility lines that are carried through the walls shall be protected to avoid damage.

When tops of drop inlets are cast in place, the faces of drop inlets and drop inlet extensions shall be placed as a part of the curb in order to preserve the proper alignment.

Precast reinforced concrete drop inlet or junction box sections shall be set with joints complying with Subsection 606.02(b)(4).

Yard drains shall be constructed of a 12" (300 mm) corrugated metal pipe with the use of a pipe elbow or tee, as the case requires, at the bottom of the drain. The ring and grate shall be set on the top of the pipe culvert as shown on the plans. The concrete square frame shall be formed and placed to match the grade of the ring and grate.

Metal rings or frames shall be set accurately to the finished elevations so that no subsequent adjustments will be necessary. They shall be set in a full mortar bed with firm bearing on the walls or securely fastened to the forms so that no movement will occur when concrete is placed around them.

Welded steel grates and frames shall be welded with 1/4" (6 mm) fillet welds according to Section 807. The grates and frames shall be painted according to Section 638 or hot dip galvanized according to AASHTO M 111, Thickness Grade 100.

Iron castings for rings and covers or grates and frames shall not be painted.

Backfilling around structures shall be with approved material, free from large lumps or clods. The material shall be placed alongside the structure in layers not to exceed 6" (150 mm) in depth at near optimum moisture content and compacted with mechanical equipment to 95% of maximum density as determined by AASHTO T 99 for the full depth of structure. The Department will perform acceptance sampling and testing of the compacted backfill material in accordance with Subsection 210.10 at the frequencies established in the Department's *Manual of Field Sampling and Testing Procedures*.

Structures shall be cleaned of any accumulation of silt, debris, or foreign matter of any kind, and shall be reasonably free of such accumulations at the time of final inspection.

609.04 Method of Measurement. Drop Inlets, Junction Boxes, and Drop Inlet Extensions of the length specified will be measured by the unit. Yard Drains will be measured by the unit. Each unit shall consist of the concrete frame, the ring and grate, and all pipe required to form the vertical portion of the drain including a standard elbow or tee.

609.05 Basis of Payment. Work completed and accepted and measured as provided above will be paid for at the contract unit price bid each for Drop Inlets, Drop Inlet Extensions, Yard Drains, or Junction Boxes, of the type specified, which price shall be full compensation for constructing drop inlets, drop inlet extensions, yard drains, or junction boxes; for furnishing, installing, and painting, if required, of rings and covers or grates and frames; for excavation and backfill; and for all materials, labor, equipment, tools, and incidentals necessary to complete the work.

Payment will be made under:

Pay Item	Pay Unit
Drop Inlets (Type___)	Each
Junction Boxes (Type___)	Each
Drop Inlet Extensions (__')(__m)	Each
Yard Drains	Each

SECTION 610
MANHOLES, DROP INLETS AND JUNCTION BOXES ADJUSTED TO GRADE

610.01 Description. This item shall consist of adjusting the top elevation of existing manholes, drop inlets, or junction boxes according to these specifications and to the grades shown on the plans, or as directed.

610.02 Materials. New materials used in the grade adjustment shall comply with Subsection 609.02. **Construction Requirements.** Construction methods, as modified below, shall comply with Subsection 609.03, except that painting of existing rings and covers or grates and frames will not be required.

The existing rings and covers or grates and frames shall be removed in a manner to avoid breaking or cracking and cleaned of old mortar before resetting at the specified elevation. Structures damaged because of the Contractor's negligence shall be repaired or replaced at no cost to the Department.

If the top of the structure is to be lowered, masonry courses shall be removed and old mortar cleaned from the remaining top course, or concrete shall be cut on a horizontal line as directed, to an elevation that will allow the rings or frames to be set in concrete to the specified grade.

If the top of the structure is to be raised, the top of walls shall be cleaned of old mortar, or the top of concrete walls shall be cleaned of old mortar and roughened, and the walls built up with concrete to an elevation that will allow the rings and frames to be set to the specified grade.

610.03 Method of Measurement. Manholes, Drop Inlets, or Junction Boxes Adjusted to Grade will be measured by the unit.

610.04 Basis of Payment. Work completed and accepted and measured as provided above will be paid for at the contract unit price bid each for Manholes Adjusted to Grade, Drop Inlets Adjusted to Grade, or Junction Boxes Adjusted to Grade, which price shall be full compensation for adjusting manholes, drop inlets, or junction boxes; for excavation and backfill; and for all materials, labor, equipment, tools, and incidentals necessary to complete the work.

Payment will be made under:

Pay Item	**Pay Unit**
Manholes Adjusted to Grade	Each
Drop Inlets Adjusted to Grade	Each
Junction Boxes Adjusted to Grade	Each

SECTION 620

SEEDING

620.01 Description. This item shall consist of furnishing and applying fertilizer, seed, mulch cover, asphalt, and water in accordance with these specifications at locations shown on the plans to be excavated or as directed by the Project Engineer.

The work under this item shall be accomplished as soon as practicable after the grading in an area has been completed in order to deter erosion of the disturbed areas and siltation of streams.

620.02 Materials. (a) Lime shall be agricultural grade ground limestone or equivalent as approved by the Engineer.

(b) Fertilizer shall be commercial grade, uniform in composition, free flowing, and suitable for application with mechanical equipment. It shall be delivered to the site in labeled containers conforming to current Arkansas fertilizer laws and bearing the name, trademark, and warranty of the producer.

(c) The seed shall be labeled in accordance with current rules and regulations of the Arkansas State Plant Board. It shall have a minimum of 98% pure seed and 85% germination by weight, and shall contain no more than 1% weed seeds. A combined total of 50 noxious weed seeds shall be the maximum amount allowed per pound of seed with the following exceptions: Johnson grass seed, wild onion seed, wild garlic seed, field bindweed seed, or nut grass seed will not be allowed in any amount. Seed shall be furnished in sealed, standard containers. Seed which has become wet, moldy, or otherwise damaged in transit or in storage will not be acceptable.

Legumes shall be inoculated with an approved culture as recommended by the manufacturer, just prior to seeding. Fescue seed shall be certified endophyte free.

Unless otherwise specified, Seeding Type 1 shall be used.

Seed shall be composed of the varieties and amounts by weight as shown below:

Seed planted between June 16 and August 31 may require more water than that specified in Section G3.3(C) in order to survive. Therefore, watering will continue after germination until growth is established.

The seeding mixture may be altered by the Engineer in selected areas with no adjustment in contract price. The alteration shall be on an equivalent cost basis.

(d) Mulch cover shall consist of straw from threshed rice, oats, wheat, barley, or rye; of wood excelsior; or of hay obtained from various legumes or grasses, such as lespedeza, clover, vetch, soybeans, bermuda, carpet sedge, bahia, fescue, or other legumes or grasses; or a combination thereof. Mulch shall be dry and reasonably free from Johnson grass or other noxious weeds, and shall not be excessively brittle or in an advanced state of decomposition. All material will be inspected and approved prior to use.

SEEDING

Group I

Variety	Lbs./Acre
March 1 - June 15	
Bermuda Grass (Common) unhulled	20
Bermuda Grass (Common) hulled	5
June 16 - August 31	
Bermuda Grass (Common) unhulled	20
Bermuda Grass (Common) hulled	5
September 1 - October 31	
Rye Grass (Annual)	100

(e) Asphalt in mulch cover shall be of such quality that the mulch cover will be bound together to form a cover mat which will stay intact under normal climatic conditions. The quality and performance of the asphalt will be determined and certified by the Engineer.

Other materials which will function equivalent to asphalt as a tackifier for mulch cover will be permitted as a substitute for asphalt subject to the written approval of the Engineer.

(f) Water shall be of irrigation quality and free of impurities that would be detrimental to plant growth.

620.03 Construction Requirements. (a) Seedbed Preparation. Areas to be seeded shall be dressed to the shape and section shown on the plans. If the plans call for replacing topsoil, this shall be done prior to any preparations for seeding. Before beginning the seedbed preparation, soil samples shall be obtained from each major soil area (such as cut backslope or fill foreslope) by the Engineer for lime requirement analysis.

Lime, at the rate determined by the lime requirement test, shall be uniformly spread on areas to be seeded prior to their being roughened or scarified. The seedbed shall be thoroughly pulverized by means of disk harrows or other approved methods, thoroughly mixing fertilizer and solid to a depth of not less than 4" (2" for slopes 4:1 or steeper) below finish slope elevation. Regardless of the pulverizing method used, the soil shall be broken with the contour of the slope. Objectionable foreign matter shall be removed and the soil left in a suitable horticultural condition to receive the fertilizer and seed. Water may be applied before, during, and after seedbed preparation, as directed by the Engineer, in order to maintain the desired moisture content in the soil.

When no lime is required, seedbed preparation shall be accomplished as specified above regardless of the method used in the distribution of fertilizer, seed, and mulch cover.

(b) Fertilization. Fertilizer shall be applied at the rate of 800 pounds per acre of 10-20-10, or the equivalent amount of plant food. Fertilizer shall be uniformly incorporated into the soil alone or in conjunction with the required lime. If the Contractor so elects, the fertilizer may be drilled into the soil or combined with the seed in the hydro-seeding operation.

(c) Seeding. (1) Broadcasting. Broadcast sowing may be accomplished by hand seeders or by approved power equipment. Either method shall result in uniform distribution and no work shall be performed during high winds. The area seeded shall be lightly firmed with a cultipacker immediately after broadcasting.

(2) Drilled in Rows. When seed is drilled in rows, the rows shall be horizontal (parallel to contour lines). Fertilizer and seed shall not be drilled together and shall not be mixed.

(3) Hydro-seeding. If a hydro-seeder is used for seeding, fertilizer and seed may be incorporated into one operation but a maximum of 800 pounds of fertilizer shall be permitted for each 1500 gallons of water. If the Contractor so elects, the fertilizer may be applied during preparation of the seedbed. The area shall be lightly firmed with a cultipacker immediately prior to hydro-seeding.

(d) Mulch Cover. Mulch cover shall be applied at the rate of 4000 pounds per acre immediately after seeding and shall be spread uniformly over the entire area by approved power mulching equipment. If the Contractor so elects, an approved mulching machine may be used whereby the application of mulch cover and asphalt may be combined into one operation. If this method is used, no change in application rates will be allowed. In its final position, the asphalt tacked mulch shall be loose enough to allow air to circulate, but compact enough to partially shade the ground and reduce the impact of rainfall on the surface of the soil. Care shall be taken to prevent asphalt materials from discoloring or marking structures, pavements, utilities, or other plant growth. Removal of any objectionable discoloration shall be at no cost to the Owner.

(e) Asphalt. Immediately following or during the application of the mulch cover on seeded areas, asphalt shall be applied at the rate of approximately 0.05 gallon per square yard. Application shall be made from a pressure distributor, so equipped to insure constant and uniform distribution. The use of asphalt may be reduced or eliminated at selected locations when directed by the Engineer.

(f) Water. After application of the mulch cover, water shall be applied in sufficient quantity, as directed by the Engineer, to thoroughly moisten the soil to the depth of pulverization and then as necessary to germinate the seed. The Contractor shall maintain growth areas from the time of germination for a period of at least 3 weeks or until final acceptance of the project, whichever is greater.

The Contractor shall have on the job before seeding is started such equipment of adequate capacity and suitable water supply to achieve the desired moisture level in the soil. The time required for application of water will not be included in the computations of contract time for completion of the project provided all other work under the contract has been completed.

(g) Restoration. Additional work and materials required because of loss through erosion will be paid for under the pertinent contract items. Additional work and materials required due to the Contractor's negligence in maintaining completed work or failure to maintain moisture level shall be accomplished at no cost to the Owner.

620.04 Method of Measurement. (a) Lime will not be measured for payment.

(b) Seeding will not be measured for payment.

(c) Mulch cover will not be measured for payment.

(d) Water will not be measured for payment.

620.05 Basis of Payment. Payment for any work described in this section shall be considered subsidiary to other items listed on the bid schedule.

SECTION 624 SOLID SODDING

624.01 Description. This item shall consist of furnishing and placing approved Bermuda sod, fertilizer, and water according to these specifications at locations shown on the plans, or as directed.

624.02 Materials. (a) The Bermuda sod shall be composed of either field grown grass or approved nursery grown grass and shall consist of a densely rooted growth of grass substantially free from noxious weeds and undesirable grasses.

The sod shall be sufficiently thick to secure a dense stand of live grass. The sod shall be live, fresh, and uninjured at the time of placing. It shall have a soil mat of sufficient thickness adhering firmly to the roots to withstand all necessary handling. It shall be placed as soon as possible after being cut and shall be kept moist from the time it is cut until it is placed in its final position.

The source of field grown sod shall be inspected and approved by the Engineer before being cut for use in the work. After approval, the area from which the sod is to be harvested shall be closely mowed and raked as necessary to remove excessive top growth and debris.

Approved devices, such as sod cutters, shall be used for cutting the sod and due care shall be exercised to retain the native soil intact. The sod shall be cut in uniform strips. The width of the sod furnished for use on the project shall be satisfactory to the Engineer. Rolled sod may be backed with a netting material for added strength in handling if necessary.

(b) Fertilizer shall be in accordance with Subsection 620.02(b).

(c) Water shall be in accordance with Subsection 620.02(f).

624.03 Construction Requirements. (a) Preparation of Bed. The area to be sodded shall be dressed to the shape and section shown on the plans and the top and bottom of slopes shall be rounded to a radius of approximately 3′ (1 m) unless otherwise directed. The finished slopes shall be free of objectionable foreign matter and the top 1" (25 mm) of soil shall be loosened and finely divided. When directed, areas consisting of poor quality soil shall be loosened roughly and covered with a layer of topsoil not less than 2" (50 mm) in depth. Water may be applied before, during, and after slope

preparation, as directed by the Engineer, in order to maintain the desired moisture content in the soil.

(b) Fertilization. Immediately before placement of sod, fertilizer shall be broadcast at the rate of 250 pounds per acre (280 kg/ha) (approximately 1 pound per 19 square yards [1 kg/35 sq m]) of 10- 20-10, or the equivalent amount of plant food, and incorporated into the top 1" (25 mm) of soil.

(c) Placement of Sod. 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. At the top of slopes the sod shall be turned into the embankment slightly and a layer of earth placed over it and compacted to conduct surface water over and onto the sod. 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 approved tamper, with care being taken to avoid tearing end strips of sod.

When sodding is completed, the sodded areas shall be cleared of loose sod, excess soil, or other foreign material; a thin application of topsoil shall be scattered over the sod as a top dressing; and the areas thoroughly moistened. Water shall be applied at a minimum rate of 20.4 M Gallons per acre (188 cu m or 188 kL per ha) or as directed by the Engineer for a period of at least 3 weeks. The Engineer will adjust the amount of water required each week to deduct any rainfall received during the 7 calendar day period prior to the weekly watering. The weekly applications of water and deductions for failure to water will not be required from January 1 through March 31. The time required for application of water will not be included in the computation of contract time for completion of the project provided all other work under the Contract has been completed.

Failure to meet this water application requirement will result in a permanent deduction in payment and /or permanent recovery of payments equal to the minimum bid price established in Subsection 620.05(d) for each M.G. (kL) not applied as directed in accordance with these specifications. Equipment and methods used to place the water shall be in accordance with Subsection 620.03(f)(4).The Contractor shall maintain sodded areas from the time of completion until final

acceptance of the project by the Engineer.

(d) Restoration. Additional work and materials required because of the Contractor's negligence in maintaining the work shall be accomplished at no cost to the Department.

When sod is other than nursery supplied, the source field shall be finished according to the agreement between the Contractor and Owner in a condition, after removal of sod, which is acceptable to the property owner and conducive to re-establishment of turf. A copy of the agreement will be provided to the Engineer before sod is removed. The agreement will stipulate the final condition of thesource field. All restoration of the source field shall be done at no cost to the Department.

624.04 Method of Measurement. (a) Solid Sodding will be measured by the square yard (square meter) of actual area covered.

(b) Water will be measured according to Section 620.

624.05 Basis of Payment. (a) Solid sodding completed and accepted and measured as provided above will be paid for at the contract unit price bid per square yard (square meter) for Solid Sodding, which price shall be full compensation for bed preparation; for furnishing and applying fertilizer, topsoil, and sod; and for all labor, equipment, tools, and incidentals necessary to complete the work.

(b) Water will be paid for under Section 620. Payment will be made under:

Pay Item	**Pay Unit**
Solid Sodding	Square Yard (Square Meter)

SECTION 626
EROSION CONTROL MATTING

626.01 Description. This item shall consist of furnishing, placing and maintaining erosion control matting according to these specifications at locations shown on the plans, or as directed.

Materials. Materials shall be furnished according to AHTD Class 1, Class 2, and Class 3. All materials shall be listed on the QPL.

The Class of matting shall be as shown on the plans and/or as specified in the project specifications. The type matting used within a particular Class shall be at the option of the Contractor, unless otherwise specified. Any matting from a higher numbered class may be used in lieu of the matting specified, but at no additional cost to the Department.

626.02 Construction Requirements. The matting shall be applied after the area has been properly shaped, fertilized, and seeded as specified on the plans.

The materials shall be applied according to the manufacturer's recommendations. Size and gage of staples, staple spacing, overlap of materials, direction of matting, etc., shall follow the manufacturer's instructions for installation for the site conditions. The Contractor shall supply the Engineer with manufacturer's guidelines before installation.

The Contractor shall maintain the matting areas until all work on the entire project has been completed and accepted.

626.03 Restoration. Additional work and materials required because of loss through erosion will be paid for under the pertinent contract items. Additional work and materials required due to the Contractor's negligence in maintaining the completed work shall be accomplished at no cost to the Department.

626.04 Method of Measurement. Matting will be measured by the square yard (square meter) of actual area covered.

626.05 Basis of Payment. Work completed and accepted and measured as provided above will be paid for at the contract unit price bid per square yard (square meter) for Erosion Control Matting of the Class specified, which price shall be full compensation for furnishing all labor, materials, equipment, tools, and incidentals necessary to complete the work.

Payment will be made under:

Pay Item	**Pay Unit**
Erosion Control Matting (Class_____)	Square Yard (Square Meter)

SECTION 627

REMOVING AND REPLACING TOPSOIL

627.01 Description. This item shall consist of excavation of a layer of topsoil from areas to be occupied by cuts and embankments, moving the material to convenient stockpile areas for storage, and replacing the stored material on completed slopes and ditches in accordance with these specifications and at locations shown on the plans or as directed.

627.02 Construction Requirements. **(a)** Removing and Storing Topsoil. Upon completion of clearing and grubbing operations and prior to beginning excavation, designated areas shall be striped of topsoil. No effort will be made to strip where topsoil is less than 2" in depth. Sufficient quantities of topsoil shall be stripped to allow distribution over the completed slopes to a depth shown on the plans or as designated by the Engineer. Topsoil stripping will not be required in excessively rocky areas nor where the ground surface is overlain with boulders or slab rock to the extent that equipment cannot operate effectively. Material to be stripped shall include grass, lead mold, pine straw, leaves, rotten wood, and humus of all kinds. It may contain a reasonable amount of the waste from clearing operations, such as small twigs and roots, which can be expected to reach early decay. Stripped material shall be moved to areas on the right of way, or other approved locations, and stockpiled in uniformly shaped storage piles susceptible to ready measurement by the cross section method. Stockpiles shall be so located that they will not interfere with any proposed construction nor constitute drainage, traffic, or other hazards, either to the project, the general public, or adjacent property. Storage should be in such locations that will afford easy access for loading, hauling, and replacement. The stored topsoil shall be protected from contamination.

(b) Replacing Topsoil. Topsoil previously stripped and stored shall be distributed over the completed slopes to a depth as shown on the plans or designated by the Engineer. Spreading and dressing of the topsoil layer shall be uniform insofar as possible. After spreading, any remaining large roots, branches, or foreign substances shall be removed to result in a smooth and clean appearance. Light rolling, disking, or other type manipulation, including sprinkling, shall be applied if necessary to cause the newly spread layer to pulverize, mix, and adhere to the slopes. Topsoil shall be placed on areas which are to receive seed or sod mulch as soon as practicable after the earthwork is completed.

(c) Restoration. Additional work and materials required because of loss through erosion will be paid for under the pertinent contract items. Additional work

and materials required due to the Contractor's negligence in maintaining completed work shall be accomplished at no cost to the Owner.

The storage sites for topsoil shall be dressed to conform to the adjacent area after the storage piles have been removed.

627.03 Method of Measurement and Payment. Removing and replacing topsoil will not be measured for payment.

SECTION 628
TOPSOIL FURNISHED AND PLACED

628.01 Description. This item consists of furnishing and placing topsoil on completed slopes and ditches according to these specifications and at locations shown on the plans or as directed by the Engineer.

628.02 Materials. Topsoil may be obtained from sources outside the right-of-way limits or from areas within the project limits that will be occupied by cuts and/or embankments. When topsoil is furnished from sources outside the right-of-way, the Contractor shall be responsible for locating and obtaining the material and for performing all work, including erosion control, prevention of water pollution, and restoration, according to the specifications. The cost of such work will be considered included in the contract unit price bid for Topsoil Furnished and Placed. At the request of the Engineer, the Contractor shall furnish copies of agreements with the property owners.

Topsoil from all sources shall be the surface layer of soil with no admixture of refuse or any material toxic to plant growth and shall be reasonably free from subsoil and stumps, roots, brush, stone, clay lumps, or similar objects larger than 2" (50 mm) in greatest diameter. In no case shall topsoil be excavated more than 12" (300 mm) from the original ground level. Brush and other vegetation that will not be incorporated with the soil during handling operations shall be cut and removed. Ordinary sods and herbaceous growth, such as grass and weeds, shall not be removed but shall be thoroughly broken up and intermixed with the soil during handling operations. Topsoil may contain a reasonable amount of waste from clearing operations, such as small twigs and roots, that can be expected to reach early decay.

628.03 Construction Operations. (a) Removing, Storing, and Handling Topsoil. Topsoil stripped from within the project shall be moved to areas on the right-of-way, or other approved locations, and stockpiled. When measurement is to be by the cross section method, the stockpiles shall be uniformly shaped and susceptible to ready measurement by the cross section method. Stockpiles shall be located so that they will not interfere with any proposed construction nor constitute drainage, traffic, or other hazards, either to the project, the general public, or adjacent property. Storage should be in such locations that will afford easy access for loading, hauling, and replacement. The stored topsoil shall be protected

from contamination.

If the condition of the soil is unsuitable due to excessive moisture, frost, or other conditions, the Contractor shall cease work under this item until the soil is in a suitable condition.

Topsoil stripped from within the project limits shall be removed prior to the taking of original cross sections. The Contractor shall schedule the work in coordination with the Resident Engineer so as to minimize any delay between the stripping of the topsoil, the taking of original cross sections, and the beginning of excavation and/or embankment construction. Failure of the Contractor to properly schedule the work will not be considered as grounds for extension of time nor for additional payment due to any resulting delays.

(b) Placing Topsoil. Topsoil shall be distributed over the completed slopes and ditches to a depth as shown on the plans or designated by the Engineer. Spreading and dressing of the topsoil layer shall be uniform insofar as possible. After spreading, any remaining large roots, branches, or other foreign substances shall be removed to leave a smooth and clean appearance.

Light rolling, disking, or other type manipulation, including sprinkling, shall be applied as necessary to cause the newly spread layer to pulverize, mix, and adhere to the slopes. Topsoil shall be placed on areas that are to receive seed or sod mulch as soon as practicable after the earthwork is completed, but shall not be placed until after final cross sections are taken. The Contractor shall schedule the work in coordination with the Resident Engineer so as to minimize any delay between the completion of the earthwork, the taking of final cross sections, and the placement of topsoil. Failure of the Contractor to properly schedule the work will not be considered as grounds for extension of time nor for additional payment due to any resulting delays.

Restoration. Additional work and materials required because of loss through erosion will be paid for under the appropriate contract item. Additional work and materials required due to the Contractor's negligence in maintaining the completed work, including failure to apply and maintain seeding, mulch cover, sod mulch, and/or solid sod as required, shall be accomplished at no cost to the Department.

The storage sites for topsoil within the right-of-way shall be dressed to conform to the adjacent area after the storage piles have been removed.

If the Contractor elects to obtain topsoil from areas within the project limits that are to be occupied by embankments, additional borrow material required to replace the topsoil will be measured and paid for under the appropriate item.

628.04 Method of Measurement. Topsoil furnished from outside the right-of-way will be measured by the cubic yard (cubic meter) in vehicles at the point of delivery for use on the project. Topsoil obtained from within the project limits will be measured by the cubic yard (cubic meter) either in stockpiles by the cross section method or in vehicles at the point of delivery for spreading. No adjustment will be made for swell.

628.05 Basis of Payment. Work completed and accepted and measured as provided above will be paid for at the contract unit price bid per cubic yard (cubic meter) for Topsoil Furnished and Placed, which price shall be full compensation for furnishing, hauling, stockpiling, moving, and placing topsoil; and for all labor, equipment, tools, and incidentals necessary to complete the work.

Payment will be made under:

Pay Item	**Pay Unit**
Topsoil Furnished and Placed	Cubic Yard (Cubic Meter)

SECTION 700

ROADWAY TESTING

700.01 Description. The contractor will be responsible for ensuring that all testing of subgrade, stabilized subgrade, road base and road surface (i.e. asphalt or concrete) is completed, as follows.

700.02 Testing Requirements.

Subgrade and Select Fill: Acceptable roadbed soils or subbase materials shall be worked a minimum six inch depth and compacted to a minimum 95 percent Standard Proctor Density (+/- 3% optimum moisture content) to be considered acceptable subgrade for further construction. Prior to testing for subgrade density, an independent testing laboratory, under the direction of the design engineer, shall supervise the proof rolling of the subgrade in accordance with Section 700.10. Once proof rolling is complete and any required repairs made, the independent testing laboratory shall test for required density with a minimum of one test for each soil type and a minimum of one test for each 500 feet of street length or part thereof.

Crushed Stone Base: The non-stabilized flexible base material shall be shaped and compacted to a minimum of 95 percent Standard Proctor Density and properly primed with an approved asphalt to be considered acceptable for further construction or surfacing. Laboratory density tests shall be performed at adequate intervals to ensure consistent density. The responsible design engineer shall determine the proper test locations, with a minimum of one test per 500 feet of street length or part thereof.

Concrete Surface: The actual placement of the concrete surface shall be monitored by a certified independent testing laboratory under the direction of the design engineer to ensure that the paving activity complies with the herein adopted state highway and transportation department standard specifications and the mix design, including slump, concrete temperature and water/cement ratio. Concrete strength tests will be required at a minimum of one test cylinder per each 250 cubic yards or part thereof.

If deemed necessary by the Engineer, due to failed test cylinders or inconsistencies noticed during the pour, the concrete streets shall be cored every 300 feet of lane length or portion thereof, at no expense to the owner, for the purpose of checking thickness. Thickness shall not be more than 0.50 inches deficient. Deficiencies of more than 0.50 inches shall be removed and replaced. The owner, may at its sole discretion choose to leave the deficient concrete slab in place and accept and extended five (5) year warranty for concrete placement at 150% of construction costs based on estimate provided by the Engineer of Record.

Concrete cylinders testing out less than 90% of design strength shall be removed and replaced. For concrete falling between 90-100% of design strength, and extended five (5) year warranty shall be provided at 150% of construction costs based on estimate provided by the Engineer of Record.

Concrete Curb and Gutter: Concrete strength test for curb and gutter will be required at the beginning of every pour and then for every 1,000 linear feet of curb and gutter poured, or portion thereof.

Asphalt Surface: The actual placement of the asphalt surface shall be monitored by a certified independent testing laboratory under the direction of the design engineer to ensure that the paving activity complies with the herein adopted state highway and transportation department standard specifications and the asphalt mix design and asphalt temperature.

Asphalt streets shall be cored, every 300 feet of lane length or portion thereof for the purpose of checking density and thickness. Exact locations of each sample shall be determined by the engineer or the engineer/owners approved representative so as to accurately represent the quality of asphalt laid in that particular area. Lanes of streets laid on different days may require additional cores at the Engineers discretion. Core samples shall be used to indicate asphalt thickness, and in no case shall be more than ¼ inch less than specified thickness. For cores that indicate thickness ¼ inch to ½ inch less than that specified, "isolation" cores will be required. To "isolate", the contractor, at no expense to the owner, shall cut cores 10 feet either side of the initial core. If both of the cores are in acceptable tolerance, the section will be accepted. If one or both of the cores fails, then additional cores will be cut 25 feet away from the initial core in the failing direction(s). Subsequent cores will be cut at 50 foot intervals in the direction of the failure until a core that passes tolerance is obtained. The isolated area will be that which falls within the limits of the acceptable thickness. The areas that fall within the ¼ inch to ½ inch less than specified thickness may be removed and replaced, or warranted for five (5) years at 150% of construction cost based on the estimate provided by the Engineer of Record. Areas that are determined to exceed the ½ inch less than specified thickness shall be removed and replaced within the limits of the acceptable thickness determined by the isolation method.

Minimum asphalt density shall be not less than 92% of the maximum theoretical density. Maximum asphalt density shall be 96% of maximum theoretical density. Asphalt densities that fall between 90% to 92% and 96% to 98% shall be left in place and an extended warranty of five (5) years at 150% of construction cost based on the estimate provided by the Engineer of Record will be required on the deficient asphalt pavement. Where densities are less than 90% or greater than 98%, the paving shall be removed and replaced. The limits of the deficient pavement shall be determined by the "isolation method" by first cutting two additional cores within 2 feet each side of the failing core, then add

the results of the density of the original core and the two additional cores densities. Divide by three, and if the average of the three core densities fall within the acceptable ranges as specified above, then the section will be accepted per the aforementioned requirements. If the average of the two re-cores fall below acceptable range, then additional cores will be cut, first going 25 feet longitudinally in each direction from the original core and determining the densities of each. A resulting failing core from that point will require an additional core being cut at 50 foot increments until a passing core density is obtained. The failed area will consist of the area falling within the limits of the passing re-cores and will be addressed per the aforementioned requirements.

Asphalt street densities measured in accordance with AHTD Test Method 461-07, and using a nuclear device equivalent to that described in ASTM D 2950 may be accepted in lieu of up to 50% of the asphalt core samples, if acceptable to the Engineer and owner, and none of the core samples take are found to be deficient in any way. Acceptance of this method will be addressed on a case by case basis by the Engineer and Owner.

All core test holes for concrete and asphalt shall be filled with non-shrink grout flush with final surface within 24 hours of the test. Grout color shall match the color of the final surface.

700.03 Proof Rolling: Proof rolling shall be performed using a rubber tired construction vehicle weighing a minimum of 25 tons, such as a fully loaded, tandem-axle dump truck, unless otherwise approved, in writing, by the engineer..

700.04 Method of Measurement. Testing will be paid as a lump sum item, and paid as a percentage of actual work complete.

700.05 Basis of Payment. Work completed and accepted and measured as provided above will be paid for at the contract lump sum price bid for Roadway Testing Allowance, which price shall be full compensation based on invoices from the testing lab submitted to the engineer by the contractor.

No adjustments in the lump sum price bid will be made for Roadway Testing required due to normal increases or decreases in contract quantities or additional testing required due to failures. However, if the amount of Roadway Testing required is increased or decreased in connection with a Change Order, compensation will be adjusted accordingly.

ETTL Engineers and Consultants, of Texarkana, AR, shall be the accepted third party laboratory to perform all testing.

Additional testing required due to failures or inconsistencies will be at the contractor's sole expense.

SECTION 801 EXCAVATION AND BACKFILLING

801.01 Description. The work under this item shall include the removal of material, of whatever nature, necessary for the construction of foundations for bridges, box culverts, and retaining walls according to the plans or as directed. It shall include the furnishing of necessary equipment and the construction of cofferdams, shoring, etc., which may be necessary for the execution of the work. It shall also include dewatering and the subsequent removal of cofferdams and shoring and the backfilling with suitable materials as herein specified. It shall also include the disposal of excavated material not required for backfill, in a manner and in locations as herein specified and/or as shown on the plans. Compliance with the applicable provisions of Section 110 is an essential requirement of work performed under this Section. Unless a specific pay item is provided in the Contract, work required to comply with Section 110 will not be paid for separately but will be considered subsidiary to other items of the work.

801.02 Preservation of Channel. No excavation shall be made within stream channel limits outside a vertical plane 3' (1 m) from the footing lines and parallel thereto unless approved by the Engineer. Unless otherwise specified, no excavation shall be made outside of cofferdams, caissons, or shorings without the permission of the Engineer. If excavation or dredging is allowed at the site of the structure before cofferdams, caissons, or shorings are sunk or in place, the Contractor shall, at no cost to the Department, and after the foundation is in place, backfill such excavation to the original ground surface or stream bed elevation with gravel or crushed rock material satisfactory to the Engineer. Excavated material not used for backfill shall be disposed of according to Section 210.

801.03 Depth of Footings. The elevation of the bottoms of footings, as shown on the plans, shall be considered as approximate only. The Engineer may require such changes in dimensions or elevations as may be necessary to secure a satisfactory foundation.

After each bridge footing in rock excavation has been completed to plan elevation, one hole 1½" (35 mm) or more in diameter shall be drilled to a minimum depth of 5' (1.5 m) for each 50 square feet (5 sq m) or less of bearing area. If the footing elevation is then lowered, the same pattern of such

holes shall be drilled after the new excavation has been completed. No direct payment will be made for this drilling as it is considered a part of the items of excavation for structures.

801.04 Preparation of Foundations. Foundations, where practicable, shall be constructed in open excavation and, where necessary, the excavated faces shall be sloped, shored, or protected by cofferdams according to approved methods.

Rock or other hard foundation material shall be reasonably free of loose material. The foundation excavation shall be cleaned and cut to a firm surface, either leveled, stepped, or roughened, as directed by the Engineer. Seams shall be cleaned and filled with concrete, mortar, or grout. Excavation in rock shall be made to neat line of footings. When the use of explosives has been approved by the Engineer, care shall be exercised to avoid shattering rock faces by excessive blasting. The Contractor shall be responsible for any extra work and associated costs caused by excessive blasting.

When concrete is to rest on an excavated surface other than rock, special care shall be taken not to disturb the bottom of the excavation. As a minimum, the final 1' (0.3 m) of excavation shall be completed by hand methods. The final removal of the foundation material to grade shall not be made until just before the concrete is to be placed. Foundation pits shall be kept dry and free of flowing water.

Details for all excavation and/or shoring for foundation work adjacent to operated railroad tracks and plans of falsework, staging, protective sheeting, or other temporary construction near the operated tracks shall be approved by the Railroad Company prior to beginning the work. The Contractor shall construct the work according to the approved plans.

801.05 Cofferdams. (a) General. Cofferdams for foundation construction shall be safely designed and constructed, and made as watertight as is necessary for proper performance of the work. The interior dimensions of cofferdams shall provide sufficient clearance for dewatering, the construction of forms, and for inspection. Cofferdams that are tilted or moved laterally shall be righted, reset, or enlarged as necessary. This shall be at no cost to the Department.

When natural conditions are encountered that render it impracticable to dewater the foundation before placing concrete, the Engineer may require the construction of a concrete foundation seal of such dimensions as may be necessary, according to Subsection 802.11. The water shall then be pumped out and the balance of the concrete placed in

the dry. During the placing of a foundation seal, the elevation of the water inside the cofferdam shall be controlled to prevent any flow through the seal.

(b) Protection of Concrete. Cofferdams shall be constructed so as to protect the concrete against damage from a sudden rising of the stream and to prevent damage to the foundation by erosion. No bracing shall be left in cofferdams in such a way as to extend into the substructure concrete without the written permission of the Engineer.

(c) Details Required. Details for each unit of cofferdam construction, complete with dimensions and kind and condition of materials, shall be submitted to the Engineer prior to construction, for informational and record purposes. These details shall be prepared and/or approved by a Registered Professional Engineer who shall certify that the adequacy of all components has been verified. File copies of all design calculations shall be maintained by the Contractor until final acceptance of the project. The Contractor shall be responsible for the results obtained by the use of the cofferdam design. Construction of the cofferdam shall be according to the details submitted to the Engineer for informational purposes.

(d) Removal. Unless otherwise provided, the cofferdams, sheeting, and bracing shall be removed after the completion of the substructure. Care shall be taken not to damage the finished concrete.

801.06 Dewatering Foundations. Pumping from the interior of any foundation enclosure shall be performed in such a manner as to prevent the movement of water through the fresh concrete. No pumping will be permitted during the placing of concrete unless it is performed from a suitable sump separated from the concrete work. The pumping shall continue until the placement of the concrete is completed.

801.07 Inspection. After each excavation is completed, the Contractor shall notify the Engineer. No concrete shall be placed until the Engineer has approved the depth of the excavation and the character of the foundation material.

801.08 Backfill. Spaces outside the streambed excavated for and not occupied by abutments, piers, or other permanent work shall be backfilled and compacted to the general level of the surrounding ground. This work shall be performed immediately after completion of each unit of concrete work and after the forms have been removed and the concrete has reached its minimum required strength. Material used for backfill shall be of the same quality as that removed and shall be reasonably free

from large or frozen lumps, wood, and other extraneous material.

Piers located within the streambed need not be backfilled unless directed on the plans or as required by the Contractor's cofferdam removal procedure. Material for backfilling in the streambed shall be reasonably clean gravel or crushed rock.

Backfill within the roadway embankment and immediately adjacent to bridge abutments, culverts, retaining walls, or other places inaccessible to rollers, shall be placed in approximately 6" (150 mm) horizontal layers, loose measurement, at near optimum moisture content, and compacted with mechanical equipment to 95% of the maximum density as determined by AASHTO T 99. The specified density will not be required immediately adjacent to wingwalls of box culverts. The backfill in front of such units shall be placed first to prevent the possibility of forward movement. Special precautions shall be taken to prevent any wedging action against the concrete, and the slope bounding the excavation for abutments and wingwalls shall be stepped or roughened to prevent wedge action. Jetting of the fill behind abutments and wingwalls will not be permitted. Backfill for box culverts shall be placed equally on both sides of the culvert in 6″ (150 mm) lifts, loose measurement, and compacted as required above.

Fill placed around piers shall be deposited uniformly on all sides to approximately the same elevation. No backfill shall be placed against abutments, retaining walls, or box culverts until the concrete has cured for at least 14 days or until test cylinders show that the minimum strength has been obtained.

Backfilling of structural plate pipe and arches shall be according to Subsection 608.03(d).

The Department will perform acceptance sampling and testing of compacted backfill material in accordance with Subsection 210.10 at the frequencies established in the Department's *Manual of Field Sampling and Testing Procedures*.

801.09 Classification of Excavation. Where excavation is not classified, all excavation will be grouped under the items Unclassified Excavation for Structures-Bridge or Unclassified Excavation for Structures-Roadway. These items shall include the removal of all materials encountered regardless of their nature or the manner in which they are removed.

Where excavation is classified it shall be classed as Common Excavation for Structures-Bridge, Common

Excavation for Structures-Roadway, Rock Excavation for Structures-Bridge, or Rock Excavation for Structures-Roadway, according to the following criteria:

* Common Excavation for Structures-Bridge and Common Excavation for Structures-Roadway shall include the removal of all materials encountered, regardless of their nature, other than rock as defined in the items Rock Excavation for Structures-Bridge or Rock Excavation for Structures-Roadway.

* Rock Excavation for Structures-Bridge and Rock Excavation for Structures-Roadway shall include the removal of such firm and compact materials as cannot be excavated without first being loosened or broken by blasting, sledging, or drilling.

Water is not considered a material for the purposes of excavation.

801.10 Method of Measurement. Work under this item will be measured by the cubic yard (cubic meter). The quantities shown on the plans will be considered as the final quantities and no further measurement will be made unless, in the opinion of the Engineer or upon evidence furnished by the Contractor, substantial variations exist between quantities shown on the plans and actual quantities due to changes in alignment or dimensions or to apparent errors. Where cofferdams are required, the quantities of excavation for bridges, as shown on the plans for the cofferdam location, shall be considered as final quantities and no further measurement will be made unless it becomes necessary to carry the footing or seal concrete below the elevation shown on the plans.

Plan quantities and the adjustments thereof are based on vertical planes parallel to and 18" (450 mm) outside the neat lines of the footing or bottom slab and wings when in material other than rock, and vertical planes parallel to and 4" (100 mm) outside the footing or bottom slab and wings in rock for all foundations except seal foundations. Plan quantities and the adjustments thereof for seal foundations are based on vertical planes parallel to the neat line of seal.

The quantities do not include the volume of any material that lies within the typical roadway cut section or within a channel change section.

When it is necessary, as directed by the Engineer, to lower the bridge footing elevation below the elevation shown on the plans, such excavation will be measured and adjusted according to the following schedule:

Depth of Bridge Footing

Excavation Below Plan Grade	Adjustment
Material between 0' and 3' (0 and 1 m) below elevation shown:	Actual Volume
Material between 3' and 7' (1 m and 2 m) below elevation shown:	Actual Volume + 50%
Material deeper than 7' (2 m) below elevation shown:	Actual Volume + negotiated adjustment factor.

When undercutting for box culverts or box culvert extensions is directed by the Engineer, the Engineer may direct that the undercut section be backfilled with roadway excavation material, borrow, or Stone Backfill. If the Engineer directs that Stone Backfill be used for backfill, the volume of excavation for undercut will not be measured for payment, and the backfill will be measured and paid for as Stone Backfill in accordance with Section 207.

If the Engineer directs that roadway excavation or borrow be used for backfill of the undercut section, the volume of excavation for the undercut will be measured by length, width, and average depth, and the computed volume will be paid for as Unclassified Excavation in accordance with Section 210. The backfill material will be included in the measurement and payment for the appropriate earthwork items under Section 210.

Undercutting and backfilling with upgraded material for the Contractor's convenience shall be at no cost to the Department.

When the item Cofferdam is included in the Contract, each cofferdam will be measured by the unit.

801.11 Basis of Payment. Work completed and accepted and measured as provided above will be paid for at the contract unit price bid per cubic yard (cubic meter) for Unclassified Excavation for Structures-Bridge, Common Excavation for Structures-Bridge, Rock Excavation for Structures-Bridge, Unclassified Excavation for Structures-Roadway, Common Excavation for Structures-Roadway, or Rock Excavation for Structures-Roadway, as the case may be, which price shall be full compensation for site preparation, excavation, and backfill; for shoring, bracing, cribbing, cofferdams, pumping, or dewatering; and for all labor, equipment, tools, and incidentals necessary to complete the work.

Excavation for bridge length culverts will be included in Excavation for Structures-Roadway.

Unclassified, Common, or Rock Excavation for Structures-

Roadway for box culvert extensions will be measured and paid for at the quantity shown on the plans.

When the item Cofferdam is included in the Contract, work completed and accepted as provided above will be paid for at the contract unit price bid per each for Cofferdams, which shall be full compensation for preparation of necessary design details and/or Registered Professional Engineer certifications; for furnishing and installing all materials; for shoring, bracing, pumping, dewatering, maintenance, removal, backfilling, and satisfactory clean-up of the area; and for all labor, equipment, tools, and incidentals necessary to complete the work. Payment will be made under:

Pay Item	**Pay Unit**
Unclassified Excavation for Structures-Bridge	Cubic Yard (Cubic Meter)
Common Excavation for Structures-Bridge	Cubic Yard (Cubic Meter)
Rock Excavation for Structures-Bridge	Cubic Yard (Cubic Meter)
Unclassified Excavation for Structures-Roadway	Cubic Yard (Cubic Meter)
Common Excavation for Structures-Roadway	Cubic Yard (Cubic Meter)
Rock Excavation for Structures-Roadway	Cubic Yard (Cubic Meter)
Cofferdam	Each

SECTION 802 CONCRETE FOR STRUCTURES

802.01 Description. This item shall consist of concrete in bridges, culverts, and miscellaneous structures, including the concrete portion of steel, timber, stone masonry, precast, prestressed, and composite structures, prepared and constructed according to these specifications and conforming to the lines, grades, dimensions, and designs shown on the plans. Concrete shall consist of approved portland cement, fine aggregate, coarse aggregate, water, and any approved chemical admixtures mixed in the proportions specified for the various classes of concrete.

802.02 Materials. The materials used in concrete shall conform to the requirements specified below. No materials shall be used that contain foreign matter, frost, or lumps or crusts of hardened substances.

(a) Cement. Unless otherwise specified, Portland cement conforming to the requirements of AASHTO M 85, Type I shall be furnished. One of the following blended cements may be used in lieu of Type I:

- Portland-Pozzolan Cement, AASHTO M 240, Type IP (20% maximum)
- Slag-Modified Portland Cement, AASHTO M 240, Type IS (25% maximum)

Fly ash or slag cement shall not be substituted for blended cements. Cement shall be from sources that are listed on the Department's Qualified Products List and that have executed a certification agreement with the Department.

The total alkalis in the Portland cement ($Na_2O + 0.658\ K_2O$) shall not exceed 0.60%. The total alkalis in the cementitious material (Portland cement, fly ash or ground granulated blast- furnace slag) shall not exceed 5 lbs./cu yd (3 kg/cu m). In lieu of using low alkali cement as specified, the Contractor may choose alternative testing of the proposed aggregates and cementitious materials as follows:

Option 1 – Test the fine and coarse aggregate sources in accordance with AASHTO T 303. If the 14 day expansion ≤ 0.10%, the requirement for low-alkali cement is waived. If the 14 day expansion is greater than 0.10%, further testing per Option 2 below is required using slag cement or fly ash.

Option 2 – Test using the specific job materials and selected replacement level of supplemental cementitious materials (slag cement or fly ash) proposed for the project according to AASHTO T 303. If the 14 day expansion is ≤ 0.10%, the requirement for low-alkali cement is waived. If the 14 day expansion is greater than 0.10%, additional testing with a different cement, different supplemental cementitious material, and/or different replacement level is required.

Type II (MH), Moderate Heat of Hydration, cement shall be used for Class B concrete. During the cool season of the year, the Engineer may approve the use of Type I cement in lieu of Type II (MH) cement for Class B concrete. Upon approval of the Engineer, Type III cement may be used in the manufacture of prestressed concrete products.

Cement furnished in sacks shall weigh not less than 94 pounds (42.6 kg) per sack. The mixing or alternate use of cement from different manufacturing plants will not be permitted. The source of cement shall not be changed without the written approval of the Engineer. Cement placed in storage shall be suitably protected. Loss in quality occurring during the storage period will be cause for rejection. If the cement furnished produces erratic results under the field conditions incident to the placing of the concrete, or in regard to the strength of the finished product, or in the time of the initial or final set, the Contractor shall, without notice from the Engineer, cease the use of that source of cement.

(b) Fine Aggregate. The fine aggregate shall consist of clean, hard, durable particles of natural sand or other approved inert material with similar characteristics.

When determined necessary by visual observation, the amount of deleterious substances will be tested by laboratory methods and shall not exceed the following limits:

	Maximum Permissible Percent by Weight
Coal and lignite (AASHTO T 113)	0.25
Clay lumps (AHTD Test Method 302)	0.5
Removed by decantation (AASHTO T 11)	2.0
Soft and flaky particles (AHTD Test Method 302)	2.0

All fine aggregate shall be free from injurious amounts of organic impurities.

Aggregates shall be subjected to testing according to AASHTO T 21. Should AASHTO T 21 produce results that indicate that the sand may possibly contain injurious or damaging organic compounds, mortar strength test specimens shall be tested according to AASHTO T 71, such that the fine aggregate has a compressive strength of 95% of the standard sand samples at 7 days. Fine aggregate shall comply with the following grading requirements when tested according to AASHTO T 27:

Sieve (mm)	**Percent Passing**
3/8" (9.5)	100
#4 (4.75)	95-100
#8 (2.36)	70-95
#16 (1.18)	45-85
#30 (0.600)	20-65
#50 (0.300)	5-30
#100 (0.150)	0-5

The fineness modulus of the fine aggregate shall not vary more than 20 points from the established value of the fine aggregate used in the mix design. In the event that the fineness modulus exceeds 20

points, a new mix design will be required. When approved by the Engineer, the source of fine aggregate may be changed in all work except bridge superstructures, but the mixing or alternate use of different sources of fine aggregate will not be permitted.

(c) Coarse Aggregate. The coarse aggregate shall consist of crushed stone or gravel.

Crushed stone shall consist of clean and durable fragments of rock of uniform quality. The stone shall have a percent of wear of not more than 40 by Los Angeles Test (AASHTO T 96), and, when subjected to 5 cycles of the Soundness Test (Sodium Sulfate, AASHTO T 104) shall have a loss not to exceed 12%. Gravel shall consist of clean, hard, durable, uncoated aggregate, crushed or uncrushed, having a percent of wear of not more than 40 by Los Angeles Test (AASHTO T 96).

When determined necessary by visual observation, the amount of deleterious substances will be tested by laboratory methods and will not exceed the following limits:

	Maximum Permissible Percent by Weight
Coal and lignite (AASHTO T 113)	0.25
Clay lumps (AHTD Test Method 302)	0.25
Soft Fragments (AHTD Test Method 302)	5.0
Total deleterious substances	5.0
Removed by decantation (AASHTO T 11)	1.0

The maximum percentage by weight removed by decantation (AASHTO T 11) from crushed stone coarse aggregate may be increased to 1.5% provided the percent loss (AASHTO T 11) from the fine aggregate does not exceed 1.0% or to 1.8% provided the percent loss from the fine aggregate does not exceed 0.5%.

Coarse aggregate shall comply with the following grading requirements when tested according to AASHTO T 27:

Class A, S, S(AE), and Seal Concrete:

	% Passing	
Sieve (mm)	**Standard Gradation AHTD**	**Alternative Gradation AASHTO M43 #57**
1½" (37.5)	-	100
1¼" (31.5)	100	-
1" (25.0)	60-100	95-100
3/4" (19.0)	35-75	-
1/2" (12.5)	-	25-60

3/8" (9.5)	10-30	-
#4 (4.75)	0-5	0-10
#8 (2.36)	-	0-5

Class B Concrete:

Sieve (mm)	Percent Passing
3" (75)	100
1¼" (31.5)	35-65
3/4" (19.0)	15-40
#4 (4.75)	0-5

The fineness modulus of the coarse aggregate shall not vary more than 20 points from the established value of the coarse aggregate used in the mix design. In the event that the fineness modulus exceeds 20 points, a new mix design will be required. When approved by the Engineer, the source of coarse aggregate may be changed in all work except bridge superstructures, but the mixing or alternate use of different sources of coarse aggregate will not be permitted.

Water. Water used in mixing or curing shall be clean and free from injurious amounts of oil, salts, or other deleterious substances, and shall not contain more than 1000 ppm of chlorides.

Water from municipal supplies approved by the State Health Department will not require testing but water from other sources shall be sampled and tested before use in concrete.

Tests will be made according to AASHTO T 26.

Where the source of water is relatively shallow, it shall be maintained at such depth and the intake so enclosed as to exclude silt, mud, grass, or other foreign materials.

(d) Admixtures. (1) General. Admixtures shall be used to improve certain characteristics of the concrete when specified on the plans or may be used when requested by the Contractor and approval is given by the Engineer. The Contractor's request shall be supported with the manufacturer's certified formulation of the proposed admixture and with sufficient evidence that the proposed admixture has given satisfactory results on other similar work. Permission to use the admixture may be withdrawn at any time by the Engineer when satisfactory results are not being obtained.

Admixtures shall be approved by the Engineer. Admixtures shall be compatible with each other, as advised by the manufacturer. The admixture dosage rate range as recommended by the manufacturer shall be used. Should the dosage rate for any admixture not yield desirable characteristics in the concrete, the dosage of admixture used shall be based on test results obtained by trial batches.

Admixtures shall be added to the mixing water by means of a mechanical dispenser that will accurately meter the additive throughout the mix water cycle. The dispenser shall be constructed and connected so that the amount of admixture entering the mixing water can be readily determined.

(2) Air Entraining Agent. Air entraining agent shall comply with the requirements of AASHTO M 154 and be approved by the Engineer. Permission to use the agent may be withdrawn at any time by the Engineer when satisfactory results are not being obtained.

(3) Retarding Agent. In order to permit the retarding of the set and extend the finishing time of concrete, a retarding agent shall be used when specified on the plans or may be used when permission for its use is requested by the Contractor and such permission is given by the Engineer. The retarding agent shall be a Type B or Type D admixture as defined in AASHTO M 194. Permission to use the agent may be withdrawn at any time by the Engineer when satisfactory results are not being obtained.

The agent shall be free of intentionally added chlorides or chloride containing compounds as a functional ingredient. When air-entrained concrete is specified, the air-entraining agent and the retarding agent shall be so incorporated that the air content of the concrete shall fall within the percentage range stipulated in the specifications. When air-entrained concrete is not specified, the concrete to which the retarding agent has been added shall have air content not greater than 3 percent.

No compensation will be made for furnishing and incorporating the agent in the mix. No additional compensation will be made for furnishing, placing, finishing, and curing the concrete involved.

(4) Other Admixtures. The use of other admixtures will be considered by the Engineer on a case by case basis upon written request from the Contractor. When admixture(s) affecting the slump of the plastic concrete are approved by the Department, the Department may, upon request of the Contractor, modify the concrete slump requirements for that concrete utilizing this approved additive. If approved, the admixture used shall be furnished at no additional cost to the Department. Permission to use an admixture may be withdrawn at any time by the Engineer when satisfactory results are not being obtained.

(e) Fly Ash. Fly ash used in concrete shall meet the requirements of AASHTO M 295, Class C or F. Mixing of Class C and Class F fly ashes will not be permitted.

(f) Slag Cement. Slag cement used in concrete shall meet the requirements of AASHTO M 302, Grade 100 or higher.

802.03 Handling and Storage of Materials. The handling and storage of concrete aggregates shall be such as to prevent segregation and contamination with foreign materials.

Coarse and fine aggregates shall be separated by bulkheads or stored in separate stockpiles sufficiently removed from each other to prevent the material at the edges of the piles from becoming intermixed. Coarse aggregate stockpiles not confined by bulkheads or bins shall be built up in layers not to exceed 4' (1.2 m) in height and each layer shall be completely in place before beginning the next. Coning or building up of stockpiles by depositing material in one place will not be permitted. In

order to control the gradation of the large aggregate for Class B concrete, it may be necessary that the Contractor stockpile the aggregate in two or more gradation ranges, blending by weight as required to obtain the specified gradation.

There shall be adequate aggregate stockpiled to allow representative sampling sufficiently in advance of any placement to determine its acceptability, with the minimum amount being that required to adequately complete the planned placement.

Cement shall be stored in suitable weather-proof buildings or silos that will protect the cement from dampness. Provision for storage shall be ample and the shipments of cement as received shall be separately stored in such a manner as to provide easy access for the identification and inspection of each shipment. Stored cement shall meet the test requirements at any time after storage when a re-test is ordered by the Engineer.

On small jobs, storage in the open may be permitted by written authorization from the Engineer, in which case a raised platform and ample waterproof covering shall be provided.

802.04 Classes of Concrete. The appropriate class of concrete shall be used in the part of the structure as specified or where designated by the Engineer. The classes are as follows:

Non Air-entrained Concrete	Air-entrained Concrete	Miscellaneous Concrete
Class A	Class S(AE)	Class M
Class B		
Class S		
Seal		

The following requirements shall govern unless otherwise shown on the plans:

Class A concrete shall be used in wingwalls and miscellaneous construction.

Class B concrete shall be used in mass concrete.

Class S or S(AE) concrete shall be used in retaining walls, box culverts, footings, piers, bents, columns, abutments, and superstructures, including girders, beams, floor slabs, and parapet walls.

Seal concrete shall be used for concrete deposited under water.

Class M concrete shall be used in miscellaneous construction as specified in Sections 500, 600, and 700.

Class S(AE) may be substituted for Class S. Class S(AE), Class S or paving concrete under Section 501 may be substituted for Class A. Acceptance criteria for strength, water/cement ratio, and slump shall be that of the Class specified. Different classes of concrete shall not be mixed in the same continuous placement.

When Class M concrete is specified, the Contractor may use any commercially produced concrete

mix or an approved Class A, S, S(AE), or paving concrete under Section 501. Unless otherwise specified, bagged commercial concrete mix may not be used for Class M concrete. For acceptance purposes, the minimum strength, maximum water/cement ratio, and maximum slump shall be that specified for Class A concrete. For small placements (approximately 1 cubic yard m [1 cu m] or less), the concrete may be mixed on site using a portable mixer. The size of each batch shall not exceed 80% of the manufacturer's rated capacity of the mixer. When mixing on site, and with the prior approval of the Engineer, the materials for each batch may be measured by volume by converting the mix design weights of each material to equivalent volumes.

802.05 Mix Design. (a)General. The concrete mixture shall be proportioned to ensure a workable and durable concrete for the various classes, as specified in Table 802-1.

The Engineer will not perform any pre-bid testing of materials. It will be the Contractor's responsibility to locate acceptable material sources unless the sources are so noted in the plans or Special Provisions.

(b) Mix Design by the Contractor. The proportions to be used in the mix for each class shall be determined by the Contractor using the absolute volume method. The Contractor may use the procedure provided in the ACI Standard 211.1 or Portland Cement Association "Design and Control of Concrete Mixtures", modified to comply with the minimum cement content and maximum water/cement ratio specified for the class of concrete. Prior to the start of production of the concrete mixture, the Contractor shall submit test results and/or certifications for all materials and detailed mix design data to the Engineer for review. Aggregate, fly ash, and slag cement material properties used in the mix design shall be representative of the exact materials proposed for use. The testing source (commercial laboratory, qualified technician, AHTD provided data, etc.) and the date of the test shall be provided. The specific plant sources for the cement, fly ash or slag cement, and aggregates shall be shown on the mix design. The documentation submitted with the mix design shall specify which procedure was used and whether oven dry or saturated surface dry weights were used in the calculations. The mix design shall specify the quantity of each component of the mix, including all authorized additives. Acceptance of the mix design by the Engineer will be based on apparent conformity to the requirements shown in Table 802-1. If the mix design fails to produce acceptable results or if there is a change in the aggregates, fly ash, or cement being used, a new mix design will be required. It shall remain the Contractor's responsibility during production to produce concrete conforming to the mix design and the minimum acceptance criteria specified. When requested by the Engineer, the Contractor shall submit samples of all materials for verification testing. Production shall not begin until the mix design is accepted by the Engineer.

A mix design submitted for acceptance need not be prepared specifically for this project, but may be a previously accepted design that uses the same materials and meets the same design criteria.

Mix designs accepted under this section will become the property of the Department and may be accepted for use on other projects, by other contractors, or by the Department.

(c) Trial Batches. Mix designs proposed by the Contractor for all Class S(AE) and Class B concretes

shall be tested by trial batches using the specific materials, including admixtures that are intended for use on the job. The Contractor shall prepare a plant batch of at least 2 cubic yards (1.5 cu m) or one-third the rated capacity of the mixer, whichever is greater. In lieu of the plant batch, the Contractor may prepare trial batches in a laboratory according to AASHTO T 126. These trial batches shall be accomplished by the Contractor under the observation of the Engineer. Sampling and testing will be conducted by the Engineer. These batches shall be sampled and tested for compliance with the specifications for slump, air content, and compressive strength.

(d) TABLE 802-1

	Class of Concrete				
Characteristic	**A**	**B**	**S**	**S(AE)**	**Seal**
Minimum Compressive Strength (psi [MPa] at 28 days)	2100 [15.0]	3000 [21.0]	3500 [24.0]**	4000 [28.0]**	2100 [15.0]
Minimum Cement Factor (bags per cubic yard) [kg/cu m]	5.5 [307]	*	6.5 [362]	6.5 [362]	6.0 [335]
Maximum Water/Cement Ratio (gal. per bag) [kg/kg]	6.5 [0.58]	*	5.5 [0.49]	5.0 [0.44]	6.5 [0.58]
Slump Range (inches) [mm]	1"-4" [25-100]	1"-4" [25-100]	1"-4" [25-100]	1"-4" [25-100]	4"-8" [100-200]
Air Content Range (%)	--	--	--	6 ± 2	--

* As determined by trial batch. Maximum water-cement ratio is 0.49. In addition, Class B shall obtain 3500 psi (24.0 MPa) compressive strength in the trial batch at 90 days.

** Class S or S(AE) concrete for use in prestressed concrete members shall have a minimum compressive strength of 5000 psi (35.0 MPa) at 28 days unless otherwise shown on the plans. The maximum size of coarse aggregate shall be 1" (25 mm).

In lieu of the above procedure, the Contractor may retain an approved independent laboratory or a Registered Professional Engineer to prepare and test trial batches. In this case, trial batch information and laboratory results shall be furnished to the Engineer along with a statement certifying that the testing was performed according to the specifications.

For Class S(AE) concrete the air-entrainment shall be accomplished by adding to the mixing water the proper amount of air-entraining agent in solution. The Contractor shall determine the amount of admixture required to produce air content within the range specified. The amount of air entraining agent shall be adjusted by the Contractor during production as necessary to keep the air content within the range specified. A mix design may be approved with respect to compressive strength when at least two test cylinders show the minimum required strength value at any age between 7 days and 28 days, inclusive.

For Class B concrete, the mix design shall produce a workable and durable concrete meeting the minimum strength requirements specified in Table 802-1 and shall have a low heat of hydration when placed in large quantities. Fly ash conforming to AASHTO M295 may be substituted for a part of the Type II (MH) Cement not to exceed 120 pounds per cubic yard (70 kg/cu m) of concrete, and shall be included in the calculation of the water/cement ratio. Ninety-day test specimens will be required for Class B trial batches. For construction purposes, the sampling and testing will comply with standard procedures for sampling and testing.

All trial batches required by these specifications or developed at the option of the Contractor shall be accomplished by the Contractor and shall be subject to the review and approval of the Engineer.

Concrete from the trial batch may be used in miscellaneous construction subject to the approval of the Engineer and further provided that the minimum compressive strength specified for the construction in which the concrete is used is attained. If the required compressive strength is not attained, the Contractor shall remove the concrete and replace it with acceptable concrete at no cost to the Department.

(d) Fly Ash. Fly ash may be used as a partial replacement for Type I cement, not exceeding 20% by weight, in all classes of concrete except Class B. Substitution shall be made at the rate of one pound (kilogram) of fly ash for each pound (kilogram) of cement replaced. The water/cement ratio shall be calculated using the total weight of both cement and fly ash. Fly ash in Class B concrete shall meet the requirements specified in Subsection 802.05(c). Mixtures with fly ash shall meet the same requirements as mixtures without fly ash. Fly ash will not be allowed as a substitute for high early strength or blended cements. Class F fly ash shall not be used in bridge deck concrete placed between October 15 and April 1. When fly ash is used, the total weight of both cement and fly ash will be used in design calculations.

When the Contractor elects to use fly ash as a partial replacement for the cement in Class S or Class S(AE) concrete, the proposed mix design shall be tested by the preparation and testing of trial batches according to Subsection 802.05(c). Trial batches will not be required for Class A concrete.

(e) Slag Cement. Slag cement may be used as a partial replacement, not exceeding 25% by weight, for Type I cement, in all classes of concrete except high early strength and seal. Substitution shall be made at the rate of one pound (kilogram) of slag cement for each pound (kilogram) of cement replaced. slag cement will not be allowed with high early strength or blended cements.

When the Contractor elects to use slag cement as a partial replacement for the cement in Class S or Class S(AE) concrete, the proposed mix design shall be tested using trial batches according to 802.05(c). Trial batches will not be required for Class A concrete.

802.06 Quality Control, Acceptance, and Adjustments in Payments. (a) Quality Control by the Contractor. The Contractor shall be responsible for quality control of materials during handling, blending, mixing, transporting, and placement operations, and for necessary adjustments in proportioning of materials used to produce the specified concrete.

The Contractor shall be responsible for determining gradation and moisture content of fine and coarse aggregates used in the concrete mixture and for testing the mixture for air content, slump, and compressive strength. The Contractor shall determine the specific locations for samples and frequency of sampling for quality control, except the minimum frequency which is listed below for aggregate gradation shall be used. In addition, the Contractor shall be required to perform acceptance sampling and testing at specific times and/or locations specified by the Engineer according to Subsection 802.06(b).

Test procedures shall be:

Coarse and Fine Aggregates	AASHTO T 27 (gradation)* AASHTO T 255 (moisture)
Air Content	AASHTO T 152
Slump	AASHTO T 119
Compressive Strength**	AASHTO T 22 (Test specimens for compressive strength determined by cylinders will be obtained according to AASHTO T 23.

*1 test per 500 cubic yards (400 cubic meters) of mix (minimum), sampled from the stockpile. A minimum of one set of tests per bridge structure will be required.

**A minimum of two (2) cylinders shall be cast and tested. Results will be based upon the average result from the two cylinders.

An adequate supply of aggregate must be stockpiled to allow representative sampling in advance of any placement, with the minimum amount being that required to complete the day's planned placement. The initial quality control test results for gradation must be completed and the test results submitted to the Engineer prior to the beginning of mix production of each class of concrete. Subsequent tests shall be taken and tested during production, and the test reports submitted to the

Engineer by the end of the next business day after the sample is taken. Any failing gradation test result will result in halting production. The aggregate remaining in the stockpile will be resampled and tested by the Contractor and the Engineer. If the test results indicate that the aggregate is outside of the specification limits in Subsection 802.02, the stockpile shall either be corrected or replaced. Passing test reports must be submitted to the Engineer before work resumes.

The Contractor shall furnish all personnel, equipment, and facilities necessary to perform the required sampling and testing. The Contractor's facilities shall be separate from any Field Laboratory and/or Field Office furnished to the Department under the Contract. Quality control sampling and testing by the Contractor shall be performed in a qualified laboratory by a certified technician.

Requirements for technician certification and laboratory qualification are contained in the Department's *Manual of Field Sampling and Testing Procedures*. The Contractor shall maintain records of all samples taken and the results of all tests performed. Test reports shall be signed and copies made available to the Engineer if requested.

The Contractor shall certify to the Engineer that the calibration of the concrete cylinder compression testing machine has been verified. This verification shall be performed in accordance with AASHTO T 22 and T 67 under any of the following conditions and documented in accordance with AASHTO T 67:

1. After an elapsed interval of 18 months (maximum) since the previous calibration.
2. After original installation of the machine or following relocation of the machine.
3. Immediately after repairs or adjustments.
4. Whenever there is a reason to doubt the accuracy of the results, without regard to the time interval since the last verification.

If the Contractor desires additional compressive strength tests to be used for scheduling purposes or to determine the time for stripping forms or loading the structure, such tests will be performed by the Contractor at no cost to the Department.

The Contractor shall provide an opportunity for the Engineer to observe all quality control sampling and testing procedures. The Contractor shall split samples with the Department when requested. The Contractor shall be required to make changes to the equipment and/or procedures if this testing or additional testing by the Department does not verify the Contractor's test results.

When individual gradation, slump, or air content measurements fall outside tolerance limits, the Contractor shall immediately make adjustments to bring the mixture within specified limits. If the Contractor fails to make proper adjustments, or if the mix is obviously defective, operations shall cease. Operations shall not resume until proper adjustments have been made.

(b) Acceptance Testing. Acceptance sampling and testing by the Contractor will be based upon lots. The lot sizes shall be determined as follows:

Slump, Air Content, and Compressive Strength: The standard lot size for acceptance of slump, air content, and compressive strength of concrete will be 400 cubic yards (300 cubic meters) of mix, with each standard lot divided into four sublots of 100 cubic yards (75 cubic meters). In addition, for Class S(AE) concrete the maximum sublot size will be 100 cubic yards (75 cubic meters) or one deck pour, whichever is less. Partial lots, of any size, may be established by the Engineer at any time. A minimum of one set of tests per bridge structure will be required. The minimum frequency for acceptance of slump, air content, and compressive strength by the Contractor shall be one set of tests for each sublot of each class of concrete. The Contractor shall obtain and test one sample taken at random from each sublot. All samples of the mixture to be tested for air content, slump, and compressive strength shall be taken from one location. The Department will determine the location for each sample in the sublot by AHTD Test Method 465.

Test methods for acceptance shall be the same as specified for quality control testing. Acceptance sampling and testing by the Contractor shall be performed in a qualified laboratory by a certified technician. Requirements for technician certification and laboratory qualification are contained in the Department's *Manual of Field Sampling and Testing Procedures*. The Contractor shall provide an opportunity for the Engineer to observe all acceptance sampling and testing procedures.

The Contractor's acceptance sampling and testing procedures, equipment, and results will be subject to independent assurance sampling and testing conducted by the Department. Independent assurance sampling and testing will be conducted at the frequencies indicated in the Department's *Manual of Field Sampling and Testing Procedures*. The Contractor shall be required to make changes to the equipment and/or procedures used if the results of the independent assurance tests do not correlate with the Contractor's test results.

Acceptance sampling and testing shall be accomplished in a timely manner. The Contractor shall maintain records of all samples taken and the results of all tests performed. Signed copies of these records shall be furnished to the Engineer for inclusion in the project files within one business day of the day that the tests are performed. The item of work being tested shall not be considered complete or accepted until test reports for all materials are submitted to the Engineer.

The Department will obtain and test a minimum of one sample taken at random from each lot, including partial lots, to be used both for verification and for acceptance. The location of the lot sample will be determined by AHTD Test Method 465. Verification testing for compressive strength will be by casting and testing cylinders and/or drilling and testing cores. Verification testing will be conducted in accordance with Subsection 106.11 and the *Manual of Field Sampling and Testing Procedures.*

The Department will perform all testing required for water, cement, fly ash, soundness and Los Angeles wear of aggregates.

(c) Acceptance and Adjustments in Payments. Acceptance and adjustment in payments will be by lot. Acceptance of a standard lot will be based on the average results of the tests performed on the lot. The average result will include the sublot results of tests performed by the Contractor and the

results of the test performed by the Department.

In the event that the compressive strengths of the test specimens in a sublot are below the specified value in Table 802-1, the Department will conduct an investigation to determine the structural adequacy of the concrete. If this investigation determines that the concrete in question is acceptable, then price adjustments will be calculated according to Table 802-2. Table 802-2 lists test properties for acceptance, price reduction, and rejection limits.

When test results for a lot fall within the limits shown in Table 802-2 as "Compliance Limits", the concrete shall be accepted with no price reduction. If test results for a lot for any single property falls within the limits shown as "Price Reduction Limits", the failing material may be left in place at a reduced price. If test results for a lot for any single property falls within the limits shown as "Rejection Limits", the failing material shall be removed and replaced at no cost to the Department. The percent the bid price shall be reduced for a lot not meeting the "Compliance Limits" for both Air Content and Compressive Strength will be determined by adding the price reduction percentages contained in Table 802-2. In the sublot containing the Department's lot test, if the result of either the Contractor's sublot test or the Department's lot test falls outside the "Compliance Limits", the two tests will be averaged and the average will be used to determine acceptance or rejection.

At the Contractor's option, additional testing for confirming price reductions or rejection due to compressive strength results may be performed by the Contractor at locations determined by the Department. In such cases three cores shall be taken in each sublot containing compressive strength results not in "Compliance Limits". The compressive strength shall be determined by the average result of the cores. Cores shall be taken according to AASHTO T 24. The average of the three cores must meet or exceed applicable price reduction limits or rejection limits. Acceptance and pay adjustments will then be determined based on these results.

When two consecutive lots or any three out of five consecutive lots fail to qualify for full payment, work will be stopped until corrective action is taken.

Continuous production of concrete not qualifying for full payment will not be allowed.

(d) Incentives. If the Contractor elects, on bridges over 150' (50 m) in length, an incentive payment for exceptional smoothness will be included in the pay schedule for Class S(AE) concrete if:

- the bridge deck smoothness criteria below are met, and
- no corrective grinding is required to achieve the incentive profile index values.

The Contractor shall furnish a California-style profilograph complying with ASTM E 1274 or an automated lightweight profilometer complying with ASTM E 950, Class 1 and calibrated to the California-style profilograph scale and take a profile near the center of all continuous traffic lanes, including auxiliary lanes and ramps. The Engineer will verify the calibration of the profilograph as frequently as necessary to assure proper operation. In order to position the profilograph, the profile

record may exclude 12.5' (4 m) of the deck at each end of the bridge if using a California-style profilograph. If using an automated lightweight profilometer, the profile record shall start and stop at the ends of the bridges at the joints. A blanking band of ±0.1" (±2.5 mm) will be used in the determination of the profile index Contract unit price adjustments will be made according to the following schedule:

PROFILE INDEX		PRICE ADJUSTMENT (% of payment for calculated volume of Class S(AE))
inches per mile per bridge	**mm per km per bridge**	
Less than 3"	Less than 50	1.05
> 3" ≤ 6"	> 50 ≤ 100	1.04
> 6" ≤ 9"	> 100 ≤ 150	1.03
> 9" ≤ 12"	> 150 ≤ 200	1.02
> 12" ≤ 15"	> 200 ≤ 250	1.01
> 15"	> 250	No incentive payment

The additional payment will be applied to the concrete in the bridge deck only. The calculation for the volume of concrete in cubic yards (cubic meters) will be based on the bridge length, bridge clear roadway width between parapets, and 7½" (190 mm) of deck thickness. The surface profile for payment will be based on the average profiles for all traffic lanes.

The Contractor shall take all profiles required by this subsection, under the observation of the Engineer. All data obtained from the profiling operations will be furnished to the Engineer at the completion of the project. The incentive payment will be determined at the completion of the project and when all profile traces have been submitted to the Engineer for the project files.

802.07 Measurement of Materials. Materials will be measured by weighing, except as otherwise specified or where other methods are specifically authorized by the Engineer. Aggregates shall be measured separately and accurately by weight. Measuring devices shall be operated in a manner that will consistently weigh the cement within ±1% and the individual aggregates within ±2% of the required weight. Measuring devices shall be so designed and plainly marked that the weights can be accurately and conveniently verified for the quantities of each component actually being used.

Cement in standard packages (sack) need not be weighed, but bulk cement shall be weighed. The mixing water shall be measured by weight or by volume.
The water measuring device shall be accurate to within ±1%.

Scales shall be satisfactory to the Engineer and shall be inspected, adjusted, and certified according to Subsection 109.01(f), except that automatic ticket printers and automatic weighing systems will

not be required.

Where volumetric measurements are authorized by the Engineer for projects where the amount of concrete is small, the weight proportions shall be converted to equivalent volumetric proportions. In such cases, suitable allowance shall be made for variations in the moisture condition of the aggregate, including the bulking effect in the fine aggregate.

Representative samples shall be taken and the moisture content determined for each kind of aggregate. When the aggregates contain more water than the quantity necessary to produce a saturated surface-dry condition, the batch weights for aggregates and water shall be adjusted accordingly.

802.08 Mixing Concrete. Concrete shall be thoroughly mixed in a mixer of an approved size and type that will ensure a uniform distribution of the materials throughout the mass.

The concrete shall be mixed only in the quantity required for immediate use. Concrete that has developed an initial set shall not be used. Re-tempering concrete will not be permitted.

Concrete may be proportioned and mixed in a stationary central plant and hauled to the point of delivery in agitator trucks of approved type or in non-agitating equipment when approved by the Engineer; proportioned in a stationary central plant and mixed in approved transit mix trucks enroute to the point of delivery; or mixed completely in transit mix trucks at the point of delivery, following the addition of mixing water.

The Engineer shall be furnished the manufacturer's rated capacity of each mixer and agitator, along with the recommended speed of rotation for the various uses of each mixer. Truck mixers and agitators shall be equipped with means by which the number of revolutions of the drum, blades, or paddles may be readily verified.

Mixers and agitators shall not be charged in excess of the manufacturer's rated capacity. Concrete shall be delivered and discharged from the truck mixer or agitator into the forms within 1½ hours after the introduction of the mixing water to the cement. In hot weather, or under other conditions contributing to quick setting of the concrete, the maximum allowable time may be reduced by the Engineer. Each batch shall be accompanied by a time slip issued at the batch plant.

Plants and transit mix trucks shall be equipped with adequate water storage and a device for accurately measuring and controlling the amount of water used in each batch. When a stationary mixer is used, a mechanical means shall be provided for automatically preventing the discharge of the mixer until the materials have been mixed for a period of not less than one minute.

Truck mixers shall be capable of combining the ingredients of the concrete into a thoroughly mixed and uniform mass, and of discharging the concrete within the specified range of consistency. The concrete shall be mixed not less than 70 nor more than 100 revolutions of the drum or blades at the rate of rotation specified by the manufacturer as the mixing speed. The pick-up and throw-over blades in the drum of all mixers shall be maintained in satisfactory condition to assure thoroughly mixed concrete.

Agitators shall be capable of maintaining the concrete in a thoroughly mixed and uniform mass and of discharging the concrete within the specified range of consistency.

When approved in writing by the Engineer, concrete may be transported in approved non-agitating equipment. Bodies of this equipment shall be smooth, watertight, metal containers equipped with gates that will permit control of the discharge of the concrete. Covers shall be provided for protection against the weather. The concrete shall be delivered in a thoroughly mixed and uniform mass and discharged within the specified range of consistency. Placement in forms shall be completed within 30 minutes after introduction of the mixing water to the cement.

Concrete shall be mixed according to the mixer manufacturer's specifications in order to obtain an acceptable mass of concrete. During the period of mixing, the mixer shall operate at the manufacturer's recommended mixing speed. Additional mixing, if any, shall be at the speed designated by the manufacturer of the equipment as agitating speed.

If additional mixing water is required to maintain the specified slump, and is added with the permission of the Engineer, approximately 20 revolutions of the mixer drum at mixing speed shall be required before discharge of any concrete.

TABLE 802-2
COMPLIANCE, PRICE REDUCTION, & REJECTION LIMITS FOR CONCRETE STRUCTURES

Property	Compliance Limits	Price Reduction Limits	Price Reduction	Lot Rejection Limits	Sublot Rejection Limits
Air Content	4% - 8%	3.5%-3.9% and 8.1%-8.4% 3.0%-3.4% and 8.5%-9.0%	10% 20%	less than 3.0% and greater than 9.0%	less than 2.0% or greater than 10.0%
Compressive Strength	≥ f'_c	95% f'_c or greater 90% f'_c or greater but less than 95% f'_c 85% f'_c or greater but less than 90% f'_c	10% 20% 30%	Less than 85% f'_c	Less than 75% f'_c

f'_c is the minimum specified compressive strength in Table 802-1 for the particular class of concrete.

When a quality control sample for air content, taken within the allowable time limits for discharge of the concrete and prior to discharge for placement, shows an air content below the specified level by more than the allowable tolerance shown in Table 802-2, the Contractor may use additional air-entraining admixture to achieve the desired air content. The air-entraining agent and water shall be mixed in a separate container, and the mixed solution added to the truck mixer and mixed for a minimum of 30 revolutions at the mixing speed. A second air content test shall then be taken to determine if the air content is now within the allowable limits.

The entire contents of the mixer, including wash water, shall be removed from the drum before the addition of materials for a succeeding batch.

There shall be sufficient capacity and transporting equipment to ensure continuous concrete delivery at the rate required.

If the concrete furnished produces erratic results relative to consistency, strength, or time of initial or final set, the Contractor shall cease the use of that concrete until corrections are made to ensure work of the specified quality.

802.09 Handling and Placing Concrete. (a) General. The Contractor shall provide sufficient supervision, manpower, equipment, tools, and materials and shall assure proper production, delivery, placement, and finishing of the concrete for each placement according to the specifications. Unless otherwise specified, concrete shall be placed continuously between authorized construction and/or expansion joints, subject to the time limits and placement rates specified below.

The time interval between batches of concrete shall not exceed 20 minutes. Unless otherwise specified, the minimum placement rate shall be 20 cubic yards per hour (15 cu m/h).

Any placement that does not produce results that conform to the specifications shall be repaired or replaced, as required, at no cost to the Department. Further placements of a similar nature and size will not be permitted until corrective measures have been taken to assure compliance with the specifications.

The minimum placement rate shall not apply to concrete other than bridges, box culverts, and retaining walls, but the interval between batches shall not exceed 20 minutes. In preparation for the placing of concrete, construction debris and extraneous matter shall be removed from the interior of forms. Struts, stays, and braces, serving temporarily to hold the forms in correct shape and alignment pending the placing of concrete, shall be removed when the concrete placement has reached an elevation rendering their service unnecessary.

(1) Conveying. Concrete shall be placed to avoid segregation of the materials and the displacement of the reinforcement. The use of long troughs, chutes, and pipes for conveying the concrete to the forms will be permitted only when authorized by the Engineer. In case an inferior quality of concrete is produced by the use of such

conveyors, the Contractor shall, without notice from the Engineer, cease the use of that conveyor until such corrections in procedure are made to ensure work of the quality specified.

Open troughs and chutes shall be of metal or metal lined. Where steep slopes are required, the chutes shall be equipped with baffles or be in short lengths that reverse the direction of movement. Aluminum chutes, troughs, and pipes shall not be used for depositing concrete.

Chutes, troughs, and pipes shall be kept clean and free from coatings of hardened concrete by thoroughly flushing with water after each run. Water used for flushing shall be discharged clear of the structure.

When placing operations involve dropping the concrete more than 5' (1.5 m), it shall be deposited through approved pipes. Walls of 10" (250 mm) thickness or less may be placed without the use of pipes, provided the concrete can be placed without segregation.

(2) Placing. Concrete shall be placed in horizontal layers not more than 18" (0.5 m) thick except as hereinafter provided. When less than a complete layer is placed, it shall be terminated in a vertical bulkhead. Each layer shall be placed and consolidated before the preceding batch has taken initial set to prevent injury to the concrete and avoid surfaces of separation between the batches. Each layer shall be consolidated so as to avoid the formation of a construction joint with a preceding layer that has not taken initial set.

Concrete in footings shall be placed in the dry unless natural conditions prohibit. In that case, concrete shall be placed according to Subsections 801.05 and/or 801.06, as appropriate. In order to separate water from the concrete, it will be permissible to utilize polyethylene sheeting or tarpaulins to maintain a physical barrier between the water and the concrete.

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 to a sufficient depth to expose sound concrete. To avoid visible joints as far as possible upon exposed faces, the top surface of the concrete adjacent to the forms shall be smoothed with a trowel. Where a "feather edge" might be produced at a construction joint, an inset form shall be used to produce an edge thickness of not less than 6" (150 mm).

Immediately following the discontinuance of placing concrete, accumulations of mortar splashed upon the reinforcing steel and the surfaces of forms should be removed. Dried mortar chips and dust shall not be puddled into the concrete. If the accumulations are not removed prior to the concrete becoming set, care shall be exercised not to damage or break the concrete-steel bond at or near the surface of the concrete while cleaning reinforcing steel.

After initial set of the concrete, the forms shall not be jarred and no strain shall be placed on the ends of projecting reinforcing bars.

(3) Consolidating. All concrete, except seal concrete, during and immediately after depositing shall be thoroughly consolidated. This shall be accomplished by mechanical vibration subject to the

following provisions:

a. The vibration shall be internal unless special authorization of other methods is given by the Engineer.

b. Vibrators shall be of a type and design approved by the Engineer. They shall be capable of transmitting vibration to the concrete at rated frequencies of not less than 4500 impulses per minute.

c. The intensity of vibration shall be such as to visibly affect a mass of concrete over a radius of at least 18" (0.5 m).

d. The Contractor shall provide a sufficient number of vibrators to properly compact each batch immediately after it is placed in the forms and shall have in reserve at all times sufficient vibratory equipment to guard against shut down of the work because of the failure of the equipment in operation.

e. Vibrators shall be manipulated to thoroughly work the concrete around the reinforcement and embedded fixtures and into the corners and angles of the forms.

Vibration shall be applied at the point of deposit and in the area of freshly deposited concrete. The vibrators shall be inserted and withdrawn out of the concrete slowly. The vibration shall be of sufficient duration and intensity to thoroughly consolidate the concrete but shall not be continued so as to cause segregation. Vibration shall not be continued at any one point to the extent that localized areas of grout are formed.

Application of vibrators shall be at points uniformly spaced and not farther apart than twice the radius over which the vibration is visibly effective.

f. Vibration shall not be applied directly or through the reinforcement to sections or layers of concrete that have hardened to the degree that the concrete ceases to be plastic under vibration. It shall not be used to make concrete flow in the forms over distances so great as to cause segregation, and vibrators shall not be used to transport concrete in the forms. When epoxy coated reinforcing steel is used, the provisions of Subsection 804.05 relative to vibrators shall apply.

g. Vibration shall be supplemented by such spading as is necessary to ensure smooth surfaces and dense concrete along form surfaces and in corners and locations impossible to reach with the vibrators.

h. These provisions shall apply to precast products except that, if approved by the Engineer, the manufacturer's methods of vibration may be used.

(b) Box Culverts. Concrete in walls and top slabs shall not be

placed less than 24 hours after the concrete in previous placements has set.

Provision shall be made for bonding the walls to the bottom slab or footing and the top slab to the walls by means of roughened longitudinal keys. Before concrete is placed in the walls or top slabs, the bottom slab, footing, or walls shall be thoroughly cleaned of extraneous material and the surface bond prepared according to Subsection 802.12. No horizontal construction joints will be allowed in any wall of a box culvert unless provided on the plans or approved by the Engineer. In the construction of box culverts 6' (1.8 m) or less in height, the walls and top slab may be constructed as a monolith.

(c) Bridge Substructures. Concrete in columns shall not be placed less than 24 hours after the concrete in footings has been placed, and shall be placed in one continuous operation, unless otherwise directed. The concrete in the columns shall be allowed to set at least 24 hours before the caps are placed. When friction collars or column dowels are used to support cap forms, the concrete for the columns shall have a minimum compressive strength of 3500 psi (24.0 MPa) before the concrete is placed for the cap.

Unless otherwise permitted by the Engineer, no concrete shall be placed in the superstructure until the column forms have been stripped sufficiently to determine the character of the concrete in the columns.

With proper handling to avoid damage to the concrete, and at the option of the Contractor, structural steel may be erected 48 hours after completion of the caps. Depositing of concrete in the deck or placing of precast concrete girders or deck units that will place dead load on the cap will not be permitted until the cap has been in place at least 7 days and has attained the minimum specified compressive strength.

(d) Bridge Superstructures. For concrete in bridge deck slabs, when a longitudinal concrete strike-off is used, the rate of placement and consolidation shall be adequate to assure that no concrete will take its initial set before the entire placement is complete. Sufficient concrete shall be placed ahead of the strike-off to fully load the beam or girder prior to strike-off. When a transverse concrete strike-off is used, the rate of placement and consolidation shall be adequate to assure that no concrete will take its initial set closer than 100' (30 m) behind the strike-off. Compliance with these requirements may require the use of a retarding agent.

Concrete shall be deposited in a manner that will ensure uniform loading of the span. For continuous spans, the concrete placing sequence shall be shown on the plans. Concrete in slab spans shall be placed in one continuous operation for each span unless otherwise provided.

Concrete in girders shall be deposited uniformly for the full length of the girder and brought up evenly in horizontal layers. Concrete in girder haunches less than 3' (1 m) in height shall be placed at the same time as that in the girder stem, and the columns or abutment tops shall be cut back to form seats for the haunches. Whenever any haunch or fillet has a vertical height of 3' (1 m) or more, the abutment or columns, the haunch, and the girder shall be placed in three successive

stages; first, up to the lower side of the haunch; second, to the lower side of the girder; and third, to completion.

For haunched continuous girders, the girder stem (including haunch) shall be placed to the top of stem. Where the size of the member is such that it cannot be made in one placement, vertical construction joints shall preferably be located within the area of contraflexure.

Concrete in deck girder spans shall be placed in one continuous operation.

Concrete in parapet or barrier walls, curbs, and sidewalks that are not placed monolithically with the deck slab shall not be placed less than 72 hours after the concrete for the deck slab of the entire simple span or the entire continuous unit has been placed, except when stage construction is specified. When stage construction is specified, the concrete in parapet or barrier walls, curbs, and sidewalks that are not placed monolithically with the deck shall not be placed less than 72 hours after the concrete for the portion of the deck slab required under that stage has been placed for the entire simple span or the entire continuous unit.

(e) Concrete Placement Intervals. Use of the minimum time intervals and compressive strengths provided above relative to expediting subsequent concrete placements shall in no way relieve the Contractor of the responsibility for attaining the minimum compressive strengths for the class of concrete specified.

802.10 Pumping. Concrete may be placed by pumping. The equipment for pumping shall be arranged and operated so that no vibrations result that might damage freshly placed concrete. Where concrete is conveyed and placed by mechanically applied pressure, the equipment shall be adequate in capacity for the work. The operation of the pump shall be such that a continuous stream of concrete without air pockets is produced. When pumping is completed, the concrete remaining in the pipe, if it is to be used, shall be ejected in such a manner that there will be no contamination of the concrete or separation of the ingredients.

Samples of concrete for slump and air content tests will be obtained at the discharge end of the pipe.

The use of aluminum pipe as a conveyance for the concrete will not be permitted.

802.11 Depositing Concrete Under Water. Concrete shall not be deposited in water except when shown on the plans or with the approval of the Engineer. Concrete deposited in water shall be Seal Concrete.

The supply of concrete shall be maintained at the rate necessary to raise the elevation over the entire seal by a minimum of 1' (0.3 m) per hour or an approved retarder shall be used as necessary for lesser placement rates.

For parts of structures under water, seal concrete shall be placed continuously from start to finish. The surface of the concrete shall be

kept as nearly horizontal as practicable. The Contractor shall provide equipment and personnel to sound the top of the seal in the presence of the Inspector in order to verify the location of the seal at all times. Previously placed seal concrete shall not have taken its initial set prior to the placement of adjacent concrete.

Concrete shall be carefully placed by means of a tremie or other approved method. Still water shall be maintained at the point of deposit. Concrete shall be deposited in such a manner that the planned horizontal concrete flow shall be no more than 15' (4.5 m). This shall be accomplished by locating the points of deposit in such a manner as to provide for a maximum flow distance of 15' (4.5 m).

A tremie shall consist of a tube having a diameter of not less than 10" (250 mm), constructed in sections having flanged couplings fitted with gaskets and an approved foot valve. The tremie shall be supported so as to permit rapid lowering when necessary to retard or stop the flow of concrete. The discharge end shall be closed at the start of the work so as to prevent water entering the tube and shall be entirely sealed. The tremie tube shall be kept sufficiently full to prevent the loss of the concrete seal. When a batch is dumped into the tube, the flow of concrete shall be induced by slightly raising the discharged end, always keeping it in the deposited concrete. If at any time the seal is lost, the tremie shall be raised, the discharge end closed for a new start, and then lowered into position with the discharge end in the previously deposited concrete. Aluminum tremies will not be permitted.

Dewatering may proceed when the seal concrete has been allowed to cure for a minimum of 72 hours at a water temperature above 45° F (7° C). All laitance or other unsatisfactory materials shall be removed from the exposed surfaces that are to support other structural loads.

Prior to the placement, the Contractor shall advise the Engineer of his methods for complying with these requirements.

802.12 Construction Joints. (a) General. Construction joints shall be made only where located on plans or shown in the placement schedule, unless otherwise approved by the Engineer.

Before depositing new concrete on or against concrete that has hardened, the forms shall be re-tightened.

The placing of concrete shall be carried continuously from joint to joint. The face edges of all joints that are exposed to view shall be carefully finished true to line and elevation.

If not detailed on the plans, or in the case of emergency, construction joints shall be placed as directed by the Engineer. Shear keys or inclined reinforcement shall be used where necessary to transmit shear or bond the two sections together. When shear keys or inclined reinforcement is not provided, the concrete shall be roughened as directed.

(b) Bonding. The surface of the hardened concrete shall be roughened in a manner that will not leave loosened particles of aggregates or damaged concrete at the surface. It shall be thoroughly

cleaned of foreign matter and laitance and saturated with water.

802.13 Falsework. Details for each unit of falsework construction for bridge span and overhang support systems, complete with dimensions and kind and condition of materials, shall be submitted to the Engineer prior to construction for informational and record purposes. These details shall be approved by a Registered Professional Engineer, who shall certify that the adequacy of all components has been verified. File copies of all design calculations shall be maintained by the Contractor until final acceptance of the project. Construction of the falsework shall be according to the details submitted to the Engineer for informational purposes. The Contractor shall be responsible for the results obtained by the use of the falsework design.

For designing falsework, a weight of 150 pounds per cubic foot (2400 kg/cu m) shall be assumed for fresh concrete. All falsework shall be designed and constructed to provide the necessary rigidity and to support the loads without appreciable settlement or deformation. Falsework shall be set to give the finished structure the camber specified.

Falsework that cannot be founded on a satisfactory footing shall be supported on piling which shall be spaced, driven, and removed as specified in the Contractor's falsework details.

The use of transverse welds greater than 1″ (25 mm) in length used for attachment of hanger brackets, nut plates, or other falsework support devices to the structural steel shall be approved by the Bridge Engineer prior to construction. The use of welds for attaching screed rail supports larger than 1″ (25 mm) diameter to the top flange of the structural steel shall be approved by the Bridge Engineer prior to construction.

All temporary field welds on structural steel shall be performed by a certified welder using low-hydrogen electrodes in accordance with Subsection 807.26 and the ANSI/AASHTO/AWS D1.5, Bridge Welding Code. Unless otherwise permitted by the Engineer, temporary welds shall be removed by grinding the weld flush.

802.14 Forms. (a) Standard Forms. Forms shall be mortar- tight and of sufficient rigidity to prevent distortion due to the pressure of the concrete and other loads incident to the construction operations. Forms shall be constructed and maintained so as to prevent warping and the opening of joints due to shrinkage of the lumber.

The forms shall be substantial and unyielding and shall be so designed that the finished concrete will conform to the proper dimensions and contours. The design of the forms shall take into account the effect of vibration of concrete as it is placed. Forms for exposed surfaces shall be made of dressed lumber or plywood of uniform thickness, steel, or other approved materials that will provide a smooth surface, and shall be mortar-tight. Forms shall have 3/4” (20 mm) fillet at all sharp corners unless otherwise directed. In the case of projections, such as girders and copings, forms shall be given a bevel or draft to ensure easy removal.

Metal snap-ties within the forms shall be so constructed as to permit their removal to a depth of at least 1" (25 mm) from the face

of the concrete. Fittings for metal snap-ties shall be of such design that, upon removal, the cavities that are left will be of the smallest possible size.

Metal inserts or anchorages within the forms shall be so constructed as to permit their removal to a depth of at least 1" (25 mm) from the face of the concrete or be covered by being embedded a minimum of 1" (25 mm) in the concrete. In case ordinary wire ties are permitted, all wires, upon removal of the forms, shall be cut back at least 1/4" (6 mm) from the face of the concrete.

All cavities shall be filled with cement mortar and the surface left sound, smooth, even, and uniform in color.

Forms shall be set and maintained true to the line designated until the concrete is sufficiently hardened. Before depositing new concrete on or against concrete that has hardened, the forms shall be re-tightened. Forms shall remain in place for the periods specified in Subsection 802.15. When forms appear to be unsatisfactory in any way, either before or during the placing of concrete, the Engineer shall order the work stopped until the defects have been corrected.

The shape, strength, rigidity, watertightness, and surface smoothness of re-used forms shall be maintained at all times. Any warped or bulged lumber must be re-sized before being re-used.

For narrow walls and columns, where the bottom of the module is inaccessible, the lower portions of the forms shall be so constructed as to facilitate cleaning out of extraneous material immediately before placing the concrete.

Forms shall be cleaned before being set to line and grade and shall be oiled prior to placing reinforcing steel in the vicinity of the forms. Materials or methods used in oiling the forms shall not result in the discoloration of the concrete.

In lieu of the conventional stationary forms, concrete parapet rail may be constructed by using an extrusion machine or other equipment specifically designed for constructing cast-in-place concrete parapet rail, provided the finished barrier is true to line and grade and the concrete is properly consolidated.

(b) Permanent Steel Deck Forms. An approved type of galvanized steel form, complying with the requirements shown on the plans and these specifications, may be used as an alternate to conventional removable forms for forming the bridge deck between the exterior beams or girders. These forms shall be designed to provide not less than the minimum concrete cover shown on the plans for all reinforcing bars in the bottom of the slabs. The effective design depth of slab shall be maintained over the entire area of the deck. Provision shall be made to provide encasement of top flanges of beams or girders in compression except where shear connectors are provided.

Detailed plans of proposed permanent steel deck forms shall be submitted to and approved by the Engineer before work of forming the bridge deck is started. The approval of the Contractor's plans shall not be considered as relieving the Contractor of any responsibility for

the results obtained by the use of these approved plans. Construction shall be according to the approved plans.

All material and elements of the permanent steel deck form units shall be fabricated from steel conforming to ASTM A653/A653M, Structural Steel (SS), Grades 33,37,40,50 Class 1 or 2, or 80, having a coating class of G165 [Structural Steel(SS), Grades 230, 255, 275, 340 Class 1 or 2, or 550, having a coating class of Z350]. Thickness and grade of form sheets and form supports shall be as designated on the shop drawings. In no case shall thicknesses be less than 22 gage for sheets and 16 gage for form supports. The Contractor shall provide a manufacturer's certification indicating compliance with the above requirements and Section 106.

Permanent steel forms shall be designed on the basis of the dead load of the form, reinforcement, and the plastic concrete, plus 50 psf (245 kg/sq m) for construction loads. Unit working stresses shall be according to the standard specifications for construction loads and the unit stress in the steel sheet shall be not more than 0.725 of the specified minimum yield strength of the material furnished, but not to exceed 36,000 psi (250 MPa). Maximum deflection shall be calculated using the weight of plastic concrete, reinforcement, and forms, or 120 psf (585 kg/sq m), whichever is greater. Maximum deflection shall not exceed 1/180 of the form span or 1/2" (12 mm), whichever is less. The form span for design and deflection shall be the clear distance between supports plus 2" (50 mm), but not less than the clear distance between the flanges of the supporting beams less 4" (100 mm) measured parallel to the form flutes.

Physical design properties shall be computed according to requirements of the latest edition of AISI *Specifications for the Design of Cold-Formed Steel Structural Members*.

All reinforcement shall have a minimum concrete cover of 1" (25 mm). Bars in the bottom layer of the main reinforcement shall be approximately centered over the valleys of the forms when necessary to achieve the minimum 1" (25 mm) concrete cover. The distance from the top of the slab to the bottom layer of main slab reinforcement shall be not less than that shown on the plans.

Permanent steel forms used in panels where longitudinal slab construction joints are located between stringers must provide adequate structural capacity without excessive deflections. Adequate external support of forms at the joint must be provided to assure that the forms do not separate from the hardened concrete.

All forms shall be installed according to detailed fabrication plans submitted to the Engineer for approval. The fabrication plans shall clearly indicate locations and methods of attachment where the forms are supported by steel beam flanges subject to tensile stresses and without shear connectors.

Form sheets shall not be permitted to rest directly on the top of the stringer or floor beam flanges. Sheets shall be securely fastened to form supports and shall have a minimum bearing length of 1" (25 mm) at each end. Form supports shall be placed in direct contact with

the flange of stringer or floor beam. All attachments shall be made by welds, bolts, clips, or other approved means. However, welding of form supports to flanges of steels other than AASHTO M 270, Grades 36 (250), 50 (345), or 50W (345W) of a
weldable grade, and to those portions of a flange subject to tensile stresses will not be permitted except as provided for in the plans. Welding shall be accomplished by certified welders and according to Subsection 807.26 except that 1/8" (3 mm) fillet welds will be permitted.

Provisions shall be made to keep the panels at an acceptable temperature before placement of concrete.

Calcium Chloride or any other admixture containing chloride salts shall not be used in the concrete placed on permanent steel deck forms.

After the deck concrete has been placed for a minimum of 2 days, the following inspection procedure shall be followed:

The forms shall be tested for soundness of the concrete and bonding of the forms to the concrete by striking the form a sharp blow with a geologist hammer. As a minimum, the forms shall be struck at 10' (3 m) intervals parallel to and 6" (150 mm) from the edge of the steel beam, and at 10' (3 m) intervals along the centerline of each bay between the beams in an X pattern with those along the beams, and at random points on a semicircle or circle, as applicable, with approximately 2' (0.5 m) radius from the above points. They shall be struck in other places as directed by the Engineer to define any suspicious or defective area. Areas where efflorescence is evident shall be thoroughly investigated.

The Contractor shall furnish all facilities such as ladders, scaffolding, etc., that will provide for a thorough inspection of the forms.

The striking of the forms shall be accomplished in such a manner and at a time that the sound is clearly audible. Properly bonded sheets attached to sound concrete will emit a clear ring when struck a sharp blow with a hammer. Honeycomb concrete and/or unbonded areas will give a different sound such as a thud or clatter. The forms shall be removed full width between beams wherever the Engineer suspects that honeycomb or unbonded areas exist so that the Engineer may make a visual examination of the concrete surface. Any defective concrete shall be repaired to match the adjacent concrete to the satisfaction of the Engineer.

The amount of sounding and form removal may be reduced, at the Engineer's discretion, after a substantial amount of slab has been constructed and inspected, if the Contractor's methods of construction and the results of the inspections as outlined above indicate that sound concrete is being obtained throughout. If the Contractor varies his procedures significantly, the initial inspection procedure shall be used to verify that the new conditions are yielding desirable results.

Any forms that must be removed because of unsatisfactory test results shall be removed by a metal saw or air-carbon-arc gouging with minimum damage to the concrete. The cut in forms parallel to the corrugations shall be located in a non-horizontal lap section of the

corrugation. The cuts parallel to the beam shall be through the supporting angles taking care not to damage the structural steel beams.

All concrete that is found defective or is damaged in removing a section of the form for inspection shall be repaired to match the adjacent concrete in section and color. All repair work shall be completed to the satisfaction of the Engineer.

Payment for forms will be made and fully covered under the unit price bid for superstructure concrete. No direct or additional payment of any kind will be made because of the use of these forms. Payment will be made for Class S(AE) Concrete in place in the bridge decks on the basis of the thickness specified on the plans, not including any excess thickness used and not including any concrete in portions of haunches that may be omitted because of the use of these forms.

802.15 Removal of Falsework and Forms. In the determination of the time for the removal of falsework and forms and the discontinuance of heating, consideration shall be given to the location and character of the structure, the weather and other conditions influencing the setting of the concrete, and the materials used in the mix.

Removal of falsework and forms shall be according to the following schedule:

Item	Minimum Time	Strength Requirement
Bottom Forms for Deck Slabs, Beams, and Caps	7 Days	Min. Spec.
Top Slabs of RC Box Culverts	7 Days	80% Spec.
Forms for Columns and Vertical Walls	24 Hours	N/A
Side Forms for Footings, Beams, and Caps	12 Hours	N/A
Side Forms for Parapets, Median Barriers, and Curb Faces	6 Hours	N/A

Both time and strength requirements must be met before removal of forms and/or falsework begins.

Forms on surfaces that will require a Class 2 finish according to Subsection 802.19 shall be removed at the earliest time permitted under these specifications in order to begin finishing operations.

Forms and their supports shall not be removed without the approval of the Engineer. Supports shall be removed in such a manner as to permit the concrete to uniformly and gradually take the stresses due to its own weight. Methods of form removal likely to cause overstressing of or damage to the concrete shall not be used.

802.16 Weather and Temperature Limitations and Protection of Concrete. When the ambient temperature at the placement site is 85° F (29° C) and rising, an approved retarding agent shall be required in all concrete used in bridge superstructures. A retarding agent will not be required in concrete used for bridge deck curb, parapet, railing, posts, sidewalks, or median treatment provided they are not placed monolithically with the deck itself.

When the internal temperature of the plastic concrete in bridge decks reaches 85° F (29° C), the Contractor shall take the necessary precautions to ensure that the temperature of succeeding batches does not exceed 90° F (32° C). Concrete batches with temperatures in excess of 90° F (32° C) will be rejected. The method used to control the concrete temperature shall be approved in writing by the Engineer. The temperature of the plastic concrete shall be determined immediately prior to its being deposited in the forms by inserting a thermometer to a depth consistent with the capabilities of the thermometer being used to obtain a true reading. Prior to beginning placement, the Contractor shall ensure that sufficient materials, labor, and equipment are available during placement to implement the previously approved cooling process.

The maximum mix temperature for all Class B concrete at the time of placement shall be 75° F (24° C). This requirement will be strictly adhered to and any concrete delivered to the job site that does not meet this provision will be rejected. The maximum differential between the internal concrete temperature and the concrete surface temperature shall not exceed 36° F (20° C). The Contractor shall devise a method for monitoring the temperature differential for at least seven days and shall have the method approved by the Engineer before the concrete is placed. The internal temperature shall be measured as nearly as practicable to the center of mass of the pour. Methods used to meet these requirements shall be submitted to the Engineer for approval. Methods that may be used to meet this provision include using ice in the mixing water, storing cement and aggregates in cool or shaded locations, watering down of coarse aggregates, installation of cooling pipes in the concrete, and use of insulation (tenting, quilts, or sand on polyethylene sheeting). Cooling by watering of fine aggregates will not be allowed.

No concrete shall be placed unless the temperature of the concrete is more than 50° F (10° C) when placed. If heating of the ingredients is necessary to meet this criterion, it shall be accomplished by a method such as dry heat or steam and not by direct flame. Water shall not be heated to more than 180° F (82° C), and shall be combined with the aggregate before the addition of cement. Frozen aggregates may not be used.

After concrete is placed, it shall be protected by insulated forms, blankets, enclosing and heating, and/or any other method approved by the Engineer that will maintain the temperature adjacent to the concrete at a minimum of 50° F (10° C) for at least 7 days. For concrete other than bridges, box culverts, and retaining walls, the requirement for maintaining the temperature at or above 50° F (10° C) shall not apply, but the concrete shall be protected and/or heated, as necessary, to prevent freezing for a period of at least 7 days.

For Class B concrete, forms shall remain in place 4 days after placing any time the temperature is below 40° F (4° C) or forecast to drop below 40° F (4° C). In addition, exposed top surfaces of the concrete shall be protected with an insulated blanket. The surface of the concrete shall not be saturated when it is exposed to freezing air temperatures.

The Contractor shall have available and ready for immediate use sufficient materials and equipment for maintaining the temperature of the concrete as required above.

Concrete that has been frozen or damaged due to weather conditions shall be removed and replaced by the Contractor at no cost to the Department.

Curing Concrete for Structures. (a) Materials. Materials used in curing concrete shall conform to one of the following types:

(1) Burlap-polyethylene sheeting shall meet the requirements of ASTM C171.

(2) Polyethylene sheeting shall have a minimum thickness of 4 mils (0.10 mm).

(3) Copolymer/synthetic blanket shall meet the performance requirements of ASTM C171. Copolymer/synthetic blankets shall be a composite of a copolymer membrane material coated over a layer of absorbent nonwoven synthetic fabric weighing at least 6 ounces per square yard (200 g/sq m), uniform in appearance, and free from visible defects.

(4) Other approved sheeting materials shall meet the performance requirements of ASTM C171.

(5) Membrane curing compound shall meet the requirements of ASTM C309, Type 1-D or Type 2.

(b) Application. The exposed concrete, immediately after finishing, shall be covered with one of the curing materials listed above and shall be kept continuously and thoroughly wet for a period of not less than 7 days after the concrete is placed. Membrane curing does not require the application of additional moisture, except as required for bridge roadway surfaces.

All Class B concrete shall be cured by free moisture. Water curing shall be provided for all exposed surfaces for a period of 14 days.

Membrane curing compound shall not be used on surfaces requiring a Class 2 finish.

Clear membrane curing compound shall be used as an interim cure for concrete bridge roadway surfaces and shall be applied immediately after final finishing. Final curing of bridge decks shall be by mats or blankets and shall be begun immediately after completing the surface test specified in Subsection 802.20(c). The mats or blankets shall be kept continuously and thoroughly wet for a period of 7 days after the concrete is placed.

When an extrusion machine is used for concrete parapet railing, curing shall be performed as specified herein and shall be accomplished as soon after extrusion as possible. Clear curing compound shall be used as an interim cure until such time as the parapet rail will support the curing methods specified.

When membrane curing is used, the exposed concrete shall be thoroughly sealed by applying the membrane curing solution immediately after the free water has left the surface. The concrete

inside the forms shall be sealed immediately after the forms are removed and necessary finishing has been done. For uniform application in the field on vertical concrete surfaces, the specified rate of application may be achieved by two coats applied at an interval of approximately 1 hour.

The Contractor shall provide satisfactory equipment and means to properly control and assure the direct application of the curing solution on the concrete surface so as to result in a uniform coverage at the rate of 1 gallon per 125 square feet (1 L/3 sq m) of area.

If rain falls on the newly coated concrete before the film has dried sufficiently to resist damage, or if the film is damaged in any other manner, a new coat of the solution shall be applied to the affected portions equal in curing value to that specified above.

802.17 Expansion and Fixed Joints. Joints shall be constructed according to the details shown on the plans.

(a) Open Joints. Open joints shall be placed in the locations shown on the plans and shall be constructed by the insertion and subsequent removal of a wood strip, metal plate, or other approved material. The insertion and removal of the template shall be accomplished without chipping or breaking the corners of the concrete. Reinforcement shall not extend across an open joint unless specified on the plans.

(b) Filled Joints. Filled expansion joints shall be constructed similar to open joints. When premolded types are specified, the filler shall be in the correct position when the concrete on the second side of the joint is placed. A joint sealer is required in addition to the joint filler. The cavity for the sealer shall be formed by the insertion and subsequent removal of a wood strip, metal plate, or other approved material. When required, adequate water stops of metal, rubber, or plastic shall be carefully placed as shown on the plans. All faces of the joint to be sealed shall be thoroughly cleaned by sand blasting, water blasting, or other approved methods prior to placing the joint seal material.

(1) Poured joint sealer shall meet the requirements of Subsection 501.02(h) for Types 3 through 7.

(2) Preformed expansion joint filler shall meet the requirements of Subsection 501.02(h) for Type 2.

When called for on the plans or in the Special Provisions the joint material shall be that specified in Section 809 or 810.

(c) Steel Joints. Plates, angles, or other structural shapes shall be accurately shaped at the shop to conform to the section of the bridge deck. The fabrication and painting shall conform to the requirements of the specifications covering those items. When specified on the plans or in the Special Provisions, the material shall be galvanized in lieu of painting.

Care shall be taken to ensure that the surface in the finished plane is true and free of warping. Positive methods shall be employed in placing the joints to keep them in correct position during the placing of the concrete. The opening at expansion joints shall be that

designated on the plans at 60° F (16° C), and care shall be taken to avoid impairment of the clearance in any manner.

(d) Felt Joints. Joint material and bearing pads shall consist of a roofing felt saturated and coated on both sides with asphalt, and coated on one side with powdered mineral matter such as talc or mica, and shall conform to ASTM D 224. Where Standard Drawings indicate the use of 45 # (2.2 kg/sq m) roofing felt, this material shall meet or exceed the requirements for ASTM D6830 Class S Type IV.

(e) Water Stops and Flashing. Water stops and flashing shall be furnished and placed as provided on the plans. They shall be spliced, welded, soldered, or otherwise joined to form continuous watertight joints and shall conform to the following requirements:

(1) Copper water stops and flashing shall conform to ASTM B152, unless otherwise specified on the plans. Sheet copper shall meet the embrittlement test of Section 10 of ASTM B152.

(2) Rubber water stops shall be formed from synthetic rubber made exclusively from neoprene, reinforcing carbon black, zinc oxide, polymerization agents, and softeners. This compound shall contain not less than 70% by volume of neoprene. The tensile strength shall not be less than 2750 psi (19 MPa) with an elongation at breaking of 600%. The Shore Durometer indication (hardness) shall be between 50 and 60. After 7 days in air at 158° F ± 2° F (70° C ± 1° C) or after 4 days in oxygen at 158° F ± 2° F (70° C ± 1° C) and 300 psi (2 MPa) pressure, the tensile strength shall be not less than 65% of the original.

The water stops shall be formed with an integral cross section in suitable molds so as to produce a uniform section with a permissible variation in dimension of ± 1/32" (±0.8 mm). No splices will be permitted in straight strips. Strips and special connection pieces shall be well cured in a manner such that any cross section shall be dense, homogeneous, and free from all porosity. Junctions in the special connection pieces shall be full molded. During the vulcanizing period, the joints shall be securely held by suitable clamps. The material at the splices shall be dense and homogeneous throughout the cross section.

(3) Polyvinylchloride (PVC) water stops shall be manufactured by the extrusion process from an elastomeric plastic compound, the base resin of which shall be polyvinylchloride (PVC). The compound shall contain any additional resins, plasticizers, stabilizers, or other materials needed to ensure that, when the material is compounded, it will meet the performance requirements given in this specification. No reclaimed PVC or other material shall be used.

The water stops shall be of the size and shape shown on the plans. They shall be dense, homogeneous, and without holes or other defects.

The material shall comply with the following physical requirements when tested under the indicated ASTM test method:

Tensile Strength	ASTM D 412	1800 psi (12.4 MPa) Minimum
Elongation	ASTM D 412	350%
Cold Brittleness	ASTM D 746	-35° F (-37° C)
Stiffness in Flexure	ASTM D 747	350 psi (2.4 MPa) Minimum

The manufacturer shall be responsible for the testing, either in his own or a recognized commercial laboratory, and shall submit a certified copy of test results.

802.18 Finishing Concrete Surfaces. (a) General. Surface finishes shall be classified as follows:

Class 1. Ordinary Surface Finish.
Class 2. Rubbed Finish.
Class 3. Textured Coating Finish.
Class 4. Exposed Aggregate Finish.
Class 5. Tined Bridge Roadway Surface Finish.
Class 6. Broomed Finish.
Class 7. Grooved Bridge Roadway Surface Finish.

All concrete shall be given a Class 1, Ordinary Surface Finish. In addition, if further finishing is required, such other types of finish will be as specified herein.

Payment for Class 1 through Class 6 finishes will be considered a part of the applicable item of concrete used. Measurement and payment for Class 7 finish will be made according to Subsections 802.24 and 802.25.

Sidewalks shall be given a Class 6 finish.

Curbs shall be given a Class 2 or Class 6 finish.

Bridge roadway surfaces shall be given a Class 5 finish unless Class 7 finish is specified on the plans.

The following surfaces shall be given a Class 2 finish except when a Class 3 finish is specified on the plans:

All Structures. Exposed surfaces of retaining walls, surfaces of concrete rails, rail posts, rail end posts, rail bases, and parapets, including the outside face.

Bridges Over Public Roads. Surfaces above finished ground of piers, columns, abutments, and retaining walls; the outside vertical surfaces of parapets, slabs, and girders; and the underneath side of the overhang outside the exterior beam.

At the option of the Contractor, a Class 3 finish may be used on all surfaces requiring a Class 2 finish provided the same class of finish is used on the entire structure.

(b) The various classes of surface finish are defined as follows:

(1) Class 1, Ordinary Surface Finish. Immediately following the removal of forms, fins and irregular projections shall be removed from all surfaces except from those that are not to be exposed or are not to be waterproofed. On all surfaces, the cavities produced by form ties and all other holes, broken corners or edges, and other defects shall be thoroughly cleaned, and after having been thoroughly saturated with water, shall be carefully pointed and trued with a mortar of cement and fine aggregate mixed in the proportion of 1:2. Mortar used in pointing shall be not more than 1 hour old. If required, the concrete shall then be rubbed or sprayed and cured as specified under Subsection 802.17. Construction and expansion joints in the completed work shall be left carefully tooled and free of mortar and concrete. The joint filler shall be left exposed for its full length with clean and true edges.

The resulting surfaces shall be true and uniform. Repaired surfaces, the appearance of which is not satisfactory to the Engineer, shall be rubbed as specified under Class 2 finish.

Exposed surfaces not protected by forms shall be struck off with a straightedge and finished with a float to a true and even surface. The use of additional mortar to provide a plastered or grout finish will not be permitted.

The tops of caps in the area of the bridge seat shall be finished with a steel trowel or by grinding to a smooth finish and true slope at the proper elevation.

(2) Class 2, Rubbed Finish. After removal of forms, the rubbing of concrete shall be started as soon as its condition will permit. Immediately before starting this work the concrete shall be thoroughly saturated with water. Sufficient time shall have elapsed before the wetting down to allow the mortar used in the pointing of rod holes and defects to thoroughly set. Surfaces to be finished shall be rubbed with a medium coarse carborundum stone, using a small amount of mortar on its face. The mortar shall be composed of cement and fine sand mixed in proportions used in the concrete being finished. Rubbing shall be continued until form marks, projections, and irregularities have been removed, voids filled, and a uniform surface has been obtained. The paste produced by this rubbing shall be left in place at this time.

After concrete above the surface being treated has been cast, the final finish shall be obtained by rubbing with a fine carborundum stone and water. This rubbing shall be continued until the entire surface is of a smooth texture and uniform color.

After the final rubbing is completed and the surface has dried, it shall be rubbed with burlap to remove loose powder and shall be left free from all unsound patches, paste, powder, and objectionable marks.

(3) Class 3, Textured Coating Finish. The material furnished for textured coating finish shall be a commercial paint type texturing product produced specifically for this purpose, and shall consist of a synthetic non-alkyd resin containing mica, perlite, non- biodegradable fibers, and durable tinting pigments. The material shall be listed on the QPL.

Unless otherwise specified in the Contract, the color of the textured coating finish shall be concrete gray, equal or close to Shade 36622 of the Federal Color Standard 595 B.

Surfaces to be coated shall be free from efflorescence, laitance, flaking, coatings, dirt, oil, and other foreign substances. The finish shall not be applied over surfaces cured with membrane curing compound until 30 days has elapsed from application of the membrane; however, the time may be reduced if the curing membrane is removed. Prior to application of the finish, the surfaces shall be free of moisture, as determined by sight and touch, and in a condition consistent with the manufacturer's published recommendations.

The finish shall be applied at the rate recommended by the manufacturer and as approved by the Engineer. The finish shall be applied with heavy duty spray equipment capable of maintaining a constant pressure as necessary for proper application. When recommended by the manufacturer and approved by the Engineer, the finish may be applied with rollers and/or brushes.

The completed finish shall be tightly bonded to the structure and shall present a uniform appearance and texture equal to or better than that required for rubbed finish. If necessary, an additional coat or coats shall be applied to produce the desired surface texture and uniformity. Upon failure to adhere positively to the structure without chipping or cracking, or if the desired surface appearance cannot be attained, the coating shall be removed from the structure and the surface given a rubbed finish, or another approved finish satisfactory to the Engineer.

Class 4, Exposed Aggregate Finish. This type of finish shall be produced by scrubbing the surface of green concrete with stiff wire or fiber brushes, using a solution of muriatic acid in the proportion of 1 part acid to 4 parts water, or by sand

blasting, until the cement film or surface is completely removed and the aggregate particles are exposed. The amount of aggregate exposure will be specified on the plans or designated by the Engineer. Any surface treated with muriatic acid shall be thoroughly washed with water to which a small amount of ammonia has been added to remove all traces of the acid. The resulting surface shall be an even pebbled texture.

(4) Class 5, Tined Bridge Roadway Surface Finish. The concrete bridge roadway surface shall be given a finish with a burlap drag, followed by tining.

The surface shall be finished by dragging a seamless strip of damp burlap over the full width of the roadway surface. The burlap drag shall consist of sufficient layers of burlap and have sufficient length in contact with the concrete to slightly groove the surface, and shall be moved forward with a minimum bow of the lead edge. The drag shall be kept damp, clean, and free of particles of hardened concrete.

The final finish shall be accomplished by using the drag finish as described above with the further application of a metal tine finishing device. The tine shall be approximately 0.032" x 0.125" (0.8 mm x 3.0 mm) of steel flat wire, 2"-5" (50 mm-125 mm) in length, and spaced on 1/2"-3/4" (13 mm-19 mm) centers. The grooves produced in the concrete shall be substantially from 1/8"- 3/16" (3 mm-5 mm) in depth. The grooves shall be transverse to the centerline of the surface. The metal tine device shall be operated by approved mechanical or manual means. Other texturing equipment may be approved by the Engineer provided it produces a texture equivalent to that produced by the metal tine.

The tining shall be terminated with a transition in depth 18" (0.5 m) from the gutter line.

As an alternate to the use of a burlap drag and a metal tine finishing device, a finned float may be used according to the following requirements:

After a tight uniform surface meeting the straightedge requirements of Subsection 802.20(b) has been achieved, the surface shall be given a texture by transverse grooving with a finned float. The finned area of the float shall be at least 4" x 36" (100 mm x 900 mm). The fins shall extend the full length of the float and cover at least half of the width. The grooves produced shall be approximately 3/16" (5 mm) in width at 3/4" (19 mm) centers and substantially 1/8"-3/16" (3 mm-5 mm) in depth. This operation shall be performed at such time and in such manner that the desired texture will be

achieved while minimizing displacement of the larger aggregate particles. The transverse grooving shall be terminated approximately 18" (0.5 m) from the gutter line at the base of the curb. The un-grooved area adjacent to the curbs shall be given a longitudinal light broom finish.

(6) Class 6, Broomed Finish. After the concrete has been deposited in place, it shall be consolidated and the surface shall be struck off by means of a strike board, floated, and broomed. An edging tool shall be used on edges and expansion joints. The surface shall not vary more than 1/4" (6 mm) under a 10' (3 m) straightedge. The surface shall have a granular or matte texture.

(7) Class 7, Grooved Bridge Roadway Surface Finish. Following straightedging according to Subsection 802.20(b) and after all excess moisture has disappeared, the concrete shall be given a finish with a belt or a burlap drag, prior to the grooved finish.

The belted finish shall be accomplished by two applications of a soft, flexible belt of approved composition 8"-12" (200 mm- 300 mm) in width. The belt shall be moved forward with a combined transverse and longitudinal motion, the longitudinal advance being very slight for the first belting, but with a sweeping motion for the final belting. Care shall be exercised that the belting operation does not work the crown out of the deck surface. Just before the concrete attains its initial set, the surface shall be given the final belting with the purpose of producing a uniform surface of roughened texture.

The burlap drag finish shall be accomplished by dragging a seamless strip of damp burlap over the full width of the surface. The burlap drag shall consist of sufficient layers of burlap and have sufficient length in contact with the concrete to slightly groove the surface and shall be moved forward with a minimum bow of the leading edge. The drag shall be kept damp, clean, and free of particles of hardened concrete. The bridge roadway surface shall be grooved perpendicular to the centerline with grooves extending across the slab to within 18" (0.5 m) of the gutter lines.

The grooves shall be cut into the concrete using a mechanical sawing device that will leave grooves 1/8"-3/16" (3 mm-5 mm) in depth and spaced on 1/2"-3/4" (13 mm-19 mm) centers. Grooving blades shall be 0.075"-0.125" (2 mm-3 mm) wide. Sawing shall not be performed before the end of the normal curing.

Residue from the grooving operations shall be removed and

the bridge deck thoroughly cleaned. Residue shall not be permitted to enter drainage facilities or streams.

802.19 Bridge Roadway Surface Construction. (a) Striking Off. After the concrete is placed and consolidated according to Subsection 802.09, bridge roadway surfaces or top slabs of structures serving as finished roadway surfaces shall be finished using approved equipment. The Contractor shall show the type, size, and weight of the finishing machine and auxiliary equipment that is to be used in the bridge deck construction on the drawings submitted for the span and overhang support system required by Subsection 802.13.

Mechanical strike-off machines shall be power driven, with oscillating type screeds, traveling on rails or headers adjusted to conform to the profile or cross section of the roadway. The screed shall be adjusted to conform to the profile or the required cross section of the roadway. Consolidation by a vibratory action of the finishing machine will not be permitted. The screeds shall have sufficient strength to retain their shape after adjustment. The finishing machine shall go over each area of the bridge roadway surface as many times as is required to obtain the required profile and cross section. A slight excess of concrete shall be kept in front of the screed at all times. This excess of concrete shall be carried all the way to the edge of the placement or form, and shall not be worked into the slab but shall be wasted. When a finishing machine travels on rails supported by fixtures embedded in the concrete area, these supports shall be removed and the holes filled and finished to the same quality and finish as the surrounding concrete. The holes shall be cleaned of grease and other foreign matter prior to filling.

When non-mechanical strike-off methods are approved, the bridge roadway surfaces or slabs shall be struck off with a screed that is parallel to the centerline of the roadway, resting on bulk heads or screed strips cut or set to the required cross section of the roadway. This screed shall be so constructed as to have sufficient strength to retain its shape and the cutting edge shall be adjusted to conform to the profile of the roadway. Screed strips or headers shall be accurately set to the specified grades, checked, and adjusted as necessary prior to the final screeding operation. The screed shall be worked back and forth over the surface until the proper profile and cross section is obtained.

Longitudinal screeds shall be of sufficient length to finish the full length of spans 50' (15 m) or less in length. Spans over 50' (15 m) in length and continuous spans shall be placed with

lengths of placements as shown on the plans. The use of longitudinal screeds on spans with a horizontal curve is prohibited.

Excess water, laitance, or foreign materials brought to the surface during the course of the finishing operations shall not be reworked into the roadway surface, but shall be removed immediately upon appearance by means of a squeegee or straightedge drawn from the center of the roadway surface toward either curb.

In general, the addition of water to the surface of the concrete to assist in finishing operations will not be permitted. If the application of water to the surface is permitted, it shall be applied as a fog spray by means of approved spray equipment.

(b) Straightedging. After finishing as described above, the entire surface shall be checked by the Contractor, in both directions, for trueness using a 10' (3 m) metal straightedge. The surface shall show no deviation in excess of 1/8" (3 mm) from the straightedge. Deviations in excess of this requirement shall be corrected before the concrete sets. The checking operation shall progress by overlapping the straightedge at least ½ the length of the preceding pass. Major deviations shall be corrected with the strike-off; minor deviations may be corrected using the straightedge or a metal float.

(c) Initial Surface Test. As soon as the surface has set sufficiently to withstand damage when walking on it, and not later than the morning following the placing of the concrete, it shall be straightedged in both directions with the 10' (3 m) straightedge and any variations exceeding 1/8" (3 mm) shall be plainly marked. In addition, profiles shall be taken at 10' (3 m) intervals along the centerline of bridge, centerline of each lane, and each gutter line. When the bridge roadway surface profiles exhibit surface deviations in excess of 1/4" (6 mm) in 20' (6 m), the Contractor shall make appropriate changes to either equipment or methods prior to proceeding with the next bridge deck placement.

After the initial placement, the straightedge and profile requirements shall extend onto the adjacent placements.

(d) Final Surface Test. Upon completion of the entire bridge superstructure, the bridge roadway surface shall be checked as specified above.

All marked areas shall be corrected by grinding until such deviations have been reduced to meet the tolerances of 1/8" (3 mm) in 10' (3 m) and 1/4" (6 mm) in 20' (6 m) at no cost to the

Department. The grinding equipment shall be power driven and specifically designed to smooth and texture portland cement concrete by means of diamond blades.

All areas that have been ground shall be re-grooved according to Subsection 802.19, Class 7.

802.20 Precast Concrete Products. (a) General. This subsection pertains to concrete units that have been cast prior to erection or installation, and shall include precast concrete slab and girder units, bent caps, rail posts, piling, and other items. The casting may be done at the site or at the Contractor's or Manufacturer's central casting plant and transported to the bridge site.

The foregoing requirements of Section 802 and those of Section 804 governing materials and construction of reinforced concrete structures, insofar as they are applicable, shall govern the materials requirements, quality control and quality acceptance, and construction methods relative to precast concrete products, except as modified and supplemented by this subsection. In case of conflict, the specifications of this subsection shall govern.

Concrete in precast products shall be placed in one continuous operation for each unit in a line. The use of split pours for multiple units in a prestress line will not be permitted.

The Engineer shall be notified prior to beginning a placement and only those completed products bearing identification marks of acceptance by the Department will be permitted for use in construction. The date of casting and a unique identification mark shall be inscribed on each unit.

(b) Quality Control and Quality Acceptance for Concrete. Quality control and quality acceptance shall be according to the provisions of Subsection 802.06.

(c) Defective Materials. Materials and manufactured products not conforming to the requirements of these specifications will be rejected and shall be removed immediately from the site of the work, unless otherwise permitted by the Engineer. No rejected material or products, the defects of which have been subsequently corrected, shall be used until written approval of the Engineer has been given.

(d) Forms. The provisions of Subsection 802.14, insofar as they are applicable, shall govern material and construction of forms. Forms shall be sufficiently true and unyielding such that the 4 sides of slabs and bent caps shall not vary more than 1/8"

(3 mm) for the full depth of the unit when tested with a straightedge in both horizontal and vertical directions. The top and bottom of bent caps and the tops of slab and girder units shall not vary more than 1/8" (3 mm) in any 10' (3 m) length when tested with a straightedge in both longitudinal and transverse directions.

(e) Reinforcing. Reinforcing steel shall be accurately located in the forms and firmly held in place by means of auxiliary steel wire supports sufficient in number and size to prevent displacement during the course of construction.

(f) Placing Concrete. Concrete shall not be deposited in the forms until the Engineer has inspected and approved the placing of the reinforcement. Vibrating shall be done with care and in such a manner as to avoid displacement of reinforcement or wires.

The maximum concrete mix temperature at the time of placement shall be 95° F (35° C). When the internal temperature of the plastic concrete reaches 90° F (32° C), the Contractor shall take necessary precautions to ensure that the temperature of succeeding batches does not exceed 95° F (35° C). No concrete shall be placed when the air temperature is below 36° F (2° C) unless provision is made for heating the ingredients and for enclosing the concrete and heating the enclosure. The minimum placement temperature of the plastic concrete mix shall be 50° F (10° C). The methods used to control the concrete temperature shall be approved by the Engineer.

(g) Curing, Removal of Forms, and Handling of Completed Units. The requirements of Subsections 802.15 and 802.17 shall be modified according to the following specifications:

Exposed surfaces shall be covered with wetted burlap-polyethylene sheeting as soon as the concrete has set sufficiently to prevent marring of surfaces, and the entire unit shall be kept continuously wet for a period of not less than 5 days. Steam curing, according to the requirements of Subsection 802.22(f)(2)f, may be used in lieu of covering with sheeting. Other precautions to ensure development of strength shall be taken if directed. Side forms may be removed when such removal will cause no breakage, distortion, slump, or misalignment of the concrete.

The precast concrete units shall remain on the bottom supporting forms until the concrete has reached a compressive strength of 2500 psi (17.0 MPa), or as specified, for slab and

cap units and 3000 psi (21.0 MPa), or as specified, for piling, as evidenced by test cylinders molded, cured, and tested as specified above. Then the units may be removed from the bottom forms to a curing or storage area. The units may be shipped and used when the concrete reaches the minimum specified 28 day compressive strength, as evidenced by test cylinders made at the time of casting, except that the minimum time between casting and shipping shall be not less than 10 days.

After casting, units shall be picked up and supported, as a minimum, at points designated on the plans. Units shall be handled, transported, and erected in such manner as to prevent cracking, spalling, or marring the concrete.

(h) Finishing Concrete Surfaces. Surfaces of precast members shall be finished according to the requirements set forth in Subsections 802.19. The exterior faces of the exterior members shall be given a Class 2 Finish. Other surfaces shall be given a Class 1 Finish, except that holes less than 3/8" (10 mm) in depth can be left. The final finish shall be made at the casting yard and any impairment of the surface occurring in transportation and erection shall be corrected before acceptance.

802.21 Prestressed Concrete Structures. (a) General. This subsection pertains to all prestressed concrete elements in structures and shall govern the manufacture, transportation, and storage of beams, slabs, piling, and other structural members of precast concrete prestressed by the pre-tensioning method. This subsection shall govern the installation of all precast prestressed members except piling, which shall be placed according to the provisions of Section 805.

Plants furnishing precast prestressed concrete products shall be certified by the Prestressed Concrete Institute. Shop drawings for prestressed concrete structures or components shall be submitted to the Engineer for review and approval before fabrication begins.

The Engineer shall be notified prior to beginning a placement and only those completed products bearing identification marks of acceptance by the Department will be permitted for use in construction. The date of casting and unique identification mark shall be inscribed on each unit.

(b) Prestressing Methods. The method of prestressing to be used shall be optional with the Contractor, subject to requirements hereinafter specified.

Prior to casting members to be prestressed, the Contractor

shall submit to the Engineer for approval complete details of the method, materials, and equipment proposed for use in the prestressing operations. Such details shall outline the method and sequence of stressing; complete specifications and details of the prestressing steel and anchoring devices proposed for use; anchoring stresses; type of enclosures; and other data pertaining to the prestressing operations, including the proposed arrangements of the prestressing units in the members.

(c) Consulting Service. Unless otherwise directed, the Contractor shall certify to the Engineer that a technician skilled in the approved prestressing method will be available to the Contractor to give such aid and instruction in the use of the prestressing equipment and installation of materials as may be necessary to obtain required results.

(2) Materials. (1) Concrete. The materials for concrete shall conform to the requirements of Subsection 802.02. The class of concrete to be used, including strength requirements, shall be as specified or shown on the plans or in the Special Provisions. Class S concrete for use in prestressed concrete girders shall be as specified in Table 802-1.

(3) Reinforcing Steel. Reinforcing steel shall conform to requirements of Section 804.

(4) Prestressing Reinforcement Steel. Prestressing reinforcement shall be high-tensile-strength steel wire, high-tensile- strength 7-wire strand, or high-tensile-strength alloy bars as specified on the plans or in the Special Provisions.

High-tensile-strength steel wire shall conform to the requirements of AASHTO M 204.

High-tensile-strength 7-wire strand shall conform to the requirements of AASHTO M 203.

Low-relaxation strand shall conform to the requirements of AASHTO M 203. The Contractor shall furnish certified test reports that the strand furnished meets all of the applicable requirements.

High-tensile-strength alloy bars shall conform to the requirements of AASHTO M 275.

At the Contractor's option, a design other than that shown on the plans may be submitted. This optional design must be approved by the Engineer. Any additional expense as a result of the Contractor's design shall be at no cost to the Department.

(5) Testing. Wire, strand, or bars to be shipped to the site

shall be assigned a lot number and tagged for identification purposes.

Samples submitted shall be according to the Department's *Manual of Field Sampling and Testing Procedures* and shall be representative of the lot to be furnished. Materials specified for testing shall be furnished at no cost to the Department and shall be delivered in sufficient time for tests to be made prior to use. If directed by the Engineer, the selection of samples shall be made at the Manufacturer's plant by the Inspector.

(d) Quality Control and Quality Acceptance for Concrete. Quality control and quality acceptance shall be according to the provisions of Subsection 802.06.

(e) Construction Requirements. (1) General. Prestressed concrete structural members shall be constructed according to the applicable requirements of the foregoing, and reinforcing steel shall be placed according to the requirements of Section 804, subject to the modifications and amendments contained in this subsection. The manufacture of precast prestressed concrete structural units shall conform to the dimensional tolerances in the latest revision of the *Manual for Quality Control for Plants and Production of Structural Precast Concrete Products MNL-116* published by the Prestressed Concrete Institute.

Girders shall have a permanent identification plate or permanent marking located on the girder in such a place that it may be read after the bridge is complete. Records shall be furnished to the Bridge Engineer and Resident Engineer which will enable them to determine the date of casting, the date of prestressing, and the location of the casting yard. The identification system, type and placement of the identification plate shall be detailed on the manufacturer's shop drawings.

(2) Manufacture. a. Prestressing Equipment. Hydraulic jacks shall be equipped with accurate pressure gauges. The Contractor may elect to substitute screw jacks or other types for hydraulic jacks. In such cases, proving rings or other approved devices shall be used in connection with the jacks. All devices, whether hydraulic jack gauges or otherwise, shall be calibrated so as to permit the stress in the prestressing steel to be determined at all times. All devices shall be calibrated at least annually and a certified calibration curve shall accompany each device. If at any time there are indications that the calibration may be in error, the Engineer may require the device to be re-calibrated. Indications that the calibration may be in error include, but are not limited to, such conditions as

apparent damage to the device or any of its components; corrosion of the device; etc.

Safety measures shall be taken by the Contractor to prevent accidents due to possible breaking of the prestressing steel or the slipping of the grips during the prestressing process.

b. Casting Yard. The precasting of prestressed concrete structural members may be done at any location selected by the Contractor, subject to the approval of the Engineer.

Before any site on Department right-of-way is approved for use as a casting yard, the Contractor shall submit to the Engineer a plan of operation showing anticipated leveling or altering of the selected area. Upon completion of the work, the site shall be cleared of equipment and rubbish and restored as nearly as possible to its original condition.

Placing Steel. Steel shall be accurately placed in the position shown on the plans, firmly held during the placing, and maintained during the setting of the concrete.

Distances from the forms and the spacing of steel shall be maintained by stays, ties, hangers, or other approved supports.

c. Pretensioning. The prestressing elements shall be positively and accurately held in position and shall be stressed by jacks. A record shall be kept of the jacking force and the elongations produced thereby. Several units may be cast in one continuous line and stressed at one time. Sufficient space shall be left between ends of units to permit access for cutting after the concrete has attained the required strength. No bond stress shall be transferred to the concrete, nor end anchorages released, until the concrete has attained a compressive strength, as shown by cylinder tests, of at least 4000 psi (28.0 MPa), or as specified. The elements shall be cut or released slowly and in such order that lateral eccentricity of prestress will be a minimum.

d. Placing Concrete. Concrete shall not be deposited in the forms until the Engineer has inspected and approved the placing of the reinforcement, anchorages, and prestressing steel. The concrete shall be vibrated internally or externally or both as directed by the Engineer. The vibrating shall be done with care and in such a manner as to avoid displacement of reinforcement or wires.

The maximum concrete mix temperature at the time of placement shall be 95° F (35° C). When the internal temperature of the plastic concrete reaches 90° F (32° C), the Contractor shall take necessary precautions to ensure that the

temperature of succeeding batches does not exceed 95° F (35° C). No concrete shall be placed when the air temperature is below 36° F (2° C) unless provision is made for heating the ingredients and for enclosing the concrete and heating the enclosure. The minimum placement temperature of the plastic concrete mix shall be 50° F (10° C). The methods used to control the concrete temperature shall be approved by the Engineer.

e. Steam Curing. Steam curing will be permitted in lieu of wet curing. If the Contractor elects to cure with steam or by any other special method, the method and its details shall be approved by the Engineer. Steam curing shall be accomplished under a suitable enclosure to contain the live steam in order to minimize moisture and heat losses. The initial application of the steam shall be 2-4 hours after the final placement of concrete to allow the initial set of the concrete to take place. If retarders are used, the waiting period before application of the steam shall be increased to 4-6 hours. The steam shall be at 100% relative humidity to prevent loss of moisture and to provide excess moisture for proper hydration of the cement. Application of the steam shall not be directly on the concrete. During application of the steam, the ambient air temperature shall increase at a rate not to exceed 40° F (22° C) per hour until a temperature of 120° F to 160° F (49° C to 71° C) is reached. The attained temperature shall be held until the concrete has reached the desired strength. Detensioning shall be accomplished immediately after steam curing has been discontinued. Additional curing is not required after detensioning. In discontinuing the steam, the ambient air temperature shall not decrease at a rate exceeding 40° F (22° C) per hour until a temperature has been reached about 20° F (10° C) above the temperature of the air to which the concrete will be exposed. The concrete shall not be exposed to temperatures below freezing for 5 days after casting.

The Contractor shall furnish recording thermometers showing the time-temperature relationship throughout the entire curing period. One such recording thermometer shall be furnished for each 200' (60
m) of casting bed of each separate enclosure. Heat sensing elements shall be freely suspended within the accelerated cure enclosure. Recording thermometers shall be kept in proper calibration and recalibrated at least annually.

Prestressed concrete units shall remain on the bottom supporting forms until the concrete has reached a compressive strength of 4000 psi (28.0 MPa), or specified strength, as evidenced by test cylinders molded, cured, and tested as herein specified. The units may then be detensioned and removed from the bottom forms to a curing and storage area. Units may

be shipped and used when the concrete reaches the greater of the minimum specified 28 day strength or 5000 psi (35.0 MPa), as evidenced by test cylinders made at the time of casting, except that the minimum time between casting and shipping shall be not less than 10 days.

f. Detensioning. Detensioning shall be performed immediately following the curing period while the concrete is still warm (100° F to 130° F [38° C to 54° C]) and moist. Forms, ties, inserts, hold downs, blocking between bulkheads, or other devices that would restrict longitudinal movement of the members along the bed shall be removed or loosened prior to transfer of stress.

In single strand detensioning, the strands shall be released by heat-cutting using a low-oxygen flame, played along the strand for a minimum of 5" (125 mm). In order for the release of stress to occur gradually, strands shall not be cut quickly but shall be heated until the metal gradually loses its strength. Detensioning shall be accomplished at both ends of the prestressing bed and at all spaces between ends of members simultaneously, unless otherwise directed. The sequence used for cutting strands shall keep the stresses nearly symmetrical about the axes of the members and the pattern and schedule shall be approved by the Engineer.

In multiple strand detensioning, strands shall be released simultaneously by hydraulic jacking. The total force shall be taken from the header by the jack, then gradually released.

Detensioning of draped strands shall follow the procedures outlined in the *Manual For Quality Control for Plants and Production of Structural Precast Concrete Products, MNL 116* published by the Precast Concrete Institute, except as modified by these specifications.

(3) Handling. Extreme care shall be exercised in handling and moving precast prestressed concrete members. Precast girders and slabs shall be transported in an upright position and the points of support and directions of the reactions with respect to the member shall be approximately the same during transportation and storage as when the member is in its final position.

After casting, precast prestressed piling shall be picked up and supported, as a minimum, at points designated on the plans. Care should be taken during storage, hoisting, and handling of the precast units to prevent cracking or damage. Units damaged by improper storing or handling shall be replaced by the Contractor at no cost to the Department.

802.22 Placing. Precast prestressed structural members

shall be placed in the structure in conformity with the plans and any Special Provisions governing the particular type of structure to be built.

802.23 Opening Structure to Traffic. Precast and cast in place spans, including top slabs of all box culverts, may be opened to traffic, public or construction, according to the following schedule. Both time and strength requirements must be met before opening the structure to traffic.

Unit	Minimum Time	Strength Requirement
Precast Spans	Immediately*	--
Cast in Place Spans	7 Days	Min. Specs.
R.C. Box Culvert Spans	7 Days	Min. Specs.

*Grouted keyways for precast spans shall be allowed to cure a minimum of 3 days prior to opening the structure to traffic.

In no event shall any spans be opened to traffic before the longitudinal and transverse joints are properly finished and the surface cleaned of foreign substances.

802.24 Method of Measurement. **(a)** Concrete of the various classes will be measured by the cubic yard (cubic meter) in place, based upon actual volume within the neat lines of the structure as shown on the plans or revised by authority of the Engineer. Concrete parapet walls will be included in the volume of concrete for payment.

No deductions will be made for the volume of concrete displaced by reinforcing steel, piling, structural steel, or expansion joint material. No deduction will be made for fillets, scorings, and chamfers 1 square inch (650 sq mm) or less in concrete cross- sectional area.

The quantities shown on the plans will be considered as the final quantities and no further measurement will be made unless, in the opinion of the Engineer or upon evidence furnished by the Contractor, substantial variations exist between quantities shown on the plans and actual quantities due to changes in alignment or dimensions or to apparent errors.

(b) Grooving will be measured by the square yard (square meter). The quantity of grooving to be paid for will be determined by multiplying the width of the grooved area by the length grooved.

(c) Precast concrete products, except for precast reinforced concrete box culverts, will be measured by the unit of each

type and size of product. Precast reinforced concrete box culverts may be substituted for cast-in-place box culverts according to Section 607. Precast piling will be measured as specified in Sections 805.

(d) Prestressed Concrete Girders will be measured by the linear foot (meter) of the type shown on the plans. The quantities shown on the plans will be considered as the final quantities and no further measurement will be made unless, in the opinion of the Engineer or upon evidence furnished by the Contractor, substantial variations exist between quantities shown on the plans and the actual quantities due to changes in alignment or dimensions or to apparent errors.

(e) Concrete used to construct miscellaneous items for which a separate pay item is provided (such as curbs, drop inlets, etc.) will not be measured or paid for separately, but full compensation therefor will be considered included in the contract unit price bid for the item in which used.

802.25 Basis of Payment. (a) Concrete of the various classes, completed and accepted and measured as provided above, will be paid for at the contract unit price bid per cubic yard (cubic meter) for the Class specified, which price shall be full compensation for furnishing all materials, forms, falsework, and bracing; for mixing, placing, consolidating, finishing, and curing; for performing mix designs and quality control and acceptance sampling and testing; and for all labor, equipment, tools, and incidentals necessary to complete the work.

Reinforcing steel, metal drains, and structural steel placed in this concrete will be paid for under other contract items. Unless otherwise provided, conduits, joint fillers and sealers, water stops, flashing, and roofing shown on the plans will not be measured or paid for separately, but full compensation therefor will be considered included in the contract unit prices bid for the various classes of concrete.

(b) Grooving completed and accepted and measured as provided above will be paid for at the contract unit price bid per square yard (square meter) for Grooving, which price shall be full compensation for furnishing all labor, equipment, tools, and incidentals necessary to complete the grooving including removal of residue and cleaning of the bridge deck.

(c) Precast and prestressed precast concrete products, except piling, prestressed girders and precast reinforced concrete box culverts, constructed, transported, erected, accepted, and measured as provided above, will be paid for at

the contract unit price bid per each for Precast Concrete Curb Units, Precast Concrete Interior Units, Precast Parapet Rail Units, or other type units as designated on the plans and in the Proposal. Prestressed Concrete Girders will be paid for at the contract unit price bid per linear foot (meter) for the type shown on the plans. The price shall be full compensation for furnishing all materials and forms; for performing mix designs and quality control and acceptance sampling and testing; for casting; for prestressing operations; for transporting and erecting units; and for all labor, equipment, tools, and incidentals necessary to complete the work. Reinforcing steel, prestressing materials, bolts, nuts, washers, wire mesh, reinforcing bar supports, grout for shear keys, joint fillers and sealers, and unreinforced bearing pads will not be measured or paid for separately, but full compensation therefor will be considered included in the contract unit prices bid for precast concrete products. Precast reinforced concrete box culverts may be substituted for cast-in-place box culverts according to Section 607.

Payment will be made under:

Pay Item	**Pay Unit**
Class B Concrete-Bridge	Cubic Yard (Cubic Meter)
Class S Concrete-Bridge	Cubic Yard (Cubic Meter)
Class S(AE) Concrete-Bridge	Cubic Yard (Cubic Meter)
Seal Concrete-Bridge	Cubic Yard (Cubic Meter)
Class A Concrete-Roadway	Cubic Yard (Cubic Meter)
Class S Concrete-Roadway	Cubic Yard (Cubic Meter)
Class S(AE) Concrete-Roadway	Cubic Yard (Cubic Meter)
Seal Concrete-Roadway	Cubic Yard (Cubic Meter)
Grooving	Square Yard (Square Meter)
__' (___m) Precast Concrete Curb Units	Each
__' (___m) Precast Concrete Interior Units	Each
__' (___m) Precast Parapet Rail Units	Each
Prestressed Concrete Girders (Type__)	Linear Foot (Meter)

SECTION 804
REINFORCING STEEL FOR STRUCTURES

804.01 Description. This item shall consist of reinforcing steel and miscellaneous accessories of the quality, type, size, and quantity designated, which shall be furnished and placed in concrete structures according to these specifications and in conformity with the details shown on the plans, or as directed.

804.02 Materials. (a) Bar Reinforcement. Bar reinforcement for concrete in sizes up to and including #18 (No. 57) shall conform to the requirements of AASHTO M 31 or M 322 Type A. Mill test reports shall be submitted for reinforcing steel.

(b) Wire and Wire Fabric. Wire, when used as reinforcement in concrete, shall conform to the requirements of AASHTO M 32 or M 225.

Wire fabric, when used as reinforcement in concrete, shall conform to the requirements of AASHTO M 55 or M 221. All wire fabric shall meet the weld shear requirements for AASHTO M 55. The type of wire fabric shall be approved by the Engineer.

(c) Bar Mat Reinforcement. Bar mat reinforcement for concrete shall conform to the requirements of AASHTO M 54.

(d) Epoxy Coating. When specified, reinforcing steel bars shall be coated according to ASTM A775 using a coating material that meets the requirements of Annex A1 of ASTM A775.

The Contractor shall supply to the Engineer a written certification that properly identifies the number of each batch of coating material used in the order; the material, quantity represented, date of manufacture, and name and address of the manufacturer; and a statement that the supplied coating material meets the requirements of Annex A1 of ASTM A775.

Patching material, compatible with coating material, inert in concrete, and meeting the requirements of Annex A2 of ASTM A775, shall be provided by the epoxy coating manufacturer.

804.03 Bar Lists and Bending Diagrams. All reinforcing steel shall be fabricated to conform to the details shown on the plans. Pins used for bending reinforcing steel shall be equal to or larger than that shown on the plans. Bar lists and bending

diagrams for reinforcing steel and bar supports will not be reviewed or approved by the Engineer. The Contractor shall be responsible for the accuracy of the fabricated reinforcing steel.

804.04 Fabrication. Bar reinforcement shall be bent to the shapes shown on the plans.

Bars shall be bent cold, unless otherwise permitted by the Engineer. No bars partially embedded in concrete shall be field bent, except as shown on the plans or specifically permitted by the Engineer.

Radii for bends shall be as shown on the plans. When not shown on the plans, radii bends on the inside of bars shall be as specified below.

Bar Number		Minimum Radii
U.S. Standard	Metric (SI)	
Stirrups and Ties		4 bar diameters
3, 4, 5, 6, 7, or 8	10, 13, 16, 19, 22, or 25	6 bar diameters
9, 10, or 11	29, 32, or 36	8 bar diameters
14 or 18	43 or 57	10 bar diameters

The Engineer or his representative shall have free access to the shop for inspection, and every facility shall be extended to him for this purpose. On a random basis, samples of bars, other than the additional test bars, may be taken by the Engineer.

Epoxy coating applicators shall be CRSI certified. The Contractor shall inform the Engineer, in writing, at least 10 days prior to performing any of the cleaning or coating operations. The Contractor shall furnish to the Engineer the coating applicator's certification certifying that all materials used, the preparation of the bars, coating, and curing were done according to these specifications and that no bars contain more than six holidays per yard (meter). The certification shall include or have attached specific results of tests of coating thickness and flexibility of coating.

804.05 Shipping, Handling, and Protection of Material. Bar reinforcement shall be shipped in standard bundles, tagged and marked according to the *Code of Standard Practice* of the Concrete Reinforcement Steel Institute.

Epoxy 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. Caution shall be used to avoid dragging or dropping the bundles. If bundled together for shipment, the bundles should be small, tightly banded with padded bands, and should be lifted with a strong back, multiple supports, or a platform bridge to prevent bar to bar abrasion from sags in the bar bundle. Epoxy coated bars shall be stored on padded and/or wooden supports. All systems for handling coated bars shall have padded contact areas. If, in the judgment of the Engineer, the coating is damaged to the extent that the coating no longer provides the intended protection, the material shall be returned to the coating applicator for repair or replacement. Patching materials or any required repair of the coating shall be at no cost to the Department.

Steel reinforcement shall be protected from damage. When placed in the work, it shall be free from dirt, detrimental rust or scale, paint, oil, or other foreign substance. Steel reinforcement shall be stored above the ground on skids, platforms, or other supports. Epoxy coated reinforcing steel that is not incorporated into the work within 90 calendar days after delivery to the project shall be protected from exposure to the sun.

Epoxy coating damaged during fabrication, shipping, or installation shall be repaired according to ASTM A775. Damaged areas less than 0.10 square inch (65 sq mm) need not be repaired but all areas larger than 0.10 square inch (65 sq mm) shall be repaired. The maximum amount of damage shall not exceed 2% of the surface area of each bar. All damaged areas shall be repaired with the material specified in Subsection 804.02(d) and according to the manufacturer's instructions. Repairs will be required on all sheared or cut ends of bars, end areas left bare during 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. Epoxy coated bars shall not be flame cut.

The Contractor shall exercise caution when placing and vibrating concrete to prevent any damage to epoxy coated bars. In order to prevent the vibrator from damaging the coated bars, the head shall be covered with a sheet of rubber or a similar material as approved by the Engineer.

804.06 Placing and Fastening. Steel reinforcement shall be accurately placed in the positions shown on the plans and firmly held during the placing and setting of concrete. Bars shall be tied at all intersections except where spacing is less

than 12" (300 mm) in each direction, in which case alternate intersections shall be tied.

Bundled bars shall be tied together at not more than 6' (2 m) centers.

Bar positions or clearances from the forms shall be maintained by means of stays, ties, hangers, or other approved devices. Reinforcing steel shall not be welded unless detailed on the plans or authorized in writing by the Engineer. Any authorized welding shall comply with Subsection 807.26. Metal bar supports that are in contact with the exterior surface of the concrete shall have protection conforming with the CRSI Specifications, Class 1 for Plastic Protected Bar Supports or Class 2 for Stainless Steel Bar Supports, with the further provision that the plastic protection may be applied either by a dipping operation or by the addition of premolded plastic tips to the legs of the supports. Epoxy Coated Bar Supports that are coated according to the provisions of CRSI "Manual of Standard Practice" with a minimum coating thickness of 5 mils (127 µm) may be substituted for Plastic Protected Bar Supports or Stainless Steel Bar Supports. All high chairs and bar bolsters shall be metal.

Plastic bar supports shall not be used.

When concrete is to rest on an excavated surface, layers of bars shall be supported above the surface by metal chairs or by precast mortar or concrete blocks. The use of rocks, pieces of stone or brick, pipe, wooden blocks, or chunks of concrete will not be permitted as bar supports or spacers. Reinforcement shall be placed by the Contractor and inspected and approved by the Engineer before the placing of concrete begins. Concrete placed in violation of this provision may be rejected and removal required. Unless otherwise shown on the plans, the spacing of supports shall conform to the recommendations of CRSI.

If fabric reinforcement is shipped in rolls, it shall be straightened into flat sheets before being placed.

Epoxy coated bars shall be placed on plastic coated or epoxy coated metal supports and shall be held in place by use of plastic coated tie wires or molded plastic clips especially fabricated for this purpose. Bar supports for epoxy coated bars shall be fully coated metal supports. Epoxy coated bar supports shall be coated according to the provisions of CRSI "Manual of Standard Practice" and shall have a minimum coating thickness of 5 mils (127 µm). In placing epoxy coated bars, care shall be maintained to prevent coated bars from being

damaged.

After the coated bars are secured to bar supports, a final visual inspection shall be made and all uncoated or damaged areas coated or repaired as required by the Engineer.

Any bar supports that deform under foot traffic or other construction activities shall not be used.

Reinforcing steel that is to be doweled into existing concrete shall be installed into drilled holes and secured using an approved non- shrink grout or a resin anchoring system listed on the Department's Qualified Products List. The diameter of the drilled holes and the installation procedures shall be as recommended by the grout manufacturer or the resin anchoring system manufacturer.

804.07 Splicing. Reinforcing steel shall be furnished in the full lengths specified on the plans. Bars spliced as a result of unforeseen construction conditions or sequences will require the written approval of the Engineer. Splices shall meet the requirements of the current edition of the AASHTO *Standard Specifications for Highway Bridges* or AASHTO *LRFD Bridge Design Specifications*, as specified in the plans.

Secondary reinforcing used for distribution of loads, such as longitudinal bars in box culverts, retaining walls, and slabs for steel girder spans, may be lapped 32 bar diameters minimum if bars are #6 (No. 19) or smaller. Primary reinforcing for columns and retaining walls which require splicing as a result of the lowering of footings shall be spliced at the upper end of the original bars. Required lengths of splices for primary reinforcing will be determined by the Bridge Engineer.

In lapped splices, the bars shall be placed in contact and fastened together in such a manner as to maintain the minimum distance to the surface of the concrete as shown on the plans. Welded or mechanical splices shall be made only if detailed on the plans or authorized in writing by the Engineer. Welding shall comply with Subsection 807.26. Mechanical splices shall be listed on the QPL and shall be the type specified on the plans or approved by the Engineer.

804.08 Lapping. Sheets of wire fabric or bar mat reinforcement shall overlap each other sufficiently to maintain a uniform strength and shall be securely fastened at the ends and edges. The lap shall be not less than one space of wire fabric or bar.

804.09 Substitutions. Bar size substitutions will be

permitted only with specific authorization by the Engineer. The substituted bars shall have an area equivalent to or larger than the design area.

804.10 Method of Measurement. Steel reinforcement properly placed and tied will be measured in pounds (kilograms) based on the total computed weight for the sizes and lengths of bars, wire fabric, or mats shown on the plans or revised by the Engineer.

Epoxy Coated Reinforcing Steel will be measured by the pound (kilogram), based on the theoretical number of pounds (kilograms) calculated on the nominal weight before application of the epoxy coating materials. No allowance will be made for the epoxy coating material, the coating process, accessories, or the testing required by the manufacturer or applicator as specified above.

The weight of wire fabric will be computed from the theoretical weight of plain wire. If the weight per square foot (square meter) is given on the plans, that weight will be used. The weight of plain round bars and deformed bars will be calculated using the following table:

U.S. STANDARD		METRIC (SI)	
Bar No.	**Weight(lbs./ft)**	**Bar No.**	**Weight (kg/m)**
3	0.376	10	0.560
4	0.668	13	0.994
5	1.043	16	1.552
6	1.502	19	2.235
7	2.044	22	3.042
8	2.670	25	3.973
9	3.400	29	5.060
10	4.303	32	6.404
11	5.313	36	7.907
14	7.65	43	11.38
18	13.60	57	20.24

The quantities shown on the plans will be considered as the final quantities and no further measurement will be made unless, in the opinion of the Engineer or upon evidence furnished by the Contractor, substantial variations exist between quantities shown on the plans and actual quantities due to changes in alignment or dimensions or to apparent errors.

If bars are substituted at the Contractor's request and as a

result more steel is used than specified, only the amount specified will be measured for payment.

When laps are made for splices other than those shown on the plans, for the convenience of the Contractor, the extra steel will not be measured for payment.

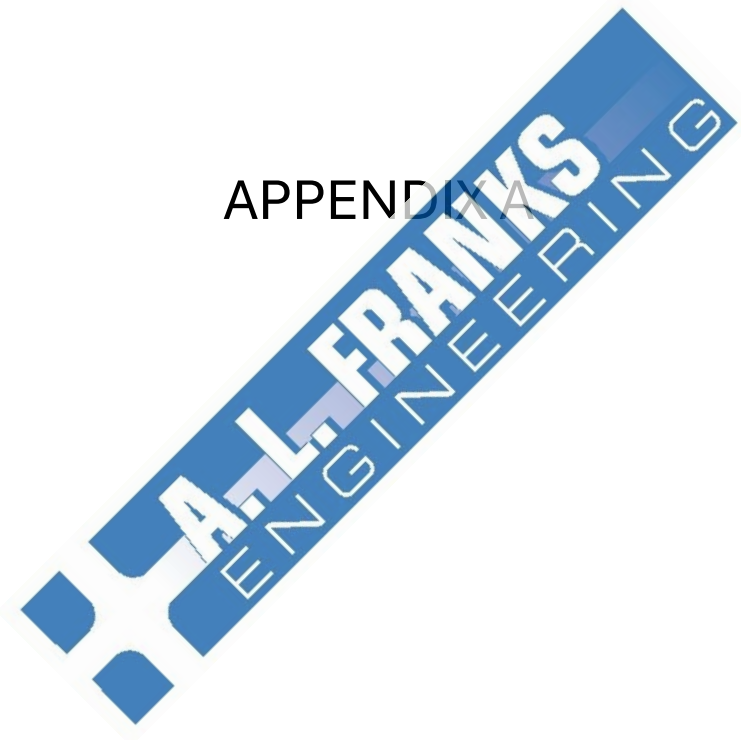
804.11 Basis of Payment. Work completed and accepted and measured as provided above will be paid for at the contract unit price per pound (kilogram) bid for Reinforcing Steel-Bridge, Reinforcing Steel-Roadway, or Epoxy Coated Reinforcing Steel, which price shall be full compensation for furnishing, bending, fabricating, epoxy coating, and placing the reinforcement; for accessories placed in concrete; and for all labor, equipment, tools, and incidentals necessary to complete the work. Clips, metal spacers, chairs, bar supports, ties, separators, wire, and other material used for fastening reinforcement in place will not be measured or paid for separately, but full compensation therefor will be considered included in the contract unit price bid for Reinforcing Steel.

When included on the plans for separate payment, wire fabric will be paid for under the applicable item of Reinforcing Steel.

Payment will be made under:

Pay Item	**Pay Unit**
Reinforcing Steel-Bridge (Grade)	Pound (Kilogram)
Reinforcing Steel-Roadway (Grade__)	Pound (Kilogram)
Epoxy Coated Reinforcing Steel (Grade___)	Pound (Kilogram)

APPENDIX A



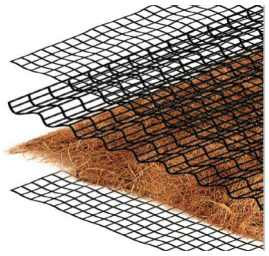
MATERIAL PROPERTY DATA SHEET

VMax® C350™

Permanent • Triple Net • Organic Fiber Matrix • Turf Reinforcement Mat

DESCRIPTION

C350 Turf Reinforcement Mat (TRM) is composed of 100% coconut fibers mechanically (stitch) bound between a three-dimensional UV stabilized, heavy duty synthetic net structure. Stitching is secured on two-inch centers using UV stabilized, synthetic thread. C350 is a permanent, three-dimensional TRM that provides immediate erosion protection and long-term turf reinforcement and is intended for applications requiring erosion protection for greater than thirty-six months.



Each roll of C350 is made in the USA and manufactured under Western Green's Quality Assurance Program to ensure a continuous distribution of fibers and consistent thickness.

Material Content	
Matrix	Coconut
Netting	Top Net: Heavyweight, UV stable Middle Net: Corrugated Ultra-Heavyweight, UV stable Bottom Net: Heavyweight, UV stable
Thread	Synthetic, UV Stable

Standard Roll Sizes				
Width	8 ft	(2.4 m)	6.5 ft	(2.0 m)
Length	90 ft	(27.4 m)	55.5 ft	(17.0 m)
Weight ± 10%	74 lb	(34.0 kg)	37 lb	(17.0 kg)
Area	80 sy	(66.9 m^2)	40 sy	(33.4 m^2)

Material available in custom roll sizes

Approvals & Classification	
Classification	FHWA: Type 5.C / ECTC: 5.D
TTI Approvals	Class 2 Type H
NTPEP Number	ECP-2020-01-14

Index Property	Test Method	Typical	
Thickness	ASTM D6525	0.58 in.	(15 mm)
Mass/Unit Area	ASTM D6566	15.0 oz/sy	(500 g/sm)
Tensile Strength – MD	ASTM D6818	750 lbs/ft	(10.9 kN/m)
Tensile Strength – TD	ASTM D6818	750 lbs/ft	(10.9 kN/m)
Elongation – MD	ASTM D6818	30%	
Elongation – TD	ASTM D6818	20%	
UV Stability	ASTM D4355	80% @1000 hr	
Light Penetration	ASTM D6567	10%	
Biomass Improvement	ASTM D7322	350%	
Specific Gravity	ASTM D792	57.4 lb/ft^3	(0.92 g/cm^3)
Porosity	ECTC	N/A	

Design Parameters		
Property	**Unvegetated**	**Vegetated[3]**
RUSLE C Factor[2]	0.05	N/A
Slope Maximum Gradient[1]	0.5H:1V	0.5H:1V
Permissible Shear Stress[2]	3.2 psf (155 Pa)	12.0 psf (575 Pa)
Permissible Velocity[2]	10.5 fps (3.2 m/s)	18.0 fps (5.5 m/s)
τ_{veg} / τ_{TRM} (HEC-15)	N/A	0.44

Manning's n Roughness (HEC-15)		
τ_{lower}	τ_{mid}	τ_{upper}
0.035	0.032	0.027

1 Maximum Gradient a recomendation for typical installations.
2 Hydraulic thresholds compliant with ASTM D6459/D6460 but generalized for typical applications.
3 Vegetated values dependent on established stand of vegetation

Rev. 4.2023

Scan for additional and updated product information, or click here.

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Evansville, IN 47725 • (800) 772-2040

MATERIAL PROPERTY DATA SHEET

FALCON PINS™

HC-12

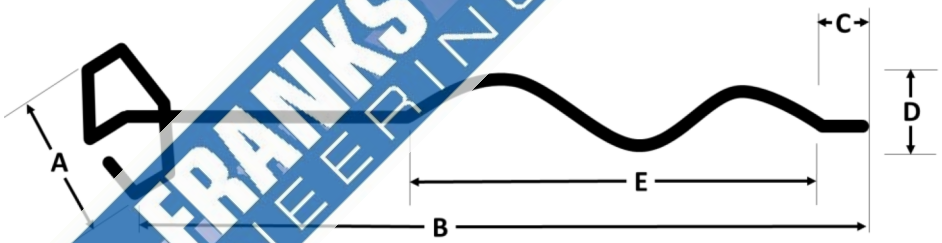
PATENT PENDING

Description

Falcon Pins by Western Green are a patent-pending fastener designed to secure erosion control mattings in place with a pull-out strength up to 10 x that of sod staples. The Falcon HC-12 has a unique 'corkscrew' coil configuration designed for soft, clayey soils. With the 'hex head' shape, the HC-12 pins are easy to install using a hand drill with a 1.5" socket attachment. For faster and easier installation, a custom driving socket is available. HC-12 pins are galvanized, made in the USA and can be installed on ARRA projects.

Dimensions and Performance

HC-12 Dimensions – in (cm)	
Hex Diameter (A)	1.5 (3.8)
Twist Pin Length (B)	12.0 (30)
Tail Length (C)	0.5 (1.3)
Coil Diameter (D)	1.0 (2.6)
Coil Length (E)	3.0 (7.6)



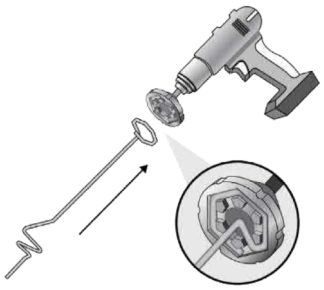
HC-12 Performance	
Pullout Resistance	Up to 200 lb (900 N)

* Pullout resistance will vary based on soil type and conditions.

Falcon Hex Pins show superior pullout resistance compared to standard fasteners. Pullout resistance will vary based on soil type. A pullout test should be conducted to verify in-situ stability. A minimum 20 lbs of pullout resistance is required for use with rolled erosion control products. HC-12 pins are optimized for clayey type sols.

Installation

- HC-12 pins can be installed with an 'off-the-shelf' 1.5" socket. A custom socket for improved performance is shown to the right.
- Ensure the tip is pushed below the TRM before drilling into ground to avoid entanglement.
- Ensure no debris is on the Falcon Pin before drilling. Debris may cause TRM fibers to entangle
- With light-weight nets, keep tension on blanket.



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MATERIAL PROPERTY DATA SHEET

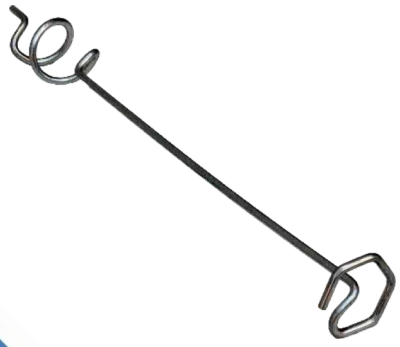
FALCON PINS™

HS-12

PATENT PENDING

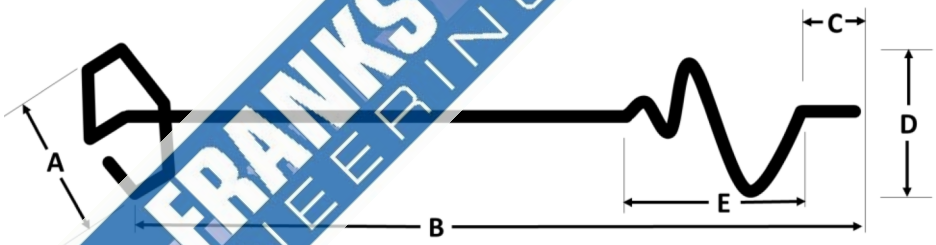
Description

Falcon Pins by Western Green are a patent-pending fastener designed to secure erosion control mattings in place with a pull-out strength up to 10 x that of sod staples. The Falcon HS-12 has a unique 'corkscrew' coil configuration designed for soft, sandy and silty soils. With the 'hex head' shape, the HS-12 pins are easy to install using a hand drill with a 1.5" socket attachment. For faster and easier installation, a custom driving socket is available. HS-12 pins are galvanized, made in the USA and can be installed on ARRA projects.



Dimensions and Performance

HS-12 Dimensions – in (cm)	
Hex Diameter (A)	1.5 (3.8)
Twist Pin Length (B)	12.0 (30)
Tail Length (C)	0.5 (1.3)
Coil Diameter (D)	1.3 (3.2)
Coil Length (E)	2.5 (6.4)



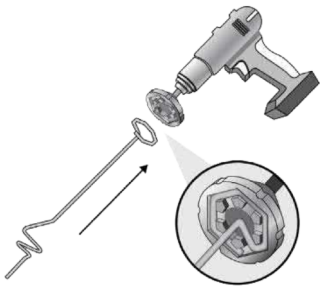
HS-12 Performance	
Pullout Resistance	Up to 250 lb (1.1 kN)

* Pullout resistance will vary based on soil type and conditions.

Falcon Hex Pins show superior pullout resistance compared to standard fasteners. Pullout resistance will vary based on soil type. A pullout test should be conducted to verify in-situ stability. A minimum 20 lbs of pullout resistance is required for use with rolled erosion control products. HS-12 pins are optimized for loose, sandy and silty type sols.

Installation

- HS-12 pins can be installed with an 'off-the-shelf' 1.5" socket. A custom socket for improved performance is shown to the right.
- Ensure the tip is pushed below the TRM before drilling into ground to avoid entanglement.
- Ensure no debris is on the Falcon Pin before drilling. Debris may cause TRM fibers to entangle
- With light-weight nets, keep tension on blanket.



FCN_MPDS_HS12_11-21

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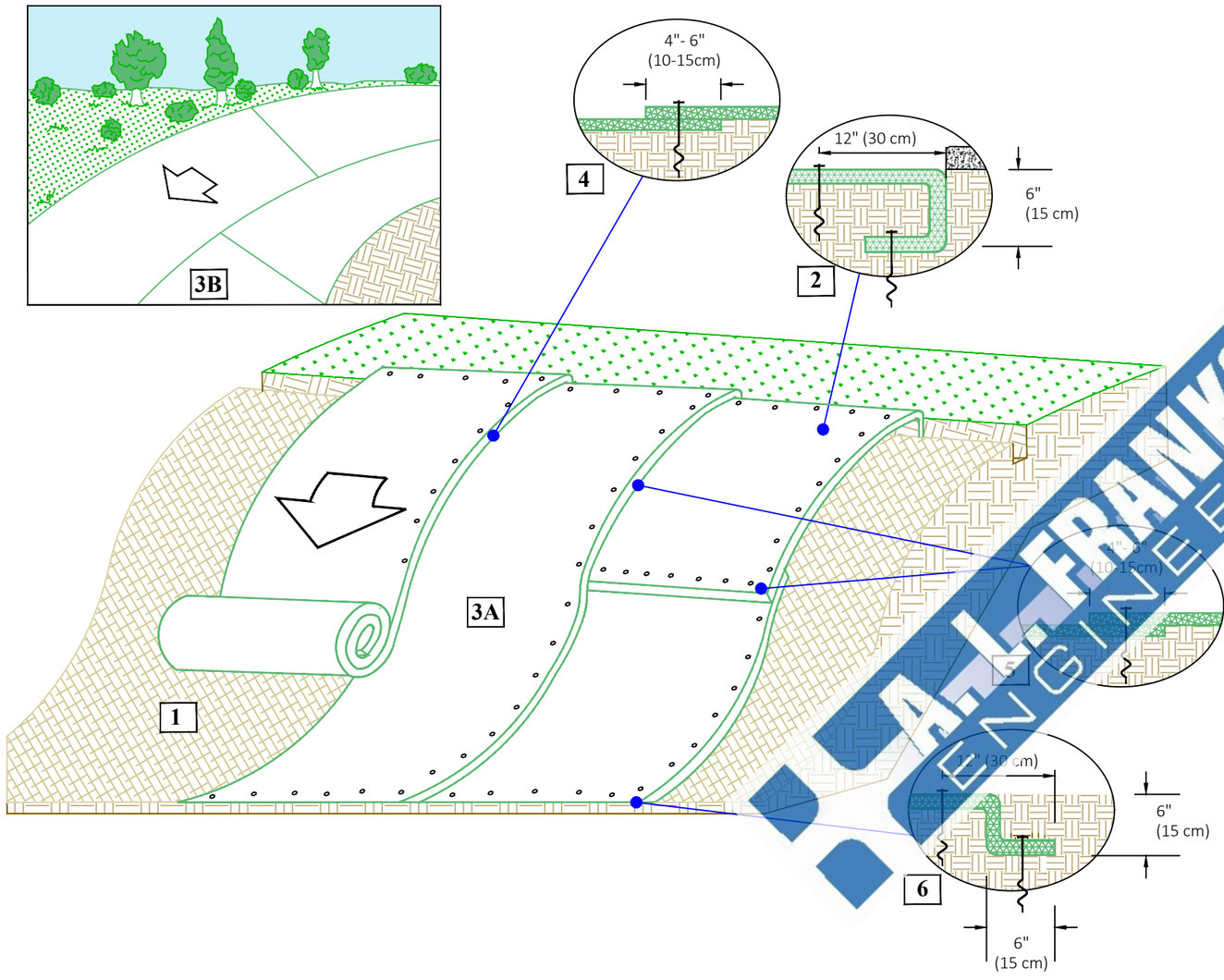
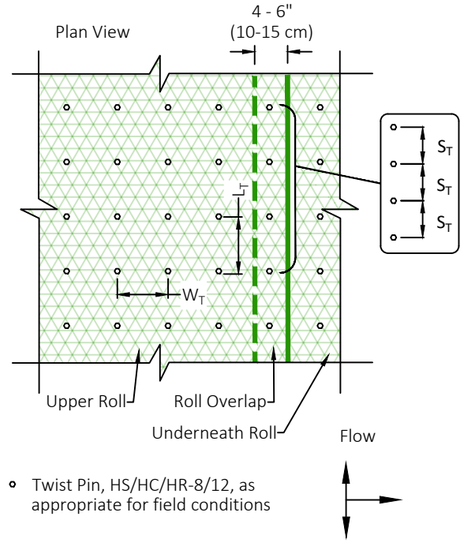


Instructions

1. Prepare soil before installing rolled erosion control products (RECPs), including any necessary application of lime, fertilizer, and seed. Ground surface must be free of debris, rocks, clay clods and raked smooth sufficient to allow intimate contact of the RECP with the soil over the entirety of the installation.
2. Begin at the top of the slope by anchoring the RECPs in a 6" (15 cm) deep X 6" (15 cm) wide trench. Anchor the RECPs with a row of staples/stakes/pins spaced at S_T apart in the bottom of the trench. Backfill and compact the trench after stapling and fold the roll over downslope. Secure RECPs over compacted soil with a row of staples/stakes/pins spaced at S_T apart across the width of the RECPs.
3. Roll the RECPs (A) down or (B) horizontally across the slope. When laying RECPs horizontal, a maximum of two roll widths or 16 feet, whichever is less, may be applied up the slope. If two roll widths or 16 ft is insufficient to cover the slope, material shall be placed vertically. RECPs will unroll with appropriate side against the soil surface. All RECPs must be securely fastened to soil surface by placing staples/stakes/pins in appropriate locations as shown in the staple pattern guide. RollMax RECPs and ECBs should utilize Staple Pattern C, TRMs and VMax materials should utilize Staple Pattern D.
4. The edges of parallel RECPs must be stapled with approximately 4" - 6" (10 - 15 cm) overlap.
5. Consecutive RECPs spliced down the slope must overlapped with the upstream mat atop the downstream mat (shingle style). The overlap should be 4" - 6" (10 - 15 cm).
6. At the terminal end, secure each mat across the width with a row of staples/stakes/pins spaced at S_T. If exposed to flow, foot traffic, wind uplift or other disruption, trench the terminal end in as shown in detail.
7. Fasteners should provide a minimum of sixty pounds of pullout resistance. Falcon HC-8 or HS-8 are typically adequate. In loose soils, longer twist pins may be necessary, HC-12 or HS-12. In hard or rocky soils, hardened spikes (12" Ardox) or Falcon HR-8 / HR- 12 pins may be used, assuming minimum pullout resistance is provided. Bio-degradable fasteners shall not be used with TRM or HPTRM materials.

Staple Pattern Guide



- Twist Pin, HS/HC/HR-8/12, as appropriate for field conditions

	Staple Pattern	
Dimension	C	D
W_T	30" (75 cm)	22" (55 cm)
L_T	30" (75 cm)	22" (55 cm)
S_T	18" (45 cm)	18" (45 cm)
Nominal Frequency	1.7/SY (2.0/Sm)	3.0/SY (3.6/Sm)
Application	ECB (Degradable)	TRM (Permanent)
Required Fastener	Min. 60# pullout	Min. 60# pullout
*Note: Staple Pattern A and B used prior to 8/2019 have been discontinued.		

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Project: Standard Slope/Rainfall Layout - RECP

Shown: Isometric View of Slope, Fastener Placement, Trenching and Overlap, Some Fasteners and Vegetation Omitted for Clarity, NTS

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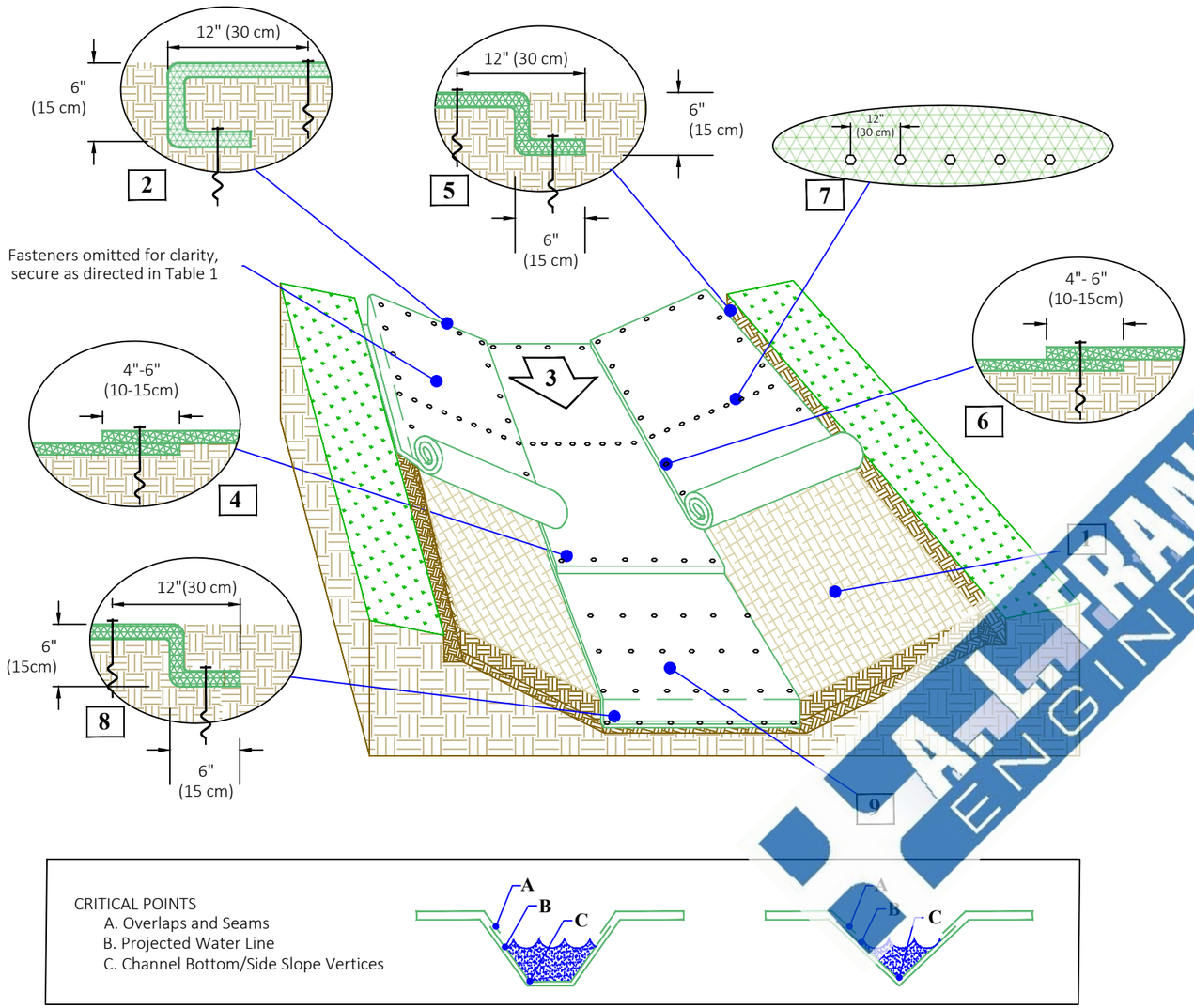
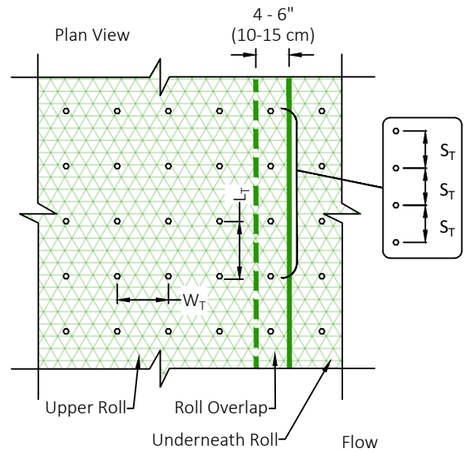


NOTES:
*Horizontal staple spacing should be altered if necessary to allow staples to secure the critical points along the channel surface.

Instructions

1. Prepare soil before installing rolled erosion control products (RECPs), including any necessary application of lime, fertilizer, and seed. Ground surface must be free of debris, rocks, clay clods and raked smooth sufficient to allow intimate contact of the RECP with the soil over the entirety of the installation.
2. Begin at the top of the channel by anchoring the RECPs in a 6" (15 cm) deep X 6" (15 cm) wide trench with the RECPs staged upstream of the trench. Anchor the RECPs with a row of twist pins spaced at S_T apart in the bottom of the trench. Backfill and compact the trench after fastening. Apply seed to the compacted soil and unroll the RECPs back over the seed and compacted soil, proceeding downstream. Secure RECPs over compacted soil with a row of twist pins located approximately 12" (30 cm) from the upstream edge of the installation, spaced at S_T.
3. Roll center RECPs in direction of water flow in bottom of channel. RECPs shall be unrolled with appropriate side against the soil surface. All RECPs must be securely fastened to soil surface by placing twist pins in appropriate locations as shown in the pin pattern guide.
4. Place consecutive RECPs end-over-end (Shingle style) with a 4"- 6" (10 - 15 cm) overlap. Secure overlaps as shown.
5. Full length edge of RECPs at top of side slopes must be anchored with a row of twist pins spaced at S_T apart in a 6" (15 cm) deep X 6"(15 cm) wide trench. Backfill and compact the trench after stapling.
6. Adjacent RECPs must be overlapped approximately 4"- 6" (10 - 15 cm) and secured with twist pins at S_T.
7. In high flow channel applications a pin check slot is recommended at 30 to 40 foot (9 -12m) intervals. Use a row of twist pins spaced at 12" (30 cm) on center over entire width of the channel.
8. The terminal end of the RECPs must be anchored with a row of twist pins spaced at S_T apart in a 6" (15 cm) deep X 6" (15 cm) wide trench (minimum). Backfill and compact the trench after stapling.
9. Secure fasteners throughout the body of the mats. Fasteners should provide a minimum of sixty pounds of pullout resistance. Falcon HC-8 or HS-8 are typically adequate. In loose soils, longer twist pins may be necessary, HC-12 or HS-12. In hard or rocky soils, hardened spikes (12" Ardox) or Falcon HR-8 / HR- 12 pins may be used, assuming minimum pullout resistance is provided. Bio-degradable fasteners shall not be used with TRM or HPTRM materials.

Pin Pattern Guide



- Twist Pin, HS/HC/HR-8/12, as appropriate for field conditions

Table 1

	Pin Pattern
Dimension	E
W_T	20" (50 cm)
L_T	20" (50 cm)
S_T	18" (45 cm)
Nominal Frequency	3.8/SY (4.6/Sm)
Required Fastener	Min. 60# Pullout

WESTERN GREEN
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EAST COAST erosion control

Project: Standard Channel Layout, Unroll w/Flow - RECP w/Falcon Twist Pins

Shown: Isometric View of Channel, Fastener Placement, Trenching and Overlap, Some Fasteners and Vegetation Omitted for Clarity, NTS

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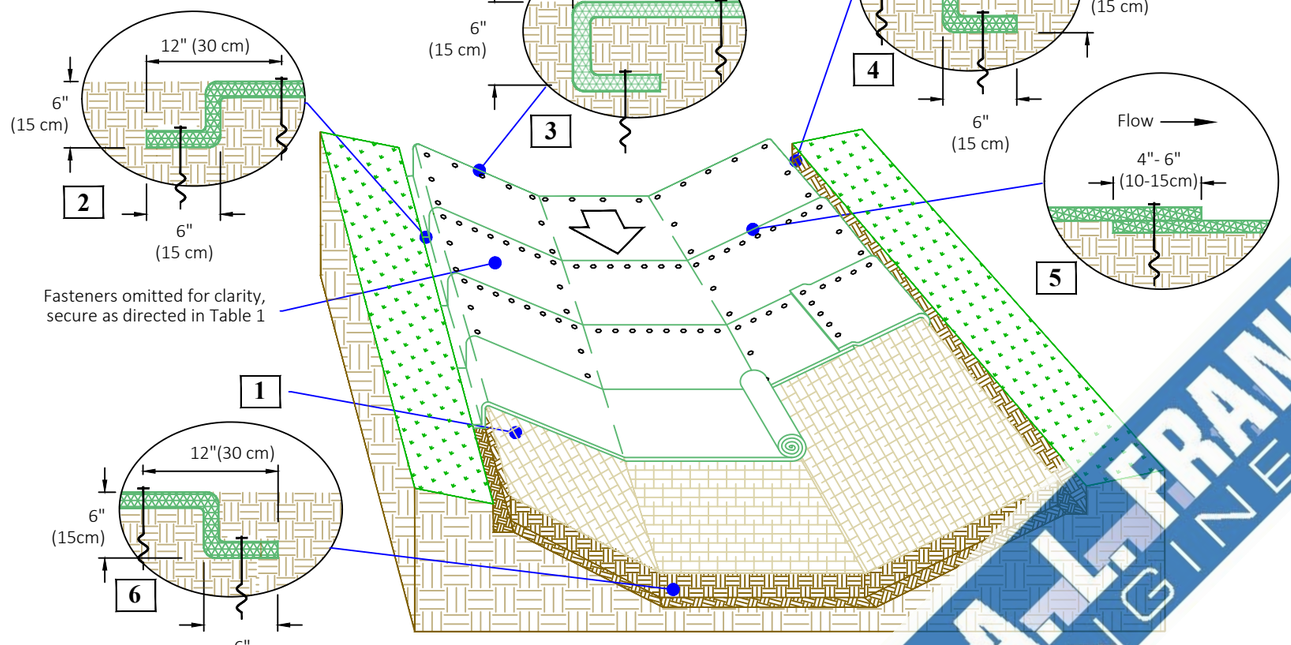
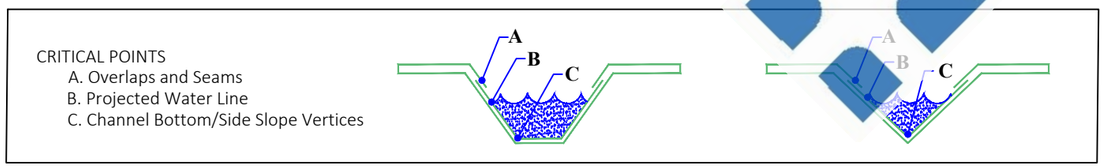


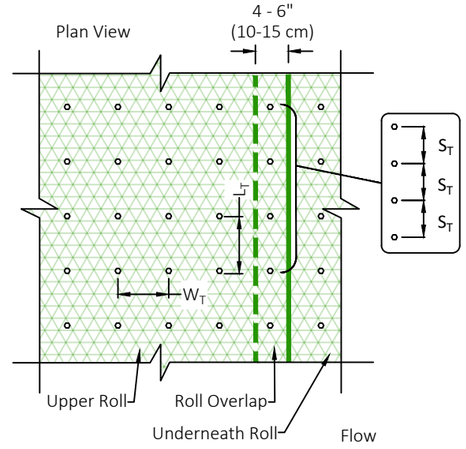


NOTES:
*Horizontal staple spacing should be altered if necessary to allow staples to secure the critical points along the channel surface.

Instructions

1. Prepare soil (fig. 1) before installing rolled erosion control products (RECPs), including any necessary application of lime, fertilizer, and seed. Ground surface must be free of debris, rocks, clay clods and raked smooth sufficient to allow intimate contact of the RECP with the soil over the entirety of the installation. Apply seed and amendments to the compacted soil.
2. Dig anchor trench, 6" (15 cm) deep X 6" (15 cm) wide, at the upstream most edge of installation across the channel. Begin at the top of the channel by unrolling the RECP across the channel, perpendicular to the direction of flow, cut to fit, carefully flip the RECP panel upstream, leaving it upside down. Place the upside down leading edge in the trench. Anchor the RECP panel with a row of twist pins spaced at S_T apart in the bottom of the trench. Backfill and compact the trench after fastening. With the RECP secured in the backfilled trench, flip the RECP panel over, right side up, over the backfill. The end result should mimic fig. 2. Secure RECP just downstream of trench with a row of twist pins located approximately 12" (30 cm) downstream from the trench, spaced at S_T.
3. Roll subsequent RECP panels across the channel, fitting the downstream panel under the upstream panel. RECPs shall be unrolled with appropriate side against the soil surface. All RECPs must be securely fastened to soil surface by placing twist pins in appropriate locations as shown in the pin pattern guide.
4. Place consecutive RECPs end-over-end (Shingle style) with a 4"- 6" (10 - 15 cm) overlap, see fig.6. Secure overlaps as shown.
5. Adjacent RECPs must be overlapped approximately 4"- 6" (10 - 15 cm) and secured with twist pins at S_T.
6. The terminal end of the RECPs must be anchored with a row of twist pins spaced at S_T apart in a 6" (15 cm) deep X 6" (15 cm) wide trench (minimum). Backfill and compact the trench after stapling.
7. Secure fasteners throughout the body of the mats. Fasteners should provide a minimum of sixty pounds of pullout resistance. Falcon HC-8 or HS-8 are typically adequate. In loose soils, longer twist pins may be necessary, HC-12 or HS-12. In hard or rocky soils, hardened spikes (12" Ardox) or Falcon HR-8 / HR- 12 pins may be used, assuming minimum pullout resistance is achieved. Bio-degradable fasteners shall not be used with TRM or HPTRM materials.

Pin Pattern Guide



- Twist Pin, HS/HC/HR-8/12, as appropriate for field conditions

Table 1

	Pin Pattern
Dimension	E
W_T	20" (50 cm)
L_T	20" (50 cm)
S_T	18" (45 cm)
Nominal Frequency	3.8/SY (4.6/Sm)
Required Fastener	Min. 60# Pullout

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Project: Standard Channel Layout, Unroll Cross Flow - RECP w/ Falcon Twist Pins

Shown: Isometric View of Channel, Fastener Placement, Trenching and Overlap, Some Fasteners and Vegetation Omitted for Clarity, NTS

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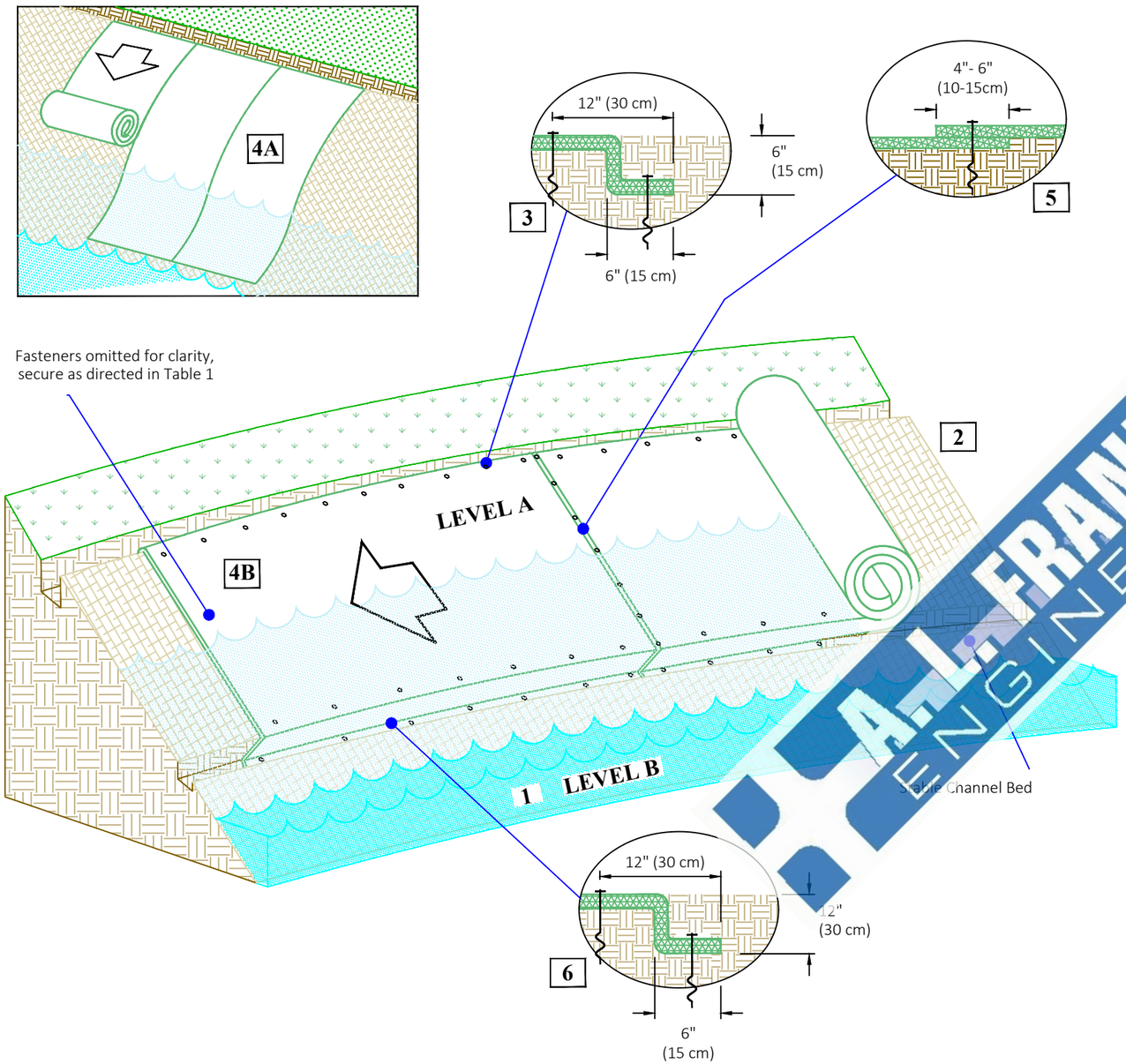
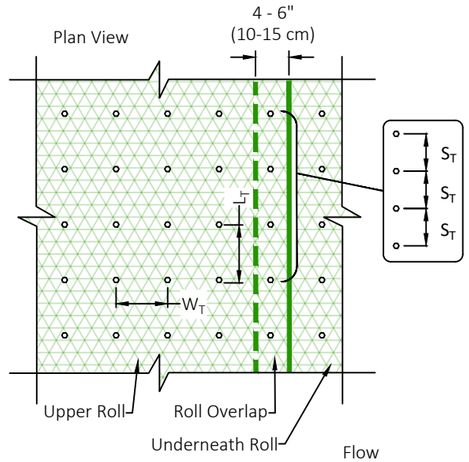


Instructions

1. For easier installation, lower water level from Level A to Level B before installation.
2. Prepare soil before installing rolled erosion control products (RECPs), including any necessary application of lime, fertilizer, and seed. Ground surface must be free of debris, rocks, clay clods and raked smooth sufficient to allow intimate contact of the RECP with the soil over the entirety of the installation.
3. Begin at the top of the shoreline by anchoring the RECPs in a 6" (15 cm) deep X 6" (15 cm) wide trench. Anchor the RECPs with a row of staples/stakes/pins spaced at S_T apart in the bottom of the trench. Backfill and compact the trench after stapling.
4. Roll RECPs either (A) down the shoreline for long banks (top to bottom) or (B) horizontally across the shoreline slope. RECPs will unroll with appropriate side against the soil surface. VMax TRMs should always be installed parallel to flow. All RECPs must be securely fastened to soil surface by placing staples/stakes/pins in appropriate locations as shown in the staple pattern guide.
5. The edges of all horizontal and vertical seams must be stapled with approximately 4" - 6" (10 - 15 cm) overlap. Note: *In streambank applications, seam overlaps should be shingled in the predominant flow direction.
6. The edges of the RECPs at or below normal water level must be anchored by placing the RECP's in a 12" (30 cm) deep X 6" (15 cm) wide anchor trench. Anchor the RECPs with a row of staples/stakes/pins spaced approximately 12"(30cm) apart in the trench. Backfill and compact the trench after stapling (stone or soil may be used as backfill). For installation at or below normal water level, use of ShoreMax mat on top of the RECP or geotextile underneath is likely required for sections below the normal water line.
7. Fasteners should provide a minimum of sixty pounds of pullout resistance. Falcon HC-8 or HS-8 are typically adequate. In loose soils, longer twist pins may be necessary, HC-12 or HS-12. In hard or rocky soils, hardened spikes (12" Ardox) or Falcon HR-8 / HR- 12 pins may be used, assuming minimum pullout resistance is provided. Bio-degradable fasteners shall not be used with TRM or HPTRM materials.

Pin Pattern Guide



- Twist Pin, HS/HC/HR-8/12, as appropriate for field conditions

Table 1

	Pin Pattern
Dimension	E
W_T	20" (50 cm)
L_T	20" (50 cm)
S_T	18" (45 cm)
Nominal Frequency	3.8/SY (4.6/Sm)
Required Fastener	Min. 60# Pullout

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Project: Standard Channel Bank Layout - RECP w/Falcon Tist Pins

Shown: Isometric View of Channel, Fastener Placement, Trenching and Overlap, Some Fasteners and Vegetation Omitted for Clarity, NTS

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