DIVISION 23. SURFACE COURSES

Construct surface courses on a prepared base, subbase, or subgrade according to the requirements specified for the various types in the following sections. Comply with the lines, grades, thicknesses, and typical cross sections shown in the contract documents or established by the Engineer.

2301. Portland Cement Concrete Pavement.
2302. Portland Cement Concrete Widening.
2303. Hot Mix Asphalt Mixtures.
2304. Detour Pavement.
2306. Bituminous Fog Seal (Pavement).
2307. Bituminous Seal Coat.
2308. Bituminous Fog Seal (Shoulders).
2309. Surface Recycling by Heater Scarification.
2310. Portland Cement Concrete Overlay.
2312. Granular Surfacing.
2314. Surface Application of Calcium Chloride.
2315. Driveway Surfacing.
2316. Pavement Smoothness.
2317. Primary and Interstate Pavement Smoothness.
2318. Cold In-Place Recycled Asphalt Pavement.
2319. Slurry Leveling, Slurry Wedge (Edge Rut Treatment), and Strip Slurry Treatment.

Section 2301. Portland Cement Concrete Pavement

2301.01 DESCRIPTION.

A single course of PCC pavement of the type and class specified in the contract. If the class of concrete is not specified, Class C concrete shall be used.

A. Standard Concrete Pavement.
Standard concrete pavement may be reinforced or non-reinforced. Use the class of concrete specified in the contract documents. Reinforce as shown in the contract documents. Place within fixed forms, consolidate, and finish by equipment operating on forms.

B. Slip Form Pavement.
Slip form pavement may be reinforced or non-reinforced concrete of the class specified in the contract documents. Reinforce as shown in the contract documents. Place, consolidate, and finish without the use of fixed forms.

2301.02 MATERIALS.

A. General.

1. Meet the requirements for the respective items in Division 41. Unless specified otherwise, use coarse aggregate of the durability class required by Section 4115.

2. Ensure compatibility of all material combinations. If the concrete materials are not producing a workable concrete mixture, a change in the material may be required. Changes will be at no additional cost to the Contracting Authority.

B. Portland Cement Concrete Pavement.

1. General.

a. Proportion materials for pavement concrete in one of the mixtures identified in Materials I.M. 529 for the class of concrete specified in the contract documents. Any of the mixtures may be used, at the Contractor's option, provided the gradation of the separate aggregates complies with the gradation required for that mixture. Do not use C-5 and C-6 concrete mix proportions for pavements on Interstate or Primary highways.

b. After October 31, use Class A concrete to construct all items of concrete pavement specified to be constructed with Class B concrete. The Engineer will either require completion by continuing placement operations past October 31, or allow the Contractor the option of a winter shutdown. When completion is required, the Contracting Authority will pay the net increase in cost of materials resulting from the change in proportions for any pavement placed within the contract period or authorized extension of the contract period. Other increases shall be at no additional cost to the Contracting Authority.

2. Combined Fine and Coarse Aggregate.

a. If using an approved fine and coarse aggregate combination, fix the proportions on the basis of the relative amount of fine and coarse aggregate contained so as to be equivalent to one of the appropriate mixes specified for screened aggregates. These proportions are based on a specific gravity of 2.62 for Class V aggregate and 2.65 for other aggregates.

b. If the material furnished shows an average specific gravity other than the above values, adjust the proportions by the ratio of the actual average specific gravity to the above values.

3. Water, Consistency, and Batch Yield.

a. Use an amount of mixing water that will produce workable concrete of uniform consistency. Unless specifically modified by the Engineer, ensure slump, measured according to Materials I.M. 317, is no less than 1/2 inch (15 mm) or no more than 4 inches (100 mm). Slump requirements will not apply to slip form paving.

b. If it is not possible to produce concrete having the required consistency without exceeding the maximum allowable water cement ratio specified, the cement content may be increased or water reducing admixture may be added. Obtain the Engineer’s approval. Do not exceed the maximum water cement ratio. Additional cement or water reducer will be considered incidental, with no additional cost to the Contracting Authority.

c. The basic absolute volume of water per unit volume of concrete is based on average conditions. If material characteristics require that the total quantity of water used to secure the required consistency reduces the batch yield (computed on the basis of absolute volumes of the batch quantities used) by more than 2.0%, the Engineer may adjust the proportions to correct the yield. This adjustment will not be a basis for adjustment of the contract unit price.

4. Entrained Air Content.
Use an approved air entraining agent. The target air content as determined by Materials I.M. 318 is 8.0%, with a tolerance of ± 2% when measured on the grade just prior to consolidation. Air content for non slip form paving is 7.0% ± 1.5%. The target air content may be adjusted by the Engineer based on random tests of the consolidated concrete behind the paving machine. These additional random tests will be used to consider the need for a target change, and will not be used in the acceptance decision.

5. Admixtures.
Approved admixtures complying with Section 4103 may be used with the Engineer's authorization.

6. Use of Supplementary Cementitious Materials.
The maximum allowable fly ash substitution rate is 20%. The GGBFS substitution rate shall not be more than 35% by weight (mass). The total mineral admixture substitution rate shall not exceed 40%. When Type IP or IS cement is used in the concrete mixture, only fly ash substitution will be permitted. Substitution of Type I/II cement with both GGBFS and fly ash will be permitted in ready mix concrete mixtures only. Between October 16 and March 15, fly ash substitution will be allowed only when maturity method is used to determine time of opening.

C. Proportioning and Mixing of Concrete Materials.
Proportion and mix materials according to the following requirements:

1. Storage and Handling of Aggregates.

a. Store and handle aggregates to avoid contamination and frequent variations in specific gravity, gradation, or moisture content of the materials used.

b. Keep fine and coarse aggregate stored in piles or bins entirely separate of one another.

c. When aggregates are trucked to the proportioning plant, the trucks must dump off a ramp or into a walled pit. In either case, they must dump into a floored area. This floor shall consist of a substantial platform or a layer of similar aggregate at least 18 inches (0.5 m) thick placed entirely below the elevation of the surrounding ground.

d. Reduce, to a minimum the Engineer considers practical, the number of changes from one material to another having different frictional characteristics, class of durability, or average specific gravity.

e. At the time of proportioning or placing in proportioning bins, the moisture content of the aggregates shall be such that water will not drain or drip from a moisture sample. Handle aggregates in a manner that will prevent variations of more than 0.5% in moisture content of successive batches. Thoroughly wet coarse aggregates having an absorption greater than 0.5% and allow to drain for at least 1 hour before being used.

f. Drain fine aggregate at least 24 hours after washing and before batching.

g. Do not allow aggregates from two sources to commingle in stockpiles or in the finished pavement, except with the Engineer's approval.

2. Storage and Handling of Cement and Fly Ash.

a. Store cement in suitable weatherproof enclosures and handle to prevent loss.

b. Apply Section 4101 to cement which has developed lumps or which has been stored for extended periods.

c. Transport and store fly ash in suitable weatherproof enclosures in a manner to keep it dry.

d. Use proportioning equipment meeting the requirements of Article 2001.20, B.

3. Measurement of Materials.

Measurement of materials shall meet the requirements for the type of equipment used and the following additional requirements:

a. Operate cement scales within a delivery tolerance of 1.0% of the mass of cement per batch. When operated manually, balance scales to tare before each batch is weighed and after each batch is discharged.

b. Use cement and fly ash scales with automatic controls which meet the requirements of Article 2001.20, B, for all bid items involving more than 6000 square yards (5000 m^2) of pavement base. Items made up of irregular areas, such as crossovers, turn lanes, and so forth, are excluded from this requirement.

c. Do not use manual controls for a period longer than 1 working day after a failure of the automatic controls, except with the Engineer's permission.

d. On work requiring automatic scales, the performance of the scale will be determined near the end of the first full day of production. Afterwards, performance of the scale will be determined at a frequency not to exceed 10,000 cubic yards (10,000 m^3) of concrete produced. Performance will be determined by comparing the accumulated mass of cement proportioned with the corresponding accumulated mass of cement shipped to the project. The Contractor shall cooperate. Cement scale performance determinations are not required when a permanent, commercial ready mix plant is used to furnish less than 10,000 cubic yards (10,000 m^3) of concrete for a contract.

e. Determine the performance of fly ash scale, if present, as in Paragraph d above.

f. Operate aggregate scales within a delivery tolerance of 1.0% for each aggregate.

g. Measure water within a delivery tolerance of 1.0% of intended quantity.

h. Measure admixtures with approved equipment and procedures that assure the quantity measured is within a delivery tolerance of 3.0% of batch quantity. Clean and flush out mechanical dispensing equipment daily, and more frequently if necessary to ensure proper operation.

4. Mixing of Materials.

a. General.

1) Mix concrete materials either at the site of placement or in a construction or stationary mixer to be used for work on the project only. Concrete may also be ready mixed or transit mixed. During any one individual placement, use the same cement, aggregates, and admixtures throughout the placement unless the Engineer approves otherwise. With the Engineer's approval, concrete mixtures may be furnished from multiple plants provided the same materials are used in each mixture and mix consistency can be maintained.

2) Mix concrete material as provided in Article 2001.21 for the type of equipment used.

3) Do not use concrete transported without continuous agitation if the elapsed period between the time the concrete is mixed and the time it is placed is greater than 30 minutes. With the Engineer's approval, an approved retarding admixture may be used at the rate prescribed in Materials I.M. 403. Also with the Engineer's approval, the mixed-to-placed time period may be extended an additional 30 minutes.

4) Do not use concrete transported with agitation when the time between start of mixing and placement is more than 90 minutes.

5) Deliver and handle concrete in a manner that will:

- Prevent objectionable segregation or damage to the concrete, and
- Facilitate placing with a minimum of handling.

6) Thoroughly clean and flush the compartment in which the concrete is transported to the work at intervals necessary to ensure hardened concrete will not accumulate in the compartment. Discharge flushing water from the compartment before it is charged with the next batch.

7) Obtain Engineer's approval for plant equipment, operation, and procedures.

b. Concrete Mixed in a Construction or Stationary Mixer.

1) Use a method of handling batches and charging the mixer that ensures complete introduction of each batch separately without loss of materials.

2) Concrete discharged from the mixer is required to be uniform in composition and consistency. If this condition is not produced because of the size of the batch, the batch size may

be reduced or the mixing time increased, or both, until this result is obtained.

c. Ready Mixed Concrete.

1) Ready mixed concrete is defined as concrete for which the required materials are as follows:

a) Proportioned in a central plant and mixed in a stationary mixer for transportation in trucks with or without agitation.

b) Proportioned and then mixed in a transit mixer prior to or during transit.

2) When additional mixing water is required at the site of placement, mix the batch for at least an additional 30 revolutions of the drum at mixing speed.

3) For main portions of the work designed to support public vehicular traffic:

a) Demonstrate to the Engineer before the work starts that each vehicle in which concrete will be delivered to the work is capable of discharging concrete having a slump not over 2 inches (50 mm) at an overall rate for its entire load of no less than 1.25 cubic yards (1 m^3) per minute.

b) Ensure concrete is delivered at a rate sufficient to maintain a sustained rate of progress no less than 100 feet (30 m) per hour for the width and depth of slab to be placed.

c) Ensure adequate and properly staffed dispatching system is utilized.

4) Ready mixed or transit mixed concrete may be used for other portions of the work under other restrictions specified for bid items involving 6000 square yards (5000 m^2) of pavement or less. Ready mixed or transit mixed concrete may also be used for irregular pavement areas such as crossovers and turn lanes.

2301.03 CONSTRUCTION.

When the contract allows for either standard or slip form pavement, the method used is the Contractor's option. When the contract allows only one type, use the type specified. When slip form is specified, small or irregular areas may be constructed with fixed forms. Irregularly shaped areas of either type of pavement may be formed and finished by hand methods.

A. Equipment.

1. General.

Provide sufficient equipment to perform all operations necessary to complete the work. Use equipment meeting the appropriate requirements of Section 2001 and the following provisions.

2. Proportioning and Mixing Equipment.

Use equipment that complies with the following:

a. Weighing and Proportioning Equipment.

Apply Article 2001.20.

b. Mixing Equipment.

Apply Article 2001.21.

c. Bins.
Apply Article 2001.06.

3. Construction Equipment for Portland Cement Concrete Pavement.
Use equipment that complies with the following requirements:

a. Equipment for Standard Concrete Pavement.

1) Side Forms.

a) General.

(1) Use side forms with a height (without horizontal joint) at least equal to the design thickness of the pavement at its edge. The additional height represented by integral curb may be secured by bolting extra forms on the top of the main form.

(2) Ensure the top face of a form does not vary from a true plane by more than 1/8 inch in 10 feet (3 mm in 3 m). Ensure the vertical face does not vary from a true plane by more than 1/4 inch in 10 feet (6 mm in 3 m).

(3) For curves having radii of 100 feet (30 m) or less, use flexible or curved forms.

b) Forms Required to Support Heavy Equipment.

(1) Use steel no thinner than U.S. standard 5 gauge (approximately 7/32 inch (5 mm)). Equip with a device that permits adjustment for horizontal and vertical curves for holding abutting sections firmly in alignment.

(2) If using forms having a height of 8 inches (200 mm) or more, ensure the base is no less than 8 inches (200 mm) wide. If using forms having a height less than 8 inches (200 mm), ensure their base width is no less than their height. Equip with no less than three staking points per each 10 feet (3 m) of length, with means for securely locking the form to each stake. Extend flange braces and staking pockets outward on the base no less than 65% of the height of the form.

c) Forms Not Required to Support Heavy Equipment.

(1) Forms not required to support heavy equipment may be made of wood or steel. Ensure forms have sufficient stiffness and are staked to remain vertical and true to line and grade during placing and finishing of concrete.

(2) Use nominal 2 inch (50 mm) stock straight wood forms.

(3) Use wood forms that are finished on the side supporting the concrete and on their upper edge.

2) Integral Curb Forms.

a) Use metal forms to form the back of all integral curbs, except where returns have a small radius or other special sections making the use of metal forms impractical.

b) Rigidly attach back forms for curb to the side forms for the pavement slab. Use all fastenings provided by the form manufacturer. Supply a sufficient length of curb forms and

number of fastenings to make it possible to leave the forms in place for at least 6 hours after the curb is place.

c) At the time the curb form is placed, ensure the top of the pavement is free of all substances which prevent the rigid fastening or accurate alignment of the curb form. Ensure the curb form extends the plane of pavement form without a variation of more than 1/8 inch (3 mm). Set the top of the curb form at the elevation of top of curb being built, except at curb runouts.

d) Sloping faced curb not more than 4 inches (100 mm) in height may be shaped to the desired cross section with a curb mule without the use of face forms.

e) For straight sections of integral curb more than 4 inches (15 mm) high, the Contractor may use face forms or a slip form curb mule. If face forms are used, provide no less than 100 feet (30 m) for each curb being constructed. Properly secure face forms to maintain their shape and position during use. Ensure the face forms produce a curb cross section matching that of the details within the contract documents. Approved hand tools and methods may be used to supplement the forms in shaping the top roll and on returns and other special sections.

f) If a slip form curb mule is used, use a slip form curb mule that is no less than 6 feet (1.8 m) long, unless mounted on a machine. Obtain the Engineer's approval before using the slip form curb mule. Both back and face forms will be required when constructing barrier curbs or any curb having a top width of 8 inches (200 mm) or more.

3) Supplementary Rails.

a) Provide suitable metal rails capable of being securely attached to the top of the side forms to provide a track which will allow spreading, finishing, and curing equipment to back over the end of the previous day's run.

b) Ensure metal rail length is sufficient to accommodate all equipment which must be backed out of the way. Also ensure the rails are of such a height that all wheels and flanges of wheels will clear the previously placed concrete by at least 1/2 inch (15 mm).

4) Form Line Excavating Machine.

Excavate form lines for all forms supporting mechanical finishing equipment to line and grade by:

- A machine designed for this purpose and approved by the Engineer, or
- An approved machine which concurrently trims the subgrade or subbase to grade.

5) Subgrade Preparation.

Trim the subgrade or subbase to grade with a machine having electronic elevation controls. The Engineer's approval is required for other trimming methods.

6) Consolidating and Finishing Equipment.

For placing and finishing standard type pavement, the following equipment will be required:

a) Vibrators.

(1) Consolidate, with a single pass of an approved internal or surface vibrator, the full width and depth of concrete requiring a finishing machine. Operate internal vibrators within a frequency range of 4000 to 8000 vibrations per minute. The Engineer may authorize the minimum vibration frequency to be lowered to 3500 vibrations per minute for particular sections of paving, such as superelevations. Operate surface vibrators within a frequency range of 3500 to 6000 vibrations per minute.

(2) Avoid operating vibrators in a manner to cause a separation of mix ingredients, either a downward displacement of large aggregate particles or an accumulation of laitance on the surface of the concrete. When forward motion of the paver is reduced, vibrator frequency may need to be reduced to avoid separation of the mix.

(3) If a vibrator fails to operate within the specifications, repair or change the vibrator before paving begins:

- The following day, or
- The same day if the continuous paving that day is stopped at a header or the end of a session.

(4) If two adjacent vibrators fail to operate within specifications, stop paving operations and repair or replace the vibrators.

(5) Stop vibrators whenever forward motion of the paver is stopped.

(6) Use an electronic vibrator monitoring device displaying the operating frequency of each individual internal vibrator for all Interstate and Primary contracts with PCC paving quantities of mainline paving over 50,000 square yards (40,000 m^2) and other projects when specified in the contract documents. When required on a contract, the vibrator monitoring device will only be required in areas where mainline pavement length exceeds 600 feet (175 m). When project staging necessitates small mainline sections be paved separately from the majority of mainline paving, the Engineer may waive this requirement for those small sections.

(7) Use a vibrator monitoring device that meets all of the following:

(a) Has a readout display near the operator's controls visible to the paver operator and the Engineer.

(b) Operates continuously while paving.

(c) Displays all vibrator frequencies with manual or automatic sequencing among all individual vibrators.

(d) Records, at a minimum, the clock time, station location, paver track speed, and operating

frequency of individual vibrators. Make recordings after each 25 feet (8 m) of paving or after each 5 minutes of time.

(8) Provide the Engineer with an electronic record daily for the first 3 days of paving and weekly thereafter. The Engineer may determine that more frequent submission is necessary, particularly if equipment malfunctions occur.

(9) If the electronic monitoring device fails to operate properly, manually check vibrators immediately. If vibrators are functioning properly, paving may continue, but correct the problem as soon as possible. If recording device fails to operate, paving may continue, but correct the malfunction within 3 paving days. The Engineer may allow additional time if circumstances are beyond the Contractor's control.

(10) Set the internal vibrator penetration depth into the concrete pavement slab to mid slab or as deep as possible while passing above reinforcing steel. Provide an operating position locking device so that no part of the vibrating unit can be lowered to the extent that it will come in contact with reinforcing steel or tie bars while paving.

(11) Do not exceed the manufacturer's recommendations for vibrator horizontal spacing. Do not exceed 16 inches (410 mm) from center to center.

(12) Mount longitudinal axis of vibrator body approximately parallel to direction of paving. Tilt trailing end of each vibrator downward to an approximate slope of 15 degrees below horizontal.

(13) Use vibrators that meet or exceed the following specifications at the manufacturer's design frequency of 10,000 vpm:

(a) Amplitude (peak to peak) 0.070 inches (1.75 mm).

(b) Centrifugal force 1200 pounds (5500 N).

b) Finishing Machine.

(1) Where side clearance is provided, a finishing machine designed for concrete paving will be required on all uniform width slabs 8 1/2 feet (2.6 m) or wider upon which a continuous line of forms more than 600 feet (180 m) in length may be set. Obtain Engineer's approval before using this machine. Utility accesses, intakes, and other small fixtures will not be considered as an obstruction to the continuity of the form line. Railroad tracks, bridges, and existing paved intersections will be considered as obstructions in the continuity of the form line.

(2) Use a finishing machine that leaves the top of the concrete slab smooth with the desired crown and at the proper elevation. When the contract documents

require the pavement to be laid partly with crown and partly without crown, equip the screed so that it can be adjusted to the change in shape at the required rate of change.

(3) If during the operation of subgrade or finishing equipment it is necessary to operate one or both sets of wheels or tracks on previously placed concrete, adjust or alter the wheels or tracks so that the bearing on the concrete will not be closer than 3 inches (75 mm) from the pavement edge. When operating with one side of the machine on pavement and the other side on forms, the wheels operating on the forms may be double flanged. Use flangeless, rubber faced wheels on the pavement. When operating over the edge of concrete less than 2 months old, support the ends of the finishing machine screeds with an approved device to provide from 1/16 to 1/8 inch (2 mm to 3 mm) clearance between the screed and previously placed pavement.

(4) Suspension resulting in a pendulum effect will not be approved.

(5) Sections of pavement not required to be finished with a finishing machine may be finished by hand equipment as provided in Article 2301.03, A, 3, d.

b. Equipment for Slip Form Concrete Pavement.

1) Form Line Excavating Machine.

When it is necessary to excavate to line and grade the path over which the pavement laying machine travels, use either:

- A machine designed for this purpose and approved by the Engineer, or
- A machine which operates concurrently with the trimming of the subgrade or subbase.

2) Subgrade Preparation.

Use an electronically controlled machine to trim the subgrade or subbase to grade to the Engineer's satisfaction.

3) Placing, Consolidating, and Finishing Equipment.

a) Use a slip form paving machine that meets all of the following:

(1) Is designed for the specific purpose of placing, consolidating, and finishing concrete pavement slabs without the use of fixed side forms.

(2) Leaves the edges of the slab vertical.

(3) Is self propelled and equipped with a means for spreading the concrete to a uniform depth before it enters the throat.

(4) Vibrates the concrete to the full width and depth being placed in a single passage. Accomplish vibration with vibrating tubes or arms working in the concrete or a vibrating pan operating on the surface of the concrete. Apply Article 2301.03, A, 3, a, for the amplitude, rate of vibration, monitoring, and locking device for depth.

(5) Produces a surface reasonably free of voids and tears.

b) When slip form paver is operated with one or both tracks on previously placed concrete, use tracks that are rubber faced, or travel on cushions of wood or belting, to prevent damage to the pavement surface.

c) Use a paver equipped with automatic horizontal and vertical grade controls.

4) False Forms.

With Engineer's approval, false forms may be used on slip form pavement work in areas that:

- Are to be subsequently abutted with other lanes of pavement in the 20 feet to 30 feet (5 m to 10 m) preceding a day's work joint, or
- Require vertical edge support.

c. Curing Equipment.

1) To apply liquid curing compounds (if used) on surfaces of pavements of uniform width for a continuous length of over 5000 feet (1500 m), use approved mechanical spraying equipment operating on the forms or outside the pavement edges. Use equipment with a shield provided to prevent undue loss of curing compound by wind action.

2) Hand spraying equipment may be used on vertical edges, hand finished sections, and all other pavement surfaces.

d. Finishing Equipment, Hand Method.

Apply the following for placing and finishing concrete by hand methods:

1) Vibrators.

Use:

- Vibration rate between 3500 to 6000 vibrations per minute, and
- Amplitude sufficient to be perceptible on the surface of the concrete more than 12 inches (0.3 m) from the vibrating unit.

2) Screed.

Use a screed that is:

- True to crown (may be of wood or metal), and
- Adjustable for crown (or furnish a separate screed for each variation in crown).

e. Finishing Tools.

Provide all finishing tools necessary for proper finishing of the concrete, including straight edges for checking and correcting finished concrete surfaces.

f. Washing Water.

Maintain an adequate supply of water suitable for washing testing equipment. Place at a convenient location near the site of concreting operations, as directed by the Engineer and at no additional cost to the Contracting Authority.

B. Subgrade Construction.

1. Unless a subbase is specified, prepare the subgrade for standard pavement according to Section 2109.

2. Comply with the following for subgrade construction for slip form pavement:

a. When the contract documents include a bid item for Class 10 excavation, perform all the work necessary for proper preparation of the subgrade.

b. When the contract documents do not include a bid item for Class 10 excavation, it may be assumed that the subgrade has been or will be shaped and compacted by others. Acceptable tolerance for that work is described in Article 2102.03, L, except that at approaches to existing improvements or structures, corrections will be based on a practical minimum cut and fill for the project.

3. Shape and compact subgrade according to the applicable following method:

a. Subbase Not Specified.
If no subbase is specified, prepare the subgrade according to the requirements of Section 2109.

b. Subbase Specified.
If a subbase under pavement is specified, prepare the subgrade according to the requirements for that type of subbase.

c. Proof Rolling Requirements.

1) Proof roll subgrades (with or without subbase) no more than 1 week prior to trimming of the final grade. Perform proof rolling with a minimum of one pass using equipment meeting the requirements of Article 2001.05.

2) Treat all areas not meeting the requirements of 2107.03, E, as specified in Section 2109.

C. Setting of Forms.

1. When side forms are used, set them accurately to the required grade and alignment. Found and secure them to maintain the required grade and alignment while concrete is being placed and finished and until it is time for the forms to be removed. Set forms on properly compacted materials.

2. Set forms with:

- The base at the design elevation of the subgrade of the pavement at its edge, and
- The top at the design elevation of the surface of the pavement at its edge.

3. With the Engineer's approval, forms having a height greater than design thickness of the edge of the pavement may be used when set as follows:

a. Side Forms.
Side forms may be set with their tops at the design elevation of the finished surface of the pavement and their bases at an elevation lower than the design base, subbase, or subgrade elevation. However, base, subbase, or subgrade material shall be excavated to meet the lower edge of the form with a straight, lateral slope no steeper than one vertical to four horizontal. Additional excavation and concrete required by this method will be at no additional cost to the Contracting Authority.

b. Integral Curb Forms.
Forms for integral curb shall be rigidly attached to supporting side forms using all fastenings provided by the manufacturer. Take special care to remove all water and laitance from the edge of the pavement before the curb is placed.

4. After setting and locking forms, tamp on both sides throughout their entire length using a suitable tool. Ensure tamping forces suitable material into contact with the base of the form for its entire length and width. Tamp the forms that are to support mechanical finishing machines. Tamping of forms set on bases or subbases may be waived if the excavation and bedding of the forms meet the Engineer's approval. If rain or standing water softens the earth or subbase so that the form is not adequately supported, reset the form on suitable material before concrete is placed.

5. Clean forms before resetting. Coat with form oil before concrete is placed against them. Use an oil that will produce a film to prevent concrete from adhering to form.

D. Fixtures in Pavement Surface.

1. Adjust utility accesses, intakes, valve holes, or other fixtures encountered within the area to be paved to conform to the finished surface of the pavement to be built. Prior to placing the concrete, clean foreign material from the outside of the fixtures for the depth of the concrete.

2. Construct fixtures as shown in the contract documents. Fixtures that fall in a form line may be boxed out if a finishing machine is being used. Do not cut or divide boxed out concrete on the original form line.

E. Placing Reinforcement and Placing Dowel Bars.

1. Placing Reinforcement.

a. Place reinforcement prior to vibration so it will be in its intended position in the completed concrete according to Article 2404.03, D. For slip form paving, tie bars may be installed after vibration, provided the concrete is consolidated around the bars. Reinforcing bars may be supported by approved chairs or be placed in position by a machine or method approved by the Engineer.

b. Use approved continuous bolsters with runners to support reinforcement for bridge approach sections. Place supports

transversely across the approach and space them longitudinally no greater than 4 feet (1.2 m). For double reinforced approach sections the top layer of reinforcing may be chaired off the bottom layer of reinforcing using approved continuous high chairs with runners, provided they are positioned directly above the continuous bolsters with runners supporting the bottom layer of reinforcing. Hold epoxy coated reinforcing steel in place with epoxy or plastic coated bar supports and epoxy or plastic coated tie wires. Use continuous bolsters with runners and continuous high chairs with runners, either plastic or steel, meeting the requirements of Materials I.M. 451.01.

c. When welded wire fabric reinforcement is used (alternate methods of placing welded wire fabric reinforcement will be considered for approval):

1) Strike the concrete off at the elevation specified for fabric reinforcement.

2) Place the sheets as indicated in the contract documents. Handle and place the fabric carefully to ensure its installation in the proper position. Ensure the fabric is flat.

3) Deposit the balance of the concrete and vibrate in a manner that will not displace or distort the fabric. Sheets that have become bent or kinked may be rejected.

2. Placing Load Transfer Devices.

a. Load transfer devices may be required in the contract documents. Accurately place these assemblies as shown. To prevent their movement during subsequent concrete paving operations, securely stake or fasten to the base to line and grade. Assemblies may be placed in fresh PCC concrete of a class A subbase, as provided in Article 2114.03, A, 2, to assure a firm connection for the subsequent paving operation. Do not use mechanical dowel bar inserters.

b. Do not use damaged assemblies. Ensure horizontal and vertical alignment of the load transfer bars does not exceed 1/4 inch (5 mm) from parallel to line and grade. Place each assembly so bars are in a horizontal plane at T/2 ± 1/2 inch (15 mm).

c. Check placement of each assembly and the position of the bars within the assembly using a suitable template or other device approved by the Engineer. If assembly is found to be placed outside the above tolerances, correct the placement.

d. Cutting the tie wires of the load transfer assemblies is optional.

3. When dowels or tie bars or other articles are to be anchored in existing concrete, use a grout system listed in Materials I.M. 491.11 or 491.22 according to the manufacturer's instructions. Obtain Engineer’s approval.

4. For horizontal installation of dowels or tie bars, use either a pressure injection system with mechanical proportioning and mixing, or encapsulated chemical anchors. Install as follows:

a. Ensure drilled or preformed holes to receive the grout match the dimensions and spacing shown in the contract documents. When

not shown in the contract documents, the maximum nominal diameter of the hole must be 1/8 inch (3 mm) larger than the outside diameter of the dowel or bar, or as recommended by the manufacturer. Blow the hole clean with compressed air immediately prior to placing the grout.

b. Pressure inject the grout into the rear of the hole. Use sufficient grout so that when the bar, insert, or other article to be grouted is placed in position, excess grout will be forced out the front of the hole. Rotate the article to be grouted during the insertion process to ensure complete coating with the grouting material. Hand proportioning and mixing will not be allowed.

5. If using grout with approved encapsulated anchors, install according to the manufacturer's recommendations.

6. Use installation procedures for vertical or angled installations that are similar to those for horizontal installation. Pourable grouts may be used. Pourable grouts shall be mechanically mixed.

F. Placing Concrete.

1. The contract documents will show the width the pavement will be constructed. Unless otherwise shown, construct the pavement in a single pass.

2. Unless the Engineer permits otherwise, place pavement to be constructed using ready mix concrete in single lane widths only. Permission will be based on evaluation of type, quality, and quantity of equipment to be used and its anticipated rate of production.

3. At the Contractor's option, pavements may be placed in single traffic lane widths under the following conditions:

a. Submit a proposed plan of operation for approval of the Engineer.

b. Furnish (at no additional cost to the Contracting Authority) additional dowels, tie bars, or extra concrete required to conform to the approved, modified method of operation.

c. Deposit concrete upon the supporting surface in a manner which will minimize segregation and disturbance of reinforcement.

d. Except when welded wire fabric reinforcement is used, deposit concrete to the full depth of the pavement in a single operation. When welded wire fabric is used, apply Article 2301.03, E.

4. Operate vibrating units as recommended by the manufacturer and in a manner which complies with Article 2301.03, A, 3, a.

5. Cure vertical edges of pavements and backs of curbs according to Article 2301.03, K.

6. Repair honeycombed areas on pavement edges immediately after removal of forms.

7. Place backfill material behind curbs, as directed by the Engineer, to prevent a flow of water in this area and subsequent undermining of pavement.

G. Multiple Lane Construction.

1. Construct all lanes and sections of pavement to the widths shown in the contract documents unless written approval has been secured for alternate methods described in Article 2301.03, F.

2. Construct expansion and contraction joints to be continuous across all lanes. Do not stagger expansion and contraction joints.

3. Edge the edge of the pavement adjacent to the steel form, or at any supplemental form or bulkhead that will be abutted by a subsequent slab, using a tool with a radius of 1/8 inch (3 mm) or less. Extend the cutting edge of the tool moving along the form downward beyond the rolled edge of the form to its vertical face. Tool the edge on abutting lanes in the same manner.

4. When keyed joints are required, fasten the keyway to the form by a method that will ensure construction of the keyed joint. Use fasteners that can remain in place until the concrete has been placed adjacent to and above the keyway.

H. Finishing and Texture.

Finish the concrete promptly after it has been placed and consolidated. Following the finishing operations, apply texture to the surface.

1. **Finishing.**
   - **a.** After the concrete has been consolidated, use the screed to strike off the surface to the true section. Finish the surface true to line and grade.
   - **b.** Ensure additional water is not added directly to the surface by spray wand, brush, or other methods. Burlap may be attached behind the screed and a small amount of water may be used to wet the burlap to facilitate finishing operations. Avoid wetting the surface to the extent a slurry is created.
   - **c.** Ensure the edge is true and uniform. Hand corrections may be needed if this is not accomplished by the paver.
   - **d.** When finishing by hand methods, consolidate concrete using vibrating units operating in the concrete. If the vibrating apparatus cannot consolidate the full width of the concrete in a single pass, use a definite system or pattern when operating the vibrator that ensures the full width of concrete in each linear foot (meter) of lane receives adequate and uniform consolidation. Obtain the Engineer's approval for the vibrating system and methods. Do not use vibrating equipment as a tool for moving concrete laterally on the grade.
   - **e.** The Contractor may use a float on the pavement surface.

2. Microtexture.

a. Microtexture is constructed to produce a roughened surface on the driving areas of the pavement.

b. Drag artificial turf, coarse carpet, or burlap longitudinally over the finished surface to produce a tight, uniform, textured surface. Burlap may be dampened to prevent adhesion of PCC mixture.

c. When, for any reason, the desired texture normally obtained by the drag is not secured, the Engineer may require that the final finish be a broom finish in lieu of, or in addition to, the drag finish. To obtain a broom finish, drag a suitable broom transversely across the surface of the plastic concrete.

3. Macrotexture.

a. General.

1) Macrotexture is constructed by placing grooves in the surface of a pavement, normally while the concrete is plastic. The Contractor may either transversely or longitudinally provide macrotexture tining.

2) When longitudinal grooving is used on mainline pavement, transverse grooving may be used on other pavement on the same project.

b. Application.

1) Where the speed limit is greater than 35 mph (60 km/h), place macrotexture on all mainline pavement, turn lanes, and the traveled portion of ramps. Macrotexturing is not required on radii, crossovers, paved medians, shoulders, and other irregular areas.

2) Transversely or longitudinally groove gapped sections of mainline pavement that utilize longitudinal texture. Hand methods may be used on these mainline sections.

3) When surface corrections are made in the hardened concrete, no macrotexture replacement is required.

4) Unless specified otherwise, groove or otherwise finish bridge approach sections in the same manner as either the adjacent bridge or pavement surface.

5) When finishing by hand methods, except for mainline pavement and ramps as described above, only microtexture will be required.

c. Operation.

1) General.

For grooving, use a mechanical device that:

- Has a single row of tines that are 1/8 inch ± 1/64 inch (3 mm ± 0.5 mm) wide, and
- Forms grooves in the plastic concrete that are1/8 inch (3 mm) deep as a target, with a ± 1/16 inch (± 1.5 mm) tolerance.

2) Transverse Grooving.

a) For transverse grooves, randomly space the tines from 3/8 inch to 1 5/8 inch (10 to 40 mm) with no more than 50% of the spacing exceeding 1 inch (25 mm).

b) At transverse joints, leave a 4 inch to 6 inch (100 to 150 mm) wide strip of pavement surface (centered along the joint) that is not grooved for the length of the joint.

3) Longitudinal Grooving.

a) For longitudinal grooves, uniformly space the tines at 3/4 inch (20 mm) intervals.

b) Accomplish longitudinal grooving using equipment with horizontal and vertical string line controls to ensure straight, uniform grooves.

c) At longitudinal joints, leave a 2 inch to 3 inch (50 to 75 mm) wide strip of pavement surface (centered along the joint) that is not grooved for the length of the joint.

d. Limitations.

1) Form grooves in a time and manner producing the desired surface texture while minimizing displacement of larger aggregate particles. Complete grooving before pavement surface permanently sets.

2) Where abutting pavement is to be placed, extend grooving as close as possible to the edge without damaging the edge. Where abutting pavement is not to be placed, do not groove the 6 inch (150 mm) area nearest the edge or 1 foot (300 mm) from the face of the curb.

3) Do not groove the outside 2 feet (0.6 meters) if placing structural rumble strips (rumble strips placed in the outside 2 feet (0.6 meters) of PCC pavements, as shown in the contract documents, to deter traffic).

4) Uniform width slabs of 20 feet (300 mm) or narrower and less than 600 feet (200 m) long may be grooved by hand methods. Mainline and ramp pavement may also be grooved by hand methods during equipment breakdowns.

4. Smoothness.

a. Construct the pavement to have a smooth riding surface within the following tolerances:

1) Periodically check the pavement longitudinally with a 10 foot (3 m) straightedge. The surface is not to deviate from a straight line by more than 1/8 inch in 10 feet (3 mm in 3 m).

2) If slip form methods are used, the 6 inches (150 mm) nearest the edge may exceed the 1/8 inch (3 mm) tolerance, but is not to exceed 1/2 inch deviation in 10 feet (13 mm deviation in 3 m).

3) Where abutting pavement is to be placed adjacent to the pavement being checked, the surface is not to deviate by more than 1/4 inch (6 mm) when checked 1 inch (25 mm) from the edge with:

- A 3 foot (1 m) straightedge used transversely, and
- A 10 foot (3 m) straightedge used longitudinally.

b. Apply Section 2317 to all PCC Pavement bid items of a Primary project if any individual PCC Pavement bid item for that project is 5000 square yards (4200 m^2) or greater. Apply Section 2316 to all other Primary projects or when specifically required for other projects.

I. Integral Curb.

1. Before placing curb concrete, remove all free water, laitance, dust, leaves, or other foreign matter which may have collected on the edge of the slab.

2. Construct integral curbs before the initial set, but following the main paving slab finishing, except as provided for in Article 2301.03, J.

3. Do not use concrete which has dried, partially hardened, or requires retempering.

4. Construct integral curb as rapidly as paving slab finishing operations will permit. Complete integral curb construction the same day the slab is placed, except for the length of section required at the end of the day's run to accommodate the mechanical placing and finishing equipment. In the section left for subsequent curb placement, depress the paving slab surface along the line of the inside curb slope so that the new concrete placed for curb is no less than 1 1/2 inches (40 mm) thick. Tie this section of curb to the slab by using No. 3 (Size 10) hooked steel bars spaced at 1 foot (300 mm) intervals. Roughen the surface of the slab back of the key notch. Create a depression around each dowel so it will project at least 2 inches (50 mm) into the curb concrete.

5. Consolidate curb concrete to secure adequate bond with the paving slab and eliminate honeycomb in the curb. Avoid disturbing the alignment of forms or gutter flow line.

6. After removing face forms or shaping with the curb slip form, complete the final finish on curbs using hand methods, including the use of a 6 foot (1.8 m) straightedge. Check the resulting surfaces of both curb and gutter using the 10 foot (3 m) straightedge. Correct if necessary. When removing forms, avoid creating slumps and disturbing partially set concrete.

7. When curb is built on slabs traversed by headers or contraction or expansion joints, extend the joints through the curb directly over the joint in the slab at the same thickness as in the main slab.

8. Edge, protect, and cure all curbs the same as other parts of the paving slab.

J. End of Run.

1. General.

a. Install an approved header whenever 30 minutes or more have elapsed since the last concrete has been deposited on the subgrade, or if such a delay is anticipated.

b. Do not construct a header joint:

- Within 5 feet (1.5 m) of an intended or previously placed contraction joint.
- Opposite a contraction joint in multiple lane construction.

c. When a header joint is installed, wait a minimum of 6 hours to resume paving which abuts the header. When concrete delivery is resumed, place it adjacent to the exposed face of the header. Thoroughly consolidate the concrete and finish with an edging tool at the joint. Sawing and sealing of this joint is not required.

d. When the end of the day's run occurs in curb section, omit sufficient curb to accommodate equipment which must be backed out of the way. Construct the portion of the curb omitted as shown in the contract documents and according to Article 2301.03, I.

2. Headers Constructed in Plastic Concrete.

a. Construct the header true to line and grade with the face perpendicular to the surface and at right angles to the centerline of the pavement. Ensure tie bar reinforcement is level, true to line and grade, and normal to the header joint.

b. Concrete collected by a finishing machine during its first pass must not be used adjacent to the header board. Promptly remove concrete screeded over the header during finishing.

c. Consolidate concrete against the header and finish with an edging tool.

d. Remove the header board and all supports before paving is resumed.

3. Headers Constructed in Hardened Concrete.

The Contractor may pave past the location of the header. After the concrete has hardened, saw the pavement perpendicular to the centerline of the pavement, creating a vertical face. Drill holes for the tie bar reinforcement and grout the reinforcement into the holes according to Article 2301.03, E. Paving operations may begin adjacent to the header after a minimum of 1 hour following the placement of the reinforcement bars.

K. Curing and Protection of Pavement.

1. General.

a. After finishing operations are complete, cure concrete pavement according to Article 2301.03, K, 2. Cure bridge approaches, medians, curbs, and ramps according to Article 2301.03, K, 2.

b. Cure vertical edges of pavement and backs of curbs by the same method used for curing the surface.

2. Curing with White Pigmented Liquid Curing Compound.

a. Apply curing compound in a fine spray to form a continuous, uniform film on the surface and vertical edges of the pavement slab.

b. Apply curing compound as soon as the free water has appreciably disappeared, but no later than 30 minutes after finishing. With the Engineer's approval, cure application timing may be adjusted due to varying weather conditions and concrete mix properties to achieve acceptable macrotexturing.

c. Use an application rate of no less than 0.067 gallon per square yard covering 15 square yards per gallon (0.3 L/m^2 covering 3 m^2/L).

d. Ensure liquid curing materials are well agitated in the supply drum or tank immediately before transfer to the distributor. Keep curing materials well agitated during application.

e. Apply using power spraying equipment capable of producing a fine spray which will not damage the surface of the concrete. Hand operated sprayers may be used for spraying the sides and irregular areas.

f. If forms are used, coat vertical edges of the pavement within 30 minutes of form removal using curing material applied at the same rate as on the surface.

g. If, due to other operations, the coating is damaged within 72 hours after being applied, immediately re-coat the affected areas. Coating of the sawed surface with curing compound will not be permitted on joints that are to be sealed. When pavement is opened to traffic prior to 72 hours after application of the curing coating, a re-coating will not be required.

h. Apply a white pigmented curing compound meeting the requirements of Section 4105.

3. Cold Weather Protection.

a. Apply cure to all concrete pavement, including exposed edges of the slab, according to Article 2301.03, K, 2, prior to applying protection.

b. Protect concrete pavement less than 36 hours old as shown in Table 2301.03-1. Payment will be made as provided in Article 2301.05.

Table 2301.03-1: Concrete Pavement Protection Requirements

Night Temperature Forecast	Type of Protection[(a)]
35°F to 32°F (2°C to 0°C)	One layer of burlap for concrete.
31°F to 25°F (-1°C to -4°C)	Two layers of burlap or one layer of plastic on one layer of burlap.
Below 25°F (-4°C)	Four layers of burlap between layers of 4 mil (100 µm) plastic, insulation blankets meeting the requirements below, or equivalent commercial insulating material approved by the Engineer.

(a) The protection is to remain until one of the following conditions is met:
1. The pavement is 5 calendar days old.
2. Opening strength is attained.
3. Forecasted low temperatures exceed 35°F (2°C) for the next 48 hours.
4. Forecasted high temperatures exceed 55°F (13°C) for the next 24 hours and subgrade temperatures are above 40°F (4°C).

c. When insulation blankets are used, use blankets consisting of a layer of closed cell polystyrene foam protected by at least one layer

of plastic film, rated by the manufacturer with a minimum R-value of 1.0 (0.1761 for metric units).

d. Shut down paving operations in time to comply with protection requirements outlined above. The cover may be temporarily removed to perform sawing or sealing. The Engineer may modify temperature restrictions and protection requirements.

4. Rain Protection.

a. Protect the pavement from rain damage.

b. To protect against the effects of rain on paving, have materials available near the worksite for proper protection of the edges and surface of concrete. Protective material may consist of sheets of burlap, paper, or plastic film. Keep planks (or other material with suitable stakes) on hand that can be used as temporary forms.

c. Failure to properly protect concrete may constitute cause for removal and replacement of defective pavement.

d. When pavement is placed directly on natural subgrade (Section 2109) construct earth check dams immediately after removing forms or after the slip form passes. This will prevent water from flowing along the edge of the pavement and undermining the slab. Space earth check dams and construct them wide enough such that they do not provide an approach over which a vehicle may be driven onto the pavement.

L. Safety Fence for Pavement.

1. In addition to the requirements of Article 1107.09, install a safety fence for the full width of the slab near the end of each day's run.

2. Support the safety fence by setting posts near to the edge of the slab. Extend posts at least 2 feet (0.6 m) into the ground. Between the posts, stretch and secure a 48 inch (1.2 m) nominal height orange mesh safety fence meeting the requirements of Article 4188.03. Cut the twisted ends of the wire off flush with the twist so that a tool would be required to cut or otherwise release the fastening.

3. Support the fence span between the posts with no less than four equally spaced plastic drums weighted to make them stable and difficult to move. Use drums approved according to Materials I.M. 488.02.

4. On urban work where it is not feasible to set posts, steel drums or sand box supports may be substituted for the end posts.

5. Place a similar safety fence parallel to and within 50 feet (15 m) from the edge of the slab at public road and side street intersections. Construct these fences similar to the end of day's run safety fences.

6. To prevent traffic from entering on and damaging the pavement slab, install safety fences within 1 hour of the completion of finishing and curing operations at the fence location. Leave safety fences in place and maintain until the concrete has attained the strength and age requirements of Article 2301.03, U.

7. Intermediate safety fences may be required for the purpose of opening the slab for access to a side road, side street, or entrance.

M. Removal of Forms.

1. Leave side forms and curb forms in place for no less than 6 hours after the concrete is placed, unless earlier removal is required by Article 2301.03, N.

2. Exercise care when removing forms to prevent cracking, spalling, or over stressing the concrete.

3. Remove all stakes in any form before the form is raised.

4. If the method of form removal causes damage to the concrete, the Engineer may require forms to remain in place for more than 6 hours.

N. Sawing Joints.

1. Saw joints in a single cutting operation for a specific joint. Make saw cuts true to line and to the dimensions shown in the contract documents.

2. Begin joint sawing as soon as the concrete has hardened sufficiently to permit sawing without raveling or moving of aggregate. Saw joints before uncontrolled cracking takes place.

3. Control joints may be sawed by any saw designed for concrete sawing.

4. If necessary, use continuous sawing operations regardless of weather or daylight conditions.

5. Discontinue sawing a joint if a crack develops ahead of the saw.

6. A heavy span saw which is supported on the new pavement will not be allowed for sawing pavements and concrete overlays less than 7 inches (180 mm) deep.

7. If the pavement has been covered or protected due to cold weather, rain, or snow, saw joints by conventional saw equipment only.

8. Saw joints requiring compression sealant materials to be installed according to Article 2301.03, P, so that the compression sealant material can be installed and function correctly.

9. Repair uncontrolled cracking or random transverse cracking (at no additional cost to the Contracting Authority). Use repair methods approved by the Engineer.

10. When the normal pavement section is reduced by box-outs, such as for intakes, construct a contraction joint by sawing. Begin at one end of the box-out and extend to the pavement edge. Alternate types of transverse

joints will be considered for approval. If box-out length exceeds 15 feet (4.5 m), construct a contraction joint at both ends.

O. Expansion Joints.

1. Install preformed joint material perpendicular to the pavement surface. Exercise care throughout pavement construction to ensure that the joint material remains in proper position.

2. Set reference stakes or markers showing exact joint location prior to placing concrete adjacent to the joint. After the mechanical finishing equipment has passed over the joint, check the joint for movement. If movement in excess of 1/2 inch (10 mm) has occurred, immediately correct the installation to its intended position.

3. After the surface finishing has been completed, edge the joint as shown in the contract documents with minimum disturbance to the adjacent concrete. Supplemental vibration equipment is required for proper consolidation of the concrete.

P. Sealing Joints.

1. Unless provided otherwise, seal joints as designated in the contract documents before any portion of the pavement is opened to the Contractor's forces or to general traffic. Saw or prepare joint openings to the designated dimensions. Clean and seal joint openings with one of the appropriate materials described in Section 4136.

2. Use joint sealer described in Article 4136.02, A, to seal sawed joints in PCC pavement, shoulders, medians, crossovers, and side road pavements, unless specified otherwise in the contract documents.

3. Within 3 hours after a joint has been wet sawed to the finished dimension, flush the wet sawing residue away from the sawed faces using a high pressure water blast operating with a minimum pressure of 1000 pounds per square inch (7000 kPa). Within 3 hours after the joint has been dry sawed to the finished dimension, blow the dry sawing residue from the joint. Use air compressors that provide moisture and oil free compressed air.

4. Immediately prior to installation of sealant, clean joints with an air blast. Do not perform sealing until visual examination verifies the joint surfaces appear dry, in addition to being clear of dust and contamination. Prepare joint sealer and install in the joint and to the proper level as shown in the contract documents and as recommended by the manufacturer. Heat hot poured sealers in a thermostatically controlled heating kettle. Heat the material to the temperature required for use, but not above that recommended by the manufacturer. After sealing, remove excess sealer from the pavement surface.

5. Place joint sealer only when the pavement and ambient air temperatures are 40°F (4°C) or above. When near this minimum,

additional air blasting or drying time, or both, may be necessary to assure a satisfactory bond to the joint faces. When this sealer cannot be properly placed due to late fall work, submit a joint construction plan and sealing details to the Engineer for approval before commencing paving. Delay the cleaning, sealing, and, if required, resawing of joints until the following spring. This delay requires the Engineer's approval.

6. When surface correction is required, repair seals damaged from the corrective work. Joint preparation, cleaning, and sealing may be delayed until after corrective work, provided the pavement is not opened to traffic before corrective work is performed.

7. The Engineer may limit the wheel loads and axle loads of equipment operating on the pavement during preparation, cleaning, and sealing operations, if prior to the age and strength specified in Article 2301.31. Additional tests to determine the modulus of rupture may be required.

8. If early pavement opening is specified, the cleaning, sealing, and, if required, resawing of joints shall be accomplished after the pavement is opened to traffic if hot pour sealing material is used.

Q. Concrete Median Strip.
Where the contract documents call for construction of concrete median strip between adjacent slabs, construct the median strip to conform to the dimensions shown and to the following provisions:

1. Construct the subgrade for the median strip to the elevation shown according to Article 2109.03, A.

2. Use the class of concrete specified for the pavement. Use placement and finishing methods that meet the requirements of Section 2301. Hand methods may be used and surface texturing will not be required.

3. Saw and seal joints as required for jointed pavement. When spacing is not designated, space joints as required for jointed pavement. Match median joints with joints in the abutting pavement.

4. Gore areas will be considered median strips. When constructed or reconstructed while the highway is open to public traffic, use Class M concrete.

R. Bridge Approach Sections, Reinforced Paved Shoulders, and Full-width Reinforcement for Pavements.

1. Construct bridge approach sections, reinforced paved shoulders, and full-width reinforcement for pavements as shown in the contract documents.

2. Use epoxy coated reinforcing according to Article 4151.03, except that cut or sheared ends need not be recoated.

3. Unless otherwise noted in the contract documents, use a clear distance of 2 inches (50 mm) between the face of concrete to near reinforcing steel.

4. Use Class C Concrete with coarse aggregate durability according to Section 4115.

S. Restriction of Operations Because of Weather.

1. Do not place concrete when stormy or inclement weather will prevent good quality work.

2. Do not use aggregates containing frozen lumps.

3. Do not place concrete on a frozen subgrade.

4. Concrete mixing and placement may be started, if weather conditions are favorable, when the air temperature is at least 34ºF (1ºC) and rising. At the time of placement, concrete shall have a temperature of at least 40ºF (4ºC).

5. Stop mixing and placing when the air temperature is 38ºF (3ºC) or less and falling.

6. During cold weather conditions, protect concrete less than 36 hours old in the manner specified in Article 2301.03, K, 3.

T. Night Operation.

Do not place concrete when darkness would prevent good quality work in placing and finishing operations. Unless shown in the contract documents or approved by the Engineer, placing and finishing operations under artificial light will not be permitted. Organize work accordingly.

U. Time for Opening Pavement for Use.

1. The time for opening pavement for use will be based on the restrictions listed in Table 2301.03-2, with flexural strength determined from beam specimens made during the progress of the work.

Table 2301.03-2: Minimum Flexural Strength

Strength Class of Concrete	Minimum Age	psi (MPa)
A	14 calendar days[(a)]	500 (3.45)
B	14 calendar days	400 (2.80)
C	7 calendar days[(b)]	500 (3.45)
M	48 hours	500 (3.45)

(a) 10 calendar days for concrete 8 inches (200 mm) thick or more.

(b) 5 calendar days for concrete 9 inches (230 mm) thick or more.

2. At the Contractor's option (unless specified otherwise in the contract documents), the time for opening pavement may be determined through the use of the maturity method as described in Materials I.M. 383.

3. Apply the following when the maturity method is used:

a. The time for opening pavement will be based on strength requirements only, as specified in Table 2301.03-2. Furnish all labor, equipment, and materials necessary for the development of the maturity-strength relationship as described in Materials I.M. 383.

b. The Engineer will determine if sufficient strength has been achieved for opening a section of pavement. The Contractor's maturity testing may be used as the basis for this determination. Provide sufficient documentation of maturity testing before opening a section to traffic.

c. Should circumstances arise which are beyond the Contractor's or Engineer's control and strength cannot be determined by the maturity method, apply minimum age, minimum flexural strength, and fly ash restrictions.

d. Develop a new maturity curve for any change of a material source or proportion in the concrete mixture.

4. Personnel performing maturity testing are required to be Level I PCC certified technicians with training for maturity testing.

5. In cases where early opening of pavement is desirable, the Engineer may require the use of Class M concrete mixtures. Such sections of pavement may be opened to traffic in accordance with Table 2301.03-2.

6. At the Contractor's option, when Type I/II cements are used, Class C fly ash may be substituted for up to 10%, by weight (mass), of the cement in Class M concrete mixtures. Type IP and Type IS cements may be used in Class M concrete mixtures without fly ash substitution.

V. Shoulders.
Construct shoulders according to Section 2121, 2122, or 2123, as indicated in the contract documents.

W. Surfacing Approaches to Intersecting Roads, Driveways, and Turnouts.
Surface approaches to intersecting roads, driveways, and turnouts as provided in Section 2315.

2301.04 METHOD OF MEASUREMENT.

Measurement will be as follows:

A. Portland Cement Concrete Pavement.

1. Square yards (square meters) of the type specified in the contract documents.

2. The coring requirements for thickness do not apply to detour pavements, paved drives, and temporary pavements. The thickness of pavement constructed will be determined from core depths as follows:

a. The division of sections, lots, and core locations will be according to Materials I.M. 346.

b. At locations determined by the Engineer, cut samples from the pavement, as directed above, by drilling with a core drill that will provide samples with a 4 inch (101.6 mm) outside diameter. Restore the surface by tamping low-slump concrete into the hole, finishing, and texturing. The Engineer will witness the core drilling, and identify and measure the cores immediately. The Engineer will measure the cores and determine the thickness index according to Materials I.M. 346. After measurement on the grade, deliver the cores to the Engineer's office or field laboratory. When cores are not measured on the grade, the Engineer will take immediate possession of the cores.

c. Coring of pavement and other work for thickness determination may be waived by mutual agreement for sections of the same design thickness less than 5,000 square yards (4200 m^2).

d. Only sections which are cored will be included in the thickness index determination. Areas not cored will be paid for at the contract unit price.

B. Integral Curb.

Incidental to the other items of work. Not measured for payment.

C. Concrete Median.

Square yards (square meters) shown in the contract documents. This will be calculated to the nearest 0.1 foot (0.1 m) of the length along the surface and the overall width of median when no integral curb is involved, or the width from back to back of curb when integral curb is involved.

D. Bridge Approach Sections.

Square yards (square meters) shown in the contract documents.

E. Excavation.

1. When the contract provides a unit price per station (meter) for earth shoulder finishing and a price per cubic yard (cubic meter) for excavation, the excavation required for preparation of natural subgrade will be measured as provided in Article 2102.04. The volume measured for payment will include only the materials actually removed above the elevation of the pavement subgrade and between vertical planes 1 foot (0.3 m) outside the edge of the finished pavement.

2. Other work connected with preparation of natural subgrade will not be measured for payment.

3. When the contract provides a unit price for earth shoulder construction (whether or not a unit price per cubic yard (cubic meter) of excavation is provided in the contract), excavation required for preparation of natural subgrade will not be measured for payment. Unless otherwise provided

in the contract documents, work connected with preparation of natural subgrade will not be measured for payment.

F. Driveway Surfacing Material.
Tons (megagrams) or cubic yards (cubic meters), as provided in the contract and in Section 2315, placed at intersecting roads, drives, and turnouts. Excavation required for placement of this material will not be measured for payment.

G. Portland Cement Concrete Pavement Samples.
Not individually counted for payment when furnished according to Article 2301.04, A, or when required in the contract documents.

H. Saw Cut and Joint Sealing.

1. Saw cut for constructing joints in new pavement will not be measured for payment.

2. Saw cut for cutting old existing pavement, which is to be abutted with new pavement, will not be measured for payment.

3. Joint sealing will not be measured for payment.

I. Safety Fence for Pavement.
Not measured for payment.

2301.05 BASIS OF PAYMENT.

Payment will be as follows:

A. Portland Cement Concrete Pavement.

1. Contract unit price for Standard or Slip-Form Portland Cement Concrete Pavement of the type specified per square yard (square meter).

2. Payment for the quantities of pavement in square yards (square meters) will be at a percentage of the contract unit price according to Table 2301.05-1.

Table 2301.05-1: Payment Schedule for Quantities of Pavement

Thickness Index Range	Percent Payment	Thickness Index Range	Percent Payment
English (Metric)		English (Metric)	
0.00 or more (0.00 or more)	103	-0.56 to -0.60 (-13.98 to -15.24)	91
-0.01 to -0.05 (-0.01 to -1.27)	102	-0.61 to -0.65 (-15.25 to -16.51)	90
-0.06 to -0.10 (-1.28 to -2.54)	101	-0.66 to -0.70 (-16.52 to -17.78)	89

-0.11 to -0.15 (-2.55 to -3.81)	100	-0.71 to -0.75 (-17.79 to -19.05)	88
-0.16 to -0.20 (-3.82 to -5.08)	99	-0.76 to -0.80 (-19.06 to -20.32)	87
-0.21 to -0.25 (-5.09 to -6.35)	98	-0.81 to -0.85 (-20.33 to -21.59)	86
-0.26 to -0.30 (-6.36 to - 7.62)	97	-0.86 to -0.90 (-21.69 to -22.86)	85
-0.31 to -0.35 (-7.63 to -8.89)	96	-0.91 to -0.95 (-22.87 to -24.13)	84
-0.36 to -0.40 (-8.90 to -10.16)	95	-0.96 to -1.00 (-24.14 to -25.40)	83
-0.41 to -0.45 (-10.17 to -11.43)	94	-1.01 to -1.05 (-25.41 to -26.67)	82
-0.46 to -0.50 (-11.44 to -12.70)	93	-1.06 to -1.10 (-26.68 to - 27.94)	81
-0.51 to -0.55 (-12.71 to -13.97)	92	-1.11 or less (-27.95 or less)	80

3. Use the following formula to determine the thickness index for the section of pavement thickness:

$$TI = (\overline{X} - S) - T$$

Where:

TI = thickness index for the section.
$\overline{X}$ = mean core length for the section.
T = design thickness.
S = core length standard deviation (of the sample) for the section.

4. Replace pavement represented by cores deficient from design thickness by 1 inch (25 mm) or greater. The deficient areas and the replacement of the deficient cores will be determined according to Materials I.M. 346.

5. At the Contractor's option, cores that are three standard deviations or greater than design thickness may be removed from analysis for thickness index determination. Do not remove more than 10% of the total cores in a section. Do not replace cores removed from the analysis.

6. Gaps in the pavement less than 500 feet (150 m), required by staging, will be considered irregular areas for analysis of pavement thickness determinations.

7. The percent payment for projects which have all core lengths greater than design thickness will be at least 100%.

B. Integral Curb.
Not paid for separately.

C. Concrete Median.
Contract unit price per square yard (square meter).

D. Bridge Approach Sections.

1. Contract unit price for bridge approach pavement per square yard (square meter).

2. Payment is full compensation for:
- Excavation for modified subbase and subdrain.
- Furnishing and installing subdrain.
- Furnishing and installing subdrain outlet.
- Furnishing and installing polymer grid.
- Furnishing and placing porous backfill material.
- Furnishing and placing modified subbase backfill material.
- Saw cutting.
- Furnishing and installing reinforcing steel, tie bars, and dowel assemblies.
- Placing, finishing, texturing, grooving, and curing.
- All joint construction.
- All other materials and labor to construct the Bridge Approach Section as shown in the contract documents.

E. Excavation.

1. When the contract provides a unit price per station (meter) for earth shoulder finishing and the contract also provides a price per cubic yard (cubic meter) for excavation, payment will be the contract unit price per cubic yard (cubic meter) for excavation in connection with subgrade preparation and building shoulders.

2. When the contract provides a unit price for earth shoulder construction, the excavation required for preparation of subgrade and construction of shoulders will not be paid for as a separate item. It is incidental to pavement construction and earth shoulder construction and is to be included in those contract prices.

3. When no price per cubic yard (cubic meter) for excavation is provided in the contract and no unit price is provided for earth shoulder finishing or earth shoulder construction, excavation necessary for subgrade preparation is incidental to pavement construction and is to be included in that contract unit price.

F. Driveway Surfacing Material.
Contract unit price as provided in Section 2315 for the quantity of driveway surfacing placed.

G. Portland Cement Concrete Pavement Samples.

1. Lump sum contract price for furnishing samples of finished pavement or other course according to Article 2301.04, A, or when required in the contract documents.

2. Payment is full compensation for furnishing all such samples for all courses or items of work.

H. Saw Cut and Joint Sealing
Incidental to the price for pavement.

I. Safety Fence for Pavement.
Incidental to the price for pavement.

J. General.

1. Deduction will not be made from the area of pavement for fixtures with an area less than 9 square feet (1 m^2). When the adjustment of a fixture to the finished grade line involves a change in elevation of 1 foot (0.3 m) or less, this adjustment shall be made without extra compensation. When this adjustment involves a change in elevation more than 1 foot (0.3 m), this work will be paid for as extra work, as provided in Article 1109.03, B.

2. When any of the types of additional protection described in Article 2301.03, K, 3, is necessary, additional payment will be made as extra work at the rate of $1.00 per square yard ($1.20 per square meter) of surface protected. Payment will be limited to protection necessary within the contract period. Protection necessary after November 15 will be paid for only when the Engineer authorizes the work.

3. Furnish concrete for test specimens and transport the specimens and molds between the grade and plant as directed by the Engineer, at no additional cost to the Contracting Authority.

4. The above prices are full compensation for furnishing all tools, equipment, labor, and materials necessary for construction of the pavement in accordance with the contract documents.

5. The cost of furnishing, installing, and monitoring vibrators, as well as the vibrator monitoring device itself, is incidental to the contract unit price for PCC pavement.

Section 2302. Portland Cement Concrete Widening

2302.01 DESCRIPTION.

Widen existing pavement with PCC according to the contract documents. This work may also involve flume removal, curb removal, and shoulder construction. Apply the appropriate provisions of Section 2301.

2302.02 MATERIALS.

A. Meet the requirements of the appropriate sections of Division 41.

B. Meet requirements for Class A or Class C concrete in Materials I.M. 529.

2302.03 CONSTRUCTION.

A. Maintenance of Traffic.
Unless indicated otherwise in the contract documents, maintain traffic through the project.

B. Flume Removal.
Remove flumes according to Section 2514.

C. Curb Removal.
Remove curb according to Section 2514.

D. Subgrade Preparation.

1. Cut a trench for the widening that is no less than 6 inches (150 mm) greater than the base width of the widening shown in the contract documents. If fixed forms are used, adjust the trench width to accommodate the forms.

2. Bring the subgrade to an elevation and cross section such that, after being rolled, the surface will be at the required elevation.

3. Correct depressions that develop during rolling. Continue rolling until the subgrade is uniformly firm, properly shaped and true to grade and cross section.

4. Remove material (other than sand) which will not readily compact under the roller. Replace with material which will compact readily, and roll that portion of the subgrade again.

5. Use a roller meeting the requirements of Article 2001.05. Adapt the roller to conditions affecting the work. The Engineer may direct the weight (mass) of the roller be reduced to the minimum to provide a smooth, firm subgrade.

6. Treat subgrade or subbase according to Article 2109.03, A. When plastic film is used, size it to be no less than the nominal width of the widening being constructed.

7. Provide ditches or drains to allow water to drain from the widening trench.

8. Complete subgrade in advance of PCC placement. For sections more than 800 feet (250 m) long, complete the subgrade no less than 800 feet (250 m) in advance of PCC placement.

9. Check finished subgrade with a template supported on the adjacent pavement surface.

10. Clean edge of the old pavement.

E. Portland Cement Concrete Widening Construction.
Construct PCC widening as follows:

1. Placing and Finishing.

a. After preparing subgrade, deposit concrete directly on subgrade without being dumped on the pavement.

b. Concrete may be placed and finished by use of fixed forms or slipform paver.

c. When a slipform paver is used, control the concrete consistency and the amount of vibration so that the full width and depth of the section is consolidated. Ensure no slump occurs after the sliding form has passed. For the slipform paver, provide a metal strike off plate no less than 3 feet (0.9 m) long and extending no more than 3 inches (75 mm) into the pavement surface being widened. Use a sliding form made of metal. To assure alignment, provide the sliding side form with adjustable rigid braces at intervals of no more than 4 feet (1.2 m).

d. Use mechanical vibrators to consolidate the concrete. Provide a sufficient number of vibrators to ensure adequate consolidation. Operate vibrators at an appropriate frequency, according to Article 2301.03, A, 6, a, which is independent of the forward speed of the paver.

e. Finish the concrete widening to be flush with the adjacent pavement surface without either edging or sealing the joint. When voids wider than 1 1/2 inches (40 mm), measured at right angles to the pavement edge, occur in the edge of the old pavement, fill them with concrete. Separate them from the widening with preformed mastic dummy joint 1/8 inch thick by 2 inches wide (3 mm thick by 50 mm wide). Install the preformed mastic dummy joint directly over the edge of the old pavement. When checked, correct high spots in excess of 1/4 inch on a 10 foot (6 mm on a 3 m) straightedge. Produce texture on the new concrete using a burlap or carpet drag.

f. When concrete widening intersects an approach road or driveway to a dwelling or business establishment, make provisions for access as follows:

1. Construct widening only halfway through the roadway or driveway access on the initial construction. Provide a suitable approach through the unpaved portion of the access. In no less than 4 working days, and no more than 7 working days, fill gaps left open. A removable header board, equipped with keyway in lieu of dowel bars, may be used at these locations.

2. A temporary bridge, approved by the Engineer, may be provided for access from driveways to dwellings or to business establishments. This will permit the widening to be constructed continuously across the driveways. At the Contractor's option, concrete used to widen the pavement at driveways to dwellings or to business establishments may have 2 pounds (2 kg) of

calcium chloride (solid form) per 100 pounds (100 kg) of cement added at the mixer for the full length of mixing cycle. When calcium chloride is used, the temporary bridges may be removed after 24 hours when suitable approaches are provided for the driveway.

2. **Contraction Joints.**
Construct transverse contraction joints as shown in the contract documents. This work will be considered incidental and shall not be paid for separately.

3. **Protection and Curing.**
   a. Protect and cure freshly finished concrete as provided in Article 2301.03, K.
   b. Construct earth check dams within 0.5 calendar days after placing concrete. This is to prevent water from flowing along the edge of the pavement to the extent that the edge of the slab may be undermined. Space earth check dams and construct them wide enough such that they do not provide an approach over which a vehicle may be driven onto the pavement.

F. Shoulders.

1. Unless otherwise specified, consider shoulder construction adjacent to pavement widening to be Type A, B, C, or D.
   a. **Type A Shoulders.**
   Blade over the foreslope both the soil excavated from the trench and material of the shoulder lying above the proposed, finished shoulder line.
   b. **Types B and C Shoulders.**
   Excavate material lying above the proposed shoulder line and haul and deposit it at the Engineer's direction within a free haul limit of 1 mile (1.6 km).
   c. **Type D Shoulders.**
   Blade the soil excavated from the trench over the shoulder and shape the shoulders and slopes, the cost of which is included in the contract unit price for trench excavation.

2. Finish shoulders to a well defined shoulder line with uniformity in width, no abrupt changes in width, and smooth foreslopes.

G. Removal of Materials from Curbs and Flumes.

1. Unless provided otherwise, clean up all materials removed from curbs and flumes. Remove these materials according to Article 1104.08.

2. Deposit materials removed from curbs and flumes and designated for salvage in areas as designated in the contract documents. No overhaul will be allowed.

H. Limitations.

1. Unless the road is closed to traffic, construct pavement widening on only one side of the pavement at a time. Open the widened pavement on one side to traffic before removing the curb on the opposite side.

2. Place backfill material and compact the unfilled portion of trench excavation on one side of the pavement to provide a usable traffic surface before:
   - Any work is done on the other side of the pavement, and
   - Paving is opened to traffic.

3. Compaction required in this operation may be accomplished by rolling with a pneumatic tired roller which has a total weight (mass) of no less than 2000 pounds (900 kg).

4. At the end of the day, restore the shoulder disturbed in connection with curb removal to the general elevation of the pavement edge, unless protected by barricades.

5. Apply Articles 1107.08 and 1107.09.

I. Opening Widening to Traffic
Concrete widening may be opened to traffic as soon as the concrete has attained the age and flexural strength according to Article 2301.03, U and the shoulder backfill material has been placed.

2302.04 METHOD OF MEASUREMENT.
Measurement will be as follows:

A. Excavation, Class 13, for Widening.
Article 2213.04, C, applies.

B. Removal of Curb.
Article 2213.04, A, applies.

C. PCC Pavement Widening.
Square yards (square meters) shown in the contract documents. The thickness of the pavement will be determined as provided in Article 2301.04.

D. Shoulders.

1. Type A, B, and C Shoulders: stations (meters) shown in the contract documents.

2. Earth shoulder finishing: not measured separately, but will be incidental work included in construction of shoulders.

3. Type D shoulders: incidental to excavation and will not be measured for payment.

E. Removal of Flumes.
Article 2213.04, B, applies.

F. Portland Cement Concrete Pavement Samples.
Article 2301.04, G, applies.

2302.05 BASIS OF PAYMENT.
Payment will be contract unit price as follows:

A. Excavation, Class 13, for Widening.
Article 2213.05, C, applies.

B. Removal of Curb.
Article 2213.05, A, applies.

C. PCC Pavement Widening.

1. Per square yard (square meter) as provided in Article 2301.05.

2. Payment is full compensation for construction of the pavement widening and all other work not paid for under other items.

D. Shoulders.

1. Type A, B, and C Shoulders: per station (meter).

2. Type D shoulders: incidental to excavation and will not be measured for payment.

E. Removal of Flumes.
Article 2213.05, B, applies.

F. Portland Cement Concrete Pavement Samples.
Article 2301.05, G, applies.

Section 2303. Hot Mix Asphalt Mixtures

2303.01 DESCRIPTION.

A. Design, produce, place, and compact HMA mixtures. Use proper quality control practices for the construction of surface, intermediate, or base course on a prepared subbase, base, or pavement to the dimensions specified in the contract documents.

B. A surface course is the upper lift for a wearing surface of a designated thickness. An intermediate course is the next lower lift or lifts of a designated thickness. Use intermediate course mixtures for leveling, strengthening, and wedge courses. A base course is the lift or lifts placed on a prepared subgrade or subbase.

2303.02 MATERIALS.

Use materials meeting the following requirements:

A. Asphalt Binder.

The Performance Graded asphalt binder, PG XX -XX, will be specified in the contract documents to meet the climate, traffic, and pavement conditions. Use asphalt binder meeting the requirements of Section 4137.

B. Aggregates.

1. Individual Aggregates.

a. Use virgin mineral aggregate as specified in Materials I.M. 510 and meeting the requirements of Section 4127.

b. When frictional classification of the coarse aggregate is required, the contract documents will specify the friction level and location. Furnish friction aggregate from sources identified in Materials I.M. T203.

1) Friction Classification L-2.

Use a combined aggregate such that:

- At least 80% of the combined aggregate retained on the No. 4 (4.75 mm) sieve is Type 4 or better friction aggregate, and
- At least 25% of the combined aggregate retained on the No. 4 (4.75 mm) sieve is Type 2 or better friction aggregate.

2) Friction Classification L-3.

Use a combined aggregate such that:

- At least 80% of the combined aggregate retained on the No. 4 (4.75 mm) sieve is Type 4 or better friction aggregate, and
- At least 45% of the combined aggregate retained on the No. 4 (4.75 mm) sieve is Type 3 or better friction aggregate, or if Type 2 is used in place of Type 3, at least 25% of the combined aggregate retained on the No. 4 (4.75 mm) sieve is Type 2.

3) Friction Classification L-4.

Use a combined aggregate such that at least 50% of the combined aggregate retained on the No. 4 (4.75 mm) sieve is Type 4 or better friction aggregate.

2. Blended Aggregates.

a. Use a blended aggregate meeting the combined aggregate requirements in Materials I.M. 510.

b. When mixtures include RAP, use a blended mineral aggregate gradation consisting of a mixture of RAP aggregate combined with virgin aggregate.

C. Recycled Asphalt Pavement.

1. RAP is salvaged asphalt pavement. Use RAP from a source designated in the contract documents, or furnish Classified RAP or Unclassified

RAP from the Contractor's stockpile. The designations Classified and Unclassified are exclusively for the use of RAP in HMA.

a. Classified RAP.

1) Classified RAP is from a documented source with the aggregate meeting the appropriate quality requirements in Materials I.M. 510, and properly stockpiled.

2) Classified RAP may be used in the base and intermediate mixtures, and in surface mixtures (unless stated otherwise in the contract documents), for which the RAP aggregate qualifies. The surface course may contain up to 15% Classified RAP. The Contractor may use more than 15% of Classified RAP for the surface course when there is quality control sampling and testing of the RAP meeting the requirements in I.M. 505. Asphalt binder contributed by the RAP is limited to no more than 30% of the total asphalt binder in the surface mix.

b. Unclassified RAP.

1) RAP is designated as Unclassified RAP if it is:

- Stockpiled RAP not meeting the requirements of Classified RAP, or
- RAP from an unknown source.

2) When an Unclassified RAP stockpile is characterized by sampling and testing for mix design, do not add material to the stockpile until the project is completed.

3) For Interstate or Primary projects, HMA base and shoulder mixtures may contain up to 10% Unclassified RAP. For Primary projects, intermediate mixtures for 1,000,000 ESALs or less may contain up to 10% Unclassified RAP. HMA base, intermediate, and shoulder mixtures for all other projects may contain up to 10% Unclassified RAP. There will be no friction aggregate credit or aggregate crushed particles credit for Unclassified RAP.

2. Unless otherwise stated in the contract documents, identify each RAP stockpile and document Classified RAP stockpiles as directed in Materials I.M. 505. Do not add material to a Classified RAP stockpile without the approval of the District Materials Engineer. Include the following information when documenting Classified RAP material in a stockpile for future use in HMA:

- Identification of the project from which the material was removed,
- Mix data from the original project including mixture type, aggregate classification, location and depth in the pavement structure,
- Extracted gradation information, if available, and
- Description of stockpile location and quantity.

3. The Engineer may reject a RAP stockpile for non-uniformity based on visual inspection. Work the stockpiles in such a manner that the materials removed are representative of a cross section of the pile.

4. Place stockpiles of RAP on a base sufficient to prevent contamination, as directed in Materials I.M. 505. Do not use RAP stockpiles containing concrete chunks, grass, dirt, wood, metal, coal tar, or other foreign or

environmentally restricted materials. RAP stockpiles may include PCC (not to exceed 10% of the stockpile) from patches or composite pavement that was milled as part of the asphalt pavement.

5. When RAP is taken from a project, or is furnished by the Contracting Authority, the contract documents will indicate quantity of RAP expected to be available and test information, if known. Salvage this material. Unless otherwise specified in the contract documents, RAP not used in HMA becomes the property of the Contractor.

6. For HMA mix design purposes, the Contracting Authority will test samples of the RAP. The aggregate gradation and amount of asphalt binder in the RAP will be based on the Contracting Authority's extraction tests. When the amount of RAP binder exceeds 20% of the total asphalt binder, change the asphalt binder grade as directed in Materials I.M. 510.

D. Hot Mix Asphalt Mixture.

1. The job mix formula (JMF) is the percentage of each material, including the asphalt binder, to be used in the HMA mixture. Ensure the JMF gradation is within the control points specified for the particular mixture designated. Use the JMF to establish a single percentage of aggregate passing each required sieve size.

2. The basic asphalt binder content is the historical, nominal mixture asphalt binder content, expressed as percent by weight (mass) of the asphalt binder in the total mixture. Apply the values in Table 2303.03-1, based on mixture size and type.

3. If the asphalt binder demand for the combination of aggregates submitted for an acceptable mix design exceeds the basic asphalt binder content (see Table 2302.02-1) by more than 0.75%, include an economic evaluation with the mix design. Base this evaluation on past job mix history, possible aggregate proportion changes, and aggregate availability and haul costs for any changes or substitutions considered.

Table 2303.02-1: Basic Asphalt Binder Content (%)

Size	Aggregate Type	1 inch (25 mm)	3/4 inch (19 mm)	1/2 inch (12.5 mm)	3/8 inch (9.5 mm)
Intermediate and Surface	Type A	4.75	5.50	6.00	6.00
Intermediate and Surface	Type B	5.25	5.75	6.00	6.25
Base	Type B	5.25	6.00	6.00	6.25

4. Use HMA mixture design meeting gyratory design and mixture criteria corresponding to the design level specified in the contract documents. The Engineer may approve the substitution of any mixture which meets

requirements for a higher mixture than specified in the contract documents, at no additional cost to the Contracting Authority.

5. Use 1,000,000 ESAL HMA base mixture for shoulders placed as a separate operation. For outside shoulders on Interstate projects, the Contractor has the option to substitute the mainline intermediate or surface mixture for a specified base mixture, at the Contractor's expense.

6. Prepare gyratory HMA mixture designs for base, intermediate, and surface mixtures. Follow the procedure outlined in Materials I.M. 510. Submit mix design complying with Materials I.M. 510.

7. Use gyratory compacter for design and field control meeting the AASHTO protocol for Superpave gyratory compactors. Compactors for which compliance with this protocol is pending may be used at the discretion of the District Materials Engineer.

E. Other Materials.

1. Tack Coat.
Tack coat may be SS-1, SS-1H, CSS-1, or CSS-1H. Do not mix CSS and SS grades. RC-70 and MC-70 may also be used after October 1, at the Contractor's option.

2. Anti-strip Agent.

a. On Primary highways designed for over 10,000,000 ESALs and Interstate highways, perform an AASHTO T 283 moisture sensitivity evaluation of the proposed HMA mixture design.

b. On all other Primary highways, perform an AASHTO T 283 moisture sensitivity evaluation of the proposed HMA mixture design if 25% or more of the plus No. 4 (4.75 mm) (virgin and RAP) aggregates or more than 40% of the total (virgin and RAP) aggregates is:

- Quartzite.
- Granite.
- Other siliceous aggregate (not a limestone or dolomite) which is obtained by crushing from ledge rock.

c. Anti-strip agent will not be required for base repair, patching, or temporary pavement.

d. The following apply when an AASHTO T 283 analysis is required:

1) The Contractor’s results equal or exceed 90% tensile strength ratio (TSR).
Submit mix design sample to the Central Materials Laboratory for testing. If the Central Laboratory results verify the Contractor’s results, no anti-strip agent will be required and no further testing will be required unless substantial mix proportion changed from the original design are made.

2) Either the Contractor’s results equal or exceed 80% but are less than 90%, or the Central Laboratory TSR results do not verify the Contractor’s results.

Obtain additional sample for AASHTO T 283 testing during the initial placement of the plant produced mix. Obtain the additional sample from a test strip, if available, or during the initial approximately 500 tons (500 Mg) of mix. Obtain sample from an area without anti-strip agent. This sample will be used to determine acceptability of the plant produced mixture for moisture sensitivity. For production taking place after this initial 500 tons (500 Mg), add anti-strip agent to the mixture until results are obtained from the Central Laboratory. Payment for the anti-strip agent will be made according to Article 2303.05, D. If Central Laboratory results on mixture without anti-strip confirm acceptability, anti-strip agent will not longer be required from the time of notification.

3) The Contractor's results fall below 80%.
Anti-strip will be required.

e. Use one of the following anti-strip agents:

1) Hydrated Lime.
Meet the requirements of AASHTO M 303, Type I. Do not apply Section 4193. Hydrated lime will not be considered part of the aggregate when determining the job mix formula and the filler/bitumen ratio.

2) Liquid Anti-strip Additives.
For each JMF, obtain approval for liquid anti-strip additives blended into the binder. Approval will be based on the following conditions:

a) The asphalt binder supplier provides test results that the additive does not negatively impact the asphalt binder properties, including short term and long term aged properties.

b) The design is to establish the optimum additive rate when comparing the dry strength of specimens prepared with asphalt binder not containing the anti-strip additive to conditioned specimens prepared with asphalt binder containing the anti-strip additive. See Materials I.M. 510 for additional information.

c) A change in the source of asphalt binder, liquid anti-strip, or aggregates will require a re-evaluation of the AASHTO T 283 test. When there is a significant change in the aggregate proportions, the Engineer may require a re-evaluation of the AASHTO T 283 test.

3) Polymer-based Liquid Aggregate Treatments.
For each JMF, obtain approval for polymer-based liquid aggregate treatments. Approval will be based on the following conditions:

a) The design establishes the optimum additive rate when comparing the dry strength of specimens prepared without the anti-strip additive to conditioned specimens prepared with asphalt binder containing the anti-strip additive. See Materials I.M. 510 for additional information.

b) A change in the source of asphalt binder, liquid additive treatment, or aggregates will require a re-evaluation of the AASHTO T 283 test.

3. Sand for Tack Coats.
Use sand meeting the requirements of Gradation No. 1 of the Aggregate Gradation Table in Section 4109.02.

4. Fabric Reinforcement.
Use fabric reinforcement meeting the requirements of Article 4196.01, B, 4.

2303.03 CONSTRUCTION.

A. General.

1. The Contractor is responsible for all aspects of the project.

2. Provide quality control management and testing, and maintain the quality characteristics specified.

3. Apply Quality Management - Asphalt (QM-A) to contracts with HMA quantities of 5000 tons (5000 Mg) or greater and all Interstate contracts. Follow the procedures and meet the criteria established in Articles 2303.02 and 2303.03, B; Section 2521; and Materials I.M. 510 and 511.

4. For contracts with less than 5000 tons (5000 Mg), the Engineer will be responsible for quality control. The Contractor is responsible for the mix design. This does not change the mix requirements from gyratory to Marshall, unless specified in the contract documents.

B. Equipment.

Provide sufficient equipment of the various types required to produce, place, and compact each layer of HMA mixture as specified. Use equipment meeting the requirements of Section 2001 with the following modifications:

1. Plant Calibration.

a. Calibrate each plant scale and metering system before work on a contract begins. Use calibration equipment meeting the manufacturer's guidelines and Materials I.M. 508.

b. The Engineer may waive calibration of permanent plant scales when a satisfactory operational history is available. The Engineer may require any scale or metering system to be recalibrated if operations indicate it is necessary.

c. Make calibration data available at the plant.

d. Calibrate each aggregate feed throughout an operating range wide enough to cover the proportion of that material required in the JMF. Make a new calibration each time there is a change in size or source of any aggregate being used.

e. For continuous and drum mixing plants, calibrate the asphalt metering pump at the operating temperature and with the outlet under pressure equal to that occurring in normal operations.

2. Paver.
Apply Article 2001.19. Spreaders described in Article 2001.13, D, may be used to place paved shoulders. Spreaders used to place the final lift

of paved shoulders shall meet additional requirements of Article 2001.19.

3. Rollers.

a. For initial and intermediate rolling, use self-propelled, steel tired, pneumatic tired, or vibratory rollers meeting the requirements of Article 2001.05, B, C, or F. Their weight (mass) or tire pressure may be adjusted when justified by conditions.

b. For finish rolling, use self-propelled, steel tired rollers or vibratory rollers in the static mode that meet the requirements of Article 2001.05, B, or F.

4. Scales.

Apply Article 2001.07, B, to paving operations regardless of the method of measurement.

C. HMA Construction.

1. Maintenance of the Subgrade and Subbase.

a. Maintain completed subgrade and subbase to the required density, true cross section, and smooth condition, prior to and during subsequent construction activities.

b. If rutting or any other damage occurs to the subgrade or subbase as a result of hauling operations, immediately repair the subgrade and subbase. Such repair will include, if necessary, removal and replacement, at no additional cost to the Contracting Authority.

c. Should traffic by others authorized to do work on the project be specifically permitted by the Engineer to use loads which exceed the Contractor's established limit, the Contracting Authority will pay repair costs for repairs directed by the Engineer.

2. Preparation of Existing Surfaces.

a. Cleaning.

Clean and prepare existing surface according to Article 2212.03, B, 1.

b. Tack Coats.

1) Apply tack coats when the entire surface area on which the coat is to be applied is free of moisture. Do not apply them when the temperature on the surface being covered is less than 25°F (-4°C).

2) Place a tack coat to form a continuous, uniform film on the area to be covered. Unless directed otherwise, spread the tack coat at an undiluted rate of 0.02 to 0.05 gallon per square yard (0.1 to 0.2 L/m^2). The tack coat may be diluted with water to improve application.

3) Allow tack coat to adequately cure prior to placement of HMA to assure bond to the underlying surface and avoid damage of the HMA being placed. If tack coat surface becomes dirty from weather or traffic, thoroughly clean and, if necessary, retack. A light application of sand cover may also be required, but this is anticipated only for excessive application rates, breakdowns, and short sections remaining at the end of a day's run.

4) On highways being constructed under traffic, use procedures that provide safety and convenience to the public (without soiling their vehicles) as controlling factors. Limit tack coat application lengths to minimize inconvenience to the public. Keep applications within the hot mixture placing work area that is controlled by flaggers at each end. Plan applications so they will be covered with hot mixture when the work area is opened to traffic at the end of the day's work.

5) Tack the vertical face of exposed, longitudinal joints as a separate operation at a rate from 0.10 to 0.15 gallon per square yard (0.5 to 0.7 L/m^2). Tack before the adjoining lift is placed. Lightly paint or spray vertical surfaces of all fixtures, curbs, bridges, or cold mixture with which the hot mixture will come in contact to facilitate a tight joint with the fresh mixture.

c. Fabric Reinforcement.

1) When fabric reinforcement is required, the locations will be designated in the contract documents.

2) Do not place fabric on wet or damp surfaces, or when the road surface is less than 50°F (10°C).

3) Apply fiberglass fabric only with an adhesive recommended by the manufacturer.

4) Place fabrics with an adhesive backing according to the manufacturer's recommendations.

5) Place other fabrics with a heavy coat of the same asphalt binder grade used in the HMA and applied at a rate of 0.20 to 0.25 gallons per square yard (0.9 to 1.1 L/m^2). Place at a temperature between 295°F and 315°F (145°C and 160°C).

6) Place fabric reinforcement according to the contract documents (full width or individual crack or joint treatment). Place fabric immediately following the adhesive or asphalt binder placement under the fabric. Placement may be by hand or by a mechanical method designed for this purpose.

7) Take precautions to avoid wrinkles in the fabric and to ensure that air bubbles are removed without breaking the fabric. Cut and lap wrinkles or folds which cannot be removed by brushing in order to provide a smooth surface.

8) Additional adhesive or asphalt binder may be required to produce a tight, bonded surface. When applied full lane width, use a minimum 12 inch (300 mm) transverse and longitudinal lap.

9) Avoid applying tack coat over longitudinally placed fabric.

10) To avoid damage to fabric, do not allow traffic over fabric during placement and during curing of the adhesive material. A light application of HMA mix may be hand sprinkled on the fabric to prevent damage from necessary equipment traffic.

11) When directed by the Engineer, repair damaged or soiled fabric prior to HMA overlay, at no additional cost to the Contracting Authority. The Engineer may also require sanding during this period, at no additional cost to the Contracting Authority.

3. Handling, Production, and Delivery.

Ensure plant operation complies with the following requirements:

a. Handling Mineral Aggregate and RAP.

1) Keep various aggregate products used separate from one another. Make adequate provisions to prevent intermingling.

2) Handle stockpiling and processing in a manner to ensure uniform incorporation of the aggregate into the mix.

3) Feed various aggregates separately in their proper proportions using feeders to the cold elevator. Feed them at a rate to permit correct and uniform temperature control of heating and drying operations.

b. Handling Asphalt Binder.

Bring asphalt binder to a temperature of 260°F to 330°F (125°C to 165°C) before being measured for mixing with the aggregates. The temperature between these limits may be further regulated according to the characteristics of the mixture, method of proportioning, and viscosity of the asphalt binder. Heat modified asphalt binder according to the supplier's recommendations.

c. Handling Anti-strip Agents.

1) Hydrated Lime.

Accurately proportion lime using a method acceptable to the Engineer.

a) Added to a Drum Mixer.

(1) Add hydrated lime at the rate of 0.75% by weight (mass) of the total aggregate (virgin and RAP) for Interstate and Primary projects. Add hydrated lime to a drum mixer using one of the following methods:

(a) Add to virgin aggregate on the primary feed belt, as a lime water slurry.

(b) Thoroughly mix with the total combined aggregate if the aggregate contains at least 3% total moisture.

(2) Alternative methods for mixing will be allowed only with the Engineer's approval. Do not introduce hydrated lime directly into a drum mixer by blowing or auguring.

b) Added to a Batch Plant.

Add hydrated lime at the rate of 0.5% by weight (mass) of the total aggregate (virgin and RAP) for Interstate and Primary projects. Introduce it to a batch plant using one of the methods below. In any case, introduce the lime prior to the start of the dry mix cycle.

(1) Place on the recycle belt which leads directly into the weigh hopper.

(2) Add directly into the pugmill.

(3) Add directly into the hot aggregate elevator into the hot aggregate stream.

c) Added to the Aggregate Stockpile.

Add hydrated lime at a rate established by the AASHTO T 283 test. The instructions for establishing the rate are discussed in Materials I.M. 510. Add it to the source aggregates defined in Article 2303.02, E, 2, thoroughly

mixed with sufficient moisture to achieve aggregate coating, and then place in the stockpile.

2) Liquid.

a) When liquid anti-strip additives are used, employ equipment complying with the anti-strip manufacturer's recommended practice to store, measure, and blend the additive with the binder.

b) The additive may be injected into the asphalt binder by the asphalt supplier or the Contractor. If the Contractor elects to add the liquid anti-strip agent, they assume the material certification responsibilities of the asphalt binder supplier. Ensure the shipping ticket reports the type and amount of additive and time of injection.

c) Ensure the asphalt supplier provides the Contactor and Engineer with the shelf life criteria defining when the anti-strip additive maintains its effectiveness. Do not use binder that has exceeded the shelf life criteria.

d) When using polymer-based aggregate treatment, comply with the manufacturer's recommended specifications and guidelines.

d. Production of Hot Mix Asphalt Mixtures.

1) Regulate the exact proportions of the various materials to be within the limits specified to produce a satisfactory bituminous coating and mixture. First dry mix the aggregates, then add the asphalt binder.

a) In batch plants, add the asphalt binder in an evenly spread sheet over the full length of the mixer box.

b) In continuous plants, spray the asphalt binder evenly into the aggregate within the first 30% of the length of the mixer box using a positive pressure spray.

c) In drum mixing plants, spray the asphalt binder evenly into the aggregate using a positive pressure spray.

2) Coating aids may be added with the Engineer's approval.

3) Operate the mixer so that the mixture is of consistently uniform temperature, and when discharged from the mixer does not vary more than 20ºF (11ºC).

4) Unless the Engineer approves, do not allow the temperature of the mixtures to exceed 330ºF (165ºC).

5) Use a rate of production that will not exceed the manufacturer's rated capacity for the mixer and will provide uniform coating. For batch mixers, use a dry mixing time of no less than 5 seconds and a wet mixing time of no less than 25 seconds. For continuous mixers, use a mixing time of no less than 30 seconds.

6) Control handling and manipulation of the hot mixture from the mixer to the final spread on the road in order to maintain uniform composition and minimize segregation of coarser particles. Minimize segregation to the extent that it cannot be visibly observed in the compacted surface. Apply only approved release agents to trucks and equipment, as specified in Article 2001.01.

7) Ensure mixture temperature allows for the specified compaction and density to be attained. Do not discharge HMA into the paver hopper when its temperature is less than:
- 245°F (120°C) for a nominal layer thickness of 1 1/2 inches (40 mm) or less, or
- 225°F (110°C) for a nominal layer thickness of more than 1 1/2 inches (40 mm).

8) Except for an unavoidable delay or breakdown, provide continuous and uniform delivery of hot HMA to any individual spreading unit. Deliver at a rate sufficient to provide as continuous an operation of the spreading unit as practical. Keep the paver hopper sufficiently full at all times to prevent non-uniform mixture flow to the screed.

4. Placement.

a. Clean the surface of each layer according to Article 2212.03, B, 1. If necessary, retack to provide bond with the succeeding course.

b. Prior to placing the final lift, correct bumps or other significant irregularities that appear or are evident in the intermediate course or other lower course.

c. Do not place HMA mixtures under the following circumstances:

1) On a wet or damp surface.

2) When road surface temperature is less than that shown in Tables 2303.03-1 and 2303.03-2.

Table 2303.03-1: Base and Intermediate Course Lifts of HMA Mixtures

Nominal Thickness - inches (mm)	Road Surface Temperature, ºF (ºC)
1 1/2 (40)	40 (4)
2 - 3 (50 - 80)	35 (2)
Over 3 (Over 80)	25 (-4)

Table 2303.03-2: Surface Course Lifts of HMA Mixtures

Nominal Thickness - inches (mm)	Road Surface Temperature, ºF (ºC)
1 (30)	50 (10)
1 1/2 (40)	45 (7)
2 and greater (50 and greater)	40 (4)

3) After November 15, except with the Engineer's approval.

d. The Engineer may further limit placement if, in the Engineer's judgment, other conditions are detrimental to quality work.

e. When placing the mixture, maintain a finishing machine forward speed that will provide a continuous uniform operation. Minimize stopping.

f. Use a wire or string line to guide finishing machine and maintain alignment. Correct edge alignment irregularities immediately.

g. The contract documents will show the total thickness to be placed. Spread the mixture at a rate such that, when compacted, the layer(s) will be the required thickness.

h. Base the minimum layer thickness on Table 2303.03-3.

Table 2303.03-3: Minimum Lift Thickness

Design Mix Size - inches (mm)	Minimum Lift Thickness - inches (mm)
3/8 (9.5)	1 (25)
1/2 (12.5)	1 1/2 (40)
3/4 (19)	2 (50)
1 (25)	3 (75)

i. Ensure the compacted thickness of the top layer does not exceed 3 inches (75 mm). This restriction does not apply to HMA shoulders.

j. The maximum compacted thickness of lower layers may exceed 4 inches (100 mm) if it is demonstrated that the thicker layers have satisfactory density. The riding characteristics of the thicker layers must be within conformance to that expected from a 3 inch (75 mm) layer.

k. Complete each layer to full width before placing succeeding layers.

l. While operating on the road surface, do not use kerosene, distillate, other petroleum fractions, or other solvents, for cleaning hand tools or for spraying the paver hopper. Do not carry containers of cleaning solution on or near the paver. When a solvent is used, do not use the paver for at least 5 hours after cleaning. Collect and remove all cleaning materials and cleaning residue from the project and plant site. The cleaning material and residue becomes the property of the Contractor.

m. Whenever practical, spread mixtures using a finishing machine. Irregular areas may be spread by hand. Spread the hot mixture uniformly to the desired depth with hot shovels and rakes. Do not dump loads faster than they can be spread properly. Do not allow workers to stand on the loose mixture while spreading.

n. After spreading, carefully smooth to remove all segregated coarse aggregate and rake marks. Use rakes and lutes designed for use on HMA mixtures.

o. Unless stated elsewhere in the contract documents, when placing two adjacent lanes, pave no more than 1 day of rated plant production before paving the adjacent lane(s). Place the adjacent lane to match the first lane during the next day of plant production.

p. Do not spread more mixture than can be compacted in the specified working hours of the same working day.

q. At the close of each working day, clear all construction equipment from the roadbed.

r. Prior to opening a lane to traffic, place fillets or full width granular shoulders according to Article 2121.03, C, 4. Place the material adjacent to and equal in thickness to the resurfacing. Fillet removal is incidental to the HMA mixture.

5. Compaction.

a. General.

1) Promptly and thoroughly compact each layer. Use mechanical tampers for areas inaccessible to the rollers.

2) Use a rolling procedure and compactive effort that will produce a surface free of ridges, marks, or bumps. Obtain the Engineer's approval for the rolling procedure and compactive effort.

b. Class I Compaction.

Intended for use on Interstate highways, and most Primary and Secondary highways. For Class I compaction, the roadway density (percent of laboratory density) will be based on the density obtained from the Quality Control Program for that day's mixture.

1) Class IA Compaction.

a) Use Class IA compaction for intermediate and surface courses for the traffic lanes of:

- Interstate highways,
- Interstate-to-Interstate ramps, and
- Primary highways as specified.

b) Compact to a minimum of 96% of laboratory density. Do not exceed 8% average air void level for roadway density specimens.

2) Class IB Compaction.

a) Use Class IB compaction for:

- All Interstate and Primary base courses,
- Primary travel lane intermediate and surface courses when Class IA compaction is not specified, and
- Primary ramps connecting to Interstate and Primary highways when Class IA compaction is not specified.

b) Compact to a minimum of 95% of laboratory density. Do not exceed 8% average air void level for roadway density specimens.

3) Class IC Compaction.

a) Use Class IC compaction for:

- HMA base widening,
- Shoulder resurfacing when specified,
- Traffic lanes of Secondary highways, and
- Any other traffic lanes when Class IA and IB are not specified.

b) Compact to a minimum of 94% of laboratory density. Do not exceed 8% average air void level for roadway density specimens.

4) Test Strip Construction for Class IA and IB Compaction.

a) For the purpose of evaluating properties of the HMA mixtures and for evaluating an effective rolling pattern:

(1) For Class IA compaction, construct a test strip at the start of intermediate course placement.

(2) For Class IA and IB compaction, construct a test strip prior to the start of surface course placement.

b) For multiple lifts using the same mix requiring Class IA compaction, when the thickness of the second lift varies

from the first lift by 1 1/2 inches (40 mm) or more, perform a test strip for the second lift.

c) When the contract documents specify both intermediate and surface courses, place a surface course test strip in lieu of intermediate mix in a section of intermediate course prior to actual surface course placement.

d) Apply the test strip to each mixture which has a plan quantity of at least 3000 tons (3000 Mg).

e) The quantity of HMA mixture subject to Class IA compaction, produced and placed for test strip production, will be limited to:

(1) 750 tons (750 Mg) for lift thicknesses of 2 inches (50 mm) or less.

(2) 1000 tons (1000 Mg) for lift thicknesses greater than 2 inches (50 mm).

f) After test strip placement, suspend further mixing and laydown operations until the laboratory test results of the plant produced mixture and core densities are available.

g) Only one test strip will be allowed for each mixture. The Engineer may require additional test strips if a complying HMA mixture or rolling pattern was not established.

h) Use procedures and documentation during test strip construction that allow the Engineer and Contractor to confirm mixture design properties and effectiveness of compaction procedures.

i) Use test strip production control that meets the requirements of Article 2303.03, D, 3, c. The number of density core samples obtained for the test strip will be increased by one. The low core result will not be used in the Quality Index (Q.I.) formula for payment for the test strip quantity.

c. Class II Compaction.

Intended for paved shoulders, temporary crossovers, onsite detours, and other situations where Class I is not specified.

1) For all rollers, make initial contact with the hot mixture using the power driven wheels or drum.

2) Perform initial rolling at a temperature so the mixture will compact without excessive distortion. Except on longitudinal joints and super-elevated curves, begin rolling with the initial roller at the outer edges of the pavement. With each successive pass, progress inward toward the center. For each reverse trip, lap all but 4 to 6 inches (100 to 150 mm) of the previous track. When reversing direction, stop the initial roller at an angle with the longitudinal direction.

3) Following the initial rolling, give the layer an intermediate rolling with a pneumatic tired roller before the temperature falls below 225°F (110°C). Cover the area no less than six times with the intermediate roller.

4) Use a finish, steel tired roller to smooth out all marks and roughness in the surface.

5) For areas inaccessible to rollers, use mechanical tampers or other approved compaction methods.

6. Joints and Runouts.

a. Construct longitudinal joints for courses on resurfacing projects directly above the longitudinal joint in the existing pavement. Limit the offset distance between longitudinal joints in succeeding full depth HMA paving courses to 3 inches (75 mm) or less. Adjust hot mixture spreading along longitudinal joints to secure complete joint closure and full compression of the mixture with a smooth surface and joint after compaction.

b. Separate transverse construction joints in succeeding courses by at least 6 feet (1.6 m). Do not use wood or metal headers to form joint edge during rolling of the fresh mixture. Saw header to a straight line at right angles to the center line to provide a full thickness vertical edge before continuing paving. Provide a 10 foot (3 m) straightedge for checking transverse construction joints for smoothness. Before compaction, use hand methods to correct surface variations at transverse construction joints indicated by the straightedge.

c. When a transverse construction joint is open to traffic, install a temporary runout 10 feet (3 m) long per 1 inch (25 mm) of lift thickness. Use suitable paper or burlap (not sand, dirt, or wood) under the taper to prevent adhesion.

d. When required to end paving for winter shutdown, locate runouts adjacent to each other. Install a winter shutdown runout 25 feet (8 m) long per 1 inch (25 mm) of lift thickness.

e. For temporary runouts open to traffic for periods greater than 4 weeks or winter shutdown runouts, the Contractor may reduce the amount of top size aggregate in the transition taper. Remove temporary runouts and winter shutdown runouts before commencing paving. Runout removal is incidental to the HMA mixture.

7. Miscellaneous Operations.

a. Leveling and Strengthening Courses.

1) The contract documents will show course thickness. Place strengthening and leveling courses as indicated in the contract documents. Use the same mixture specified for the base or intermediate course.

2) When the width of strengthening or leveling course is 8 feet (2.4 m) or more, spread using a finishing machine.

3) Compact leveling courses using Class II compaction, except make all passes with a pneumatic roller.

b. Wedge Courses.

1) Use the base or intermediate mixture to construct wedge courses used to secure desired curve super-elevation. When possible, spread using a finishing machine.

2) Place wedge courses in compacted layers no thicker than 3 inches (75 mm). Avoid crushing the coarse aggregate. Place wedge courses to the full width of the pavement.

3) On super-elevated curves which require wedge course placement, stage the shoulder construction. After completing each day's wedge placement operations and prior to suspending that day's construction activities, construct a full

width shoulder on the high side up to the completed wedge course elevation. Shoulder construction staging will be considered incidental to shoulder construction.

c. Fixtures in the Pavement Surface.

1) Adjust utility accesses, intakes, or other fixtures encountered within the area to be covered by HMA to conform to the final adjacent finished surface. Unless specified otherwise in the plans, adjust fixtures:

- Between placing the surface course and the layer preceding the surface course, or
- After placing the surface course using a composite patch or PCC patch.

2) Use PCC and HMA patch material complying with the requirements of Section 2529. Make patches large enough to accommodate the structure being adjusted.

3) Construct patches to be square. Orient them diagonally to the direction of traffic flow. Ensure the elevation of the adjusted fixture and patch does not differ from the elevation of the surrounding pavement surface by more than 1/4 inch (6 mm).

d. Fillets for Intersecting Roads and Driveways.

1) Shape, clean of loose material, and tack coat the surface adjacent to the pavement being surfaced when fillets are designated in the contract documents for driveways to homesteads and commercial establishments and at intersecting roads. On the tack coated surface, place and compact the hot mixture in layers equal to the adjacent layer. Extend from the edge of the pavement as shown on the plans.

2) Place and compact fillets at intersecting roads at the same time as the adjacent layer.

3) Entrance fillets that are 8 feet (2.4 m) or wider may be placed as a separate operation. Pave fillets which are 8 feet (2.4 m) or wider with a self propelled finishing machine described in Article 2001.19.

4) The Engineer may approve other equipment for placement of fillets, based on a demonstration of satisfactory results.

e. Stop Sign Rumble Strips.

If the plans include the bid item Rumble Strip Panel (In Full Depth Patch), apply Section 2529. To meet the requirements of placing Stop Sign Rumble Strips before opening roadway sections to traffic, the Contractor may construct temporary rumble strip panels meeting the final pattern and location of the Stop Sign Rumble Strip indicated in the plans

f. Paved HMA Shoulders.

1) Compact paved HMA shoulders using one of the following methods:

a) Class II compaction (Article 2303.03, C, 5, c),

b) Rolling pattern established during the first day of shoulder placement to achieve Class 1C compaction (Article 2303.03, C, 5, b, 3), or

c) Same rolling pattern established for mainline lanes, as determined by density coring.

2) Shoulder area will not be included in calculations for density price adjustment on mainline. A price adjustment may be applied to shoulder areas that do not adhere to the established roller pattern.

D. Quality Assurance Program.
For each HMA mixture bid item of more than 1000 tons (1000 Mg), apply requirements of this article.

HMA mixture bid items of 1000 tons (1000 Mg) or less and patching bid items are both defined as small quantities. For those bid items, meet the requirements of Article 2303.03, E.

1. General.
Follow the procedures and meet the criteria established in Articles 2303.02 and 2303.03, B, Section 2521, and Materials I.M. 510 and 511.

2. Mix Design - Job Mix Formula.

a. The Contractor is responsible for the JMF for each mixture.

b. Submit a completed JMF, using the computer format of Form 956, for approval to the materials lab designated by the Contracting Authority. Submit supporting documentation demonstrating the design process was followed and how the recommended JMF was determined. Include an economic evaluation when required. Include trial and final proposed aggregate proportions (Form 955) and corresponding gyratory data. In addition, submit sufficient loose mixture and individual material samples for approval of the design.

c. Personnel preparing the JMF shall be Iowa DOT certified in bituminous mix design.

d. If the JMF is not satisfactory, submit another JMF for review. An approved JMF will be required prior to beginning plant production. The Contractor will be charged $1000 for each JMF approval requested and performed which exceeds two per mix size, type, and proposal item on any individual project or group of tied projects.

3. Plant Production.

a. General.

1) Perform sampling and testing to provide the quality control of the mixture during plant production. Certified Plant Inspection according to Section 2521 is required.

2) Personnel performing production quality control testing shall be Iowa DOT certified for the duties performed.

3) Provide easy and safe access for Iowa DOT staff to the location in the plant where samples are taken.

4) A "significant mix change" is defined as a single occurrence of an aggregate interchange of greater than 5%, a single occurrence of an asphalt content change greater than 0.2%, or any deletion or introduction of a new material into the mix.

b. Sampling and Testing.

1) Sample and test asphalt binder to verify the quality of the binder grade. Take asphalt binder samples at random times as

directed and witnessed by the Engineer according to Materials I.M. 204.

2) Use cold feed gradation for aggregate gradation control to assure materials are being proportioned according to the specifications. Take aggregate samples at random times as directed and witnessed by the Engineer according to Materials I.M. 204. The Engineer will secure the samples according to Materials I.M. 511.

3) Sample the hot HMA mixture at random locations as directed and witnessed by the Engineer according to Materials I.M. 322. Secure the samples according to Materials I.M. 511.

4) Assist the Engineer with material sampling for verification testing. When the Engineer provides notification that a sample is to be taken, obtain sample within 15 minutes.

5) Each day's production of a mix design will be considered a lot.

- **a)** When the anticipated quantity for the day is 2000 tons (2000 Mg) or more, divide that day's production into four sublots, with the first sublot being the first 500 tons (500 Mg) produced. The Engineer will divide the remaining anticipated quantity for the day into three equally sized sublots.
- **b)** When the anticipated quantity for the day is less than 2000 tons (2000 Mg), use the first 500 tons (500 Mg) produced for the first daily sublot. The Engineer will establish 750 ton (750 Mg) daily sublots for mix production exceeding the first 500 tons (500 Mg).

6) No more than four paired hot HMA mixture samples will be required for acceptance of a lot.

7) Do not take paired samples from the first 100 tons (100 Mg) of mix produced each day or the first 100 tons (100 Mg) of mix following a significant mix change.

8) Test the quality control sample of each production paired sample as follows:

- **a)** Prepare and compact two gyratory specimens according to Materials I.M. 325G.
- **b)** Determine the density for each specimen according to Materials I.M. 321. Average the results to determine sample density.
- **c)** Use the field quality control laboratory compaction for field density control. The laboratory density for field control will be the bulk specific gravity of compacted mixture (G_{mb}) at N_{design}. Bulk specific gravity at N_{design} will be determined by compacting specimens to N_{max} and back calculating the bulk specific gravity at N_{design}.
- **d)** Determine the Theoretical Maximum Specific Gravity of the uncompacted mixture according to Materials I.M. 350 or other test methods recognized by AASHTO or ASTM.
- **e)** Determine laboratory air voids for each sample according to Materials I.M. 501.

9) When liquid anti-strip additives are used, satisfy one of the following methods to regulate the quantity of additive:

a) Present certification that the equipment used to measure and blend the liquid anti-strip additive:
- Meets the anti-strip supplier's recommended practice,
- Is directly tied to the asphalt binder supply system, and
- Has been calibrated to the equipment manufacturer's guidelines.

b) Test the binder to measure the quantity of liquid anti-strip additive in the binder for every 5000 tons (5000Mg) of HMA production. Obtain the Engineer's approval for the supplier's test method prior to use of the test.

c) Run AASHTO T 283 during production. If unable to certify or test for the presence and quality, run AASHTO T 283 each 10,000 tons (10,000 Mg) of production to measure the effectiveness of the additive. Ensure test results satisfy 80% TSR when compared to the dry strength of specimens prepared with asphalt binder containing the additive.

c. Production Control.

1) After the JMF is established, the combined aggregate furnished for the project, the quantity of asphalt binder, and the laboratory air voids should consistently comply with the JMF, as target values. Control them within the production tolerance given in Table 2303.03-4.

Table 2303.03-4: Production Tolerances

Measured Characteristic	Target Value (%)	Specification Tolerance (%) [(a)]
Cold feed gradation No. 4 (4.75 mm) and larger sieves	by JMF	± 7.0
Cold feed gradation No. 8 (2.36 mm)	by JMF	± 5.0
Cold feed gradation No. 30 (600 µm)	by JMF	± 4.0
Cold feed gradation No. 200 (75 µm)	by JMF	± 2.0 [(b)]
Daily asphalt binder content	by JMF	± 0.3
Field laboratory air voids	4.0 [(c)]	-0.5/+1.0 [(d)]
VMA [(e)]	by JMF	± 1.0 [(f)]

(a) Based on single test unless noted otherwise.

(b) Maintain the filler/bitumen ratio of the plant produced mixture between 0.6 and 1.4.

(c) Unless otherwise specified.

(d) Based on the moving average of four test values.

(e) Restricted to an asphalt film thickness as specified for the level of HMA mixture.

(f) Based on the daily lot average.

2) Control plant production so that the plant produced HMA mixture will meet mixture design criteria (within the test tolerances given in Table 2303.03-4) for Air Voids and VMA at N_{design} gyrations of the gyratory compactor. Monitor the slope of the gyratory compaction curve of plant produced material. Slope variations in excess of ±0.40 of the mixture design gyratory compaction curve slope may indicate potential problems with uniformity of the mixture.

3) The gyratory mix design gradation control points for the size mixture designated in the project plans will not apply to plant production control.

4) Strive for the target value of the percent air void and asphalt binder by adjusting gradation and asphalt binder content.

5) Produce a uniform composition mixture complying with the JMF.

6) Adjustments to the JMF target gradation and asphalt binder content values may be made.

- **a)** The Contractor determines from quality control testing that adjustments are necessary to achieve the specified properties.
- **b)** Consult with the Engineer regarding adjustments to the JMF.
- **c)** The Contractor's adjustment recommendations prevail, provided all specifications and established mix criteria are being met for plant production.

7) Measure estimated film thickness and voids in the mineral aggregate (VMA) for specification compliance every day of HMA production.

8) Prepare quality control charts according to Materials I.M. 511. Keep the charts current and available showing both individual sample results and moving average values. Base moving average values on four consecutive sample results. Moving averages may restart only in the event of a mandatory plant shutdown for failure to maintain the average within the production tolerance. Include the target value and specification tolerances on control charts.

9) Calculate laboratory voids for individual samples according to Materials I.M. 501. Use the individual density and individual maximum specific gravity determined for each sample. To determine the moving average of laboratory voids, use the average of the last four individual sample laboratory voids.

10) Monitor the test results and make mix adjustments, when appropriate, to keep the mixture near the target values. Notify the Engineer whenever the process approaches a specification tolerance limit. Cease operations when the moving average point for laboratory air voids is outside the specification tolerance limit. Assume responsibility to cease operations, including not incorporating material which has not been placed. Do not start the process again until notifying the Engineer of the corrective action proposed.

4. Construction.

a. Density.

1) Take density samples from the compacted mixture and test no later than the next working day following placement and compaction.

2) A lot is considered to be one layer of one mixture placed during a day's operation. The Engineer may approve classifying multiple layers of construction placed during a single day as a lot provided only one mixture was used.

3) The Engineer may waive sampling for density in the following situations, provided compaction has been thorough and effective:

- When the day's operation is not more than 2500 square yards (2500 m^2),
- When the day's operation is not more than 500 tons (500 Mg),
- When the mixture is being placed in irregular areas, or
- When placing wedge or strengthening courses.

4) The Engineer will obtain and test density samples for each lot according to Materials I.M. 204. The Engineer will determine the core locations. The minimum number of cores is set forth in Materials I.M. 204, Appendix F. The length laid in each lot will be divided into approximately equal sublots. Obtain one sample at a random location, as directed and witnessed by the Engineer, in each sublot.

5) If a sample is damaged or measures less than 70% or more than 150% of the intended thickness, an alternate sampling location will be determined and used. Take samples from no less than 1 foot (300 mm) from the edge of a given pass of the placing equipment, from run-outs, or from day's work joints or structures.

6) Determine the quality index for density of each lot using the following formula:

$$QI_{Density} = \frac{(\text{Average } G_{mb})_{\text{Field Lot}} - ((\%\ \text{Density})_{\text{Specified}} \times (\text{Average } G_{mb})_{\text{Lab Lot}})}{(\text{Standard Deviation } G_{mb})_{\text{Field Lot}}}$$

where $QI_{Density}$ = Quality Index for density
G_{mb} = bulk Specific Gravity of the mixture

7) When the quality index falls below 0.00, the Engineer may declare the lot or parts of the lot defective.

8) If one of the density test values from a lot is an outlier, identified according to the procedure described in Materials I.M. 501, do not use the outlier value to determine the quality index. Use the remaining density test values to determine the quality index.

9) If only one laboratory density value is obtained that day, combine that value with the next day's test results to evaluate both days' production. If two or more laboratory density values are obtained that day, then use the average of those tests

alone. If a significant mix change has been made, only the appropriate laboratory density values should be used with the corresponding density cores.

b. Thickness.

1) The Engineer will measure the cores, exclusive of sealcoat, according to Materials I.M. 337. All areas of uniform and similar thickness and width for the project will be divided into lots.

2) Use the frequency specified for taking density samples from the surface lift when measuring for completed thickness. Samples for thickness not tested for density, because they are less than 70% of the intended thickness, are included for thickness. In these particular instances, do not measure the thickness of additional sufficiently thick samples used for density tests. Take thickness samples full depth of the completed course. After measurement, remove the density samples for the top layer from the core.

3) If any of the measurements for a lot is less than the designated thickness, the quality index for thickness of that lot will be determined by the following formula:

(English)

$$QI_{Thickness} = \frac{\text{Average Thickness}_{Measured} - (\text{Thickness}_{Plan} - 0.5)}{\text{Maximum Thickness}_{Measured} - \text{Minimum Thickness}_{Measured}}$$

(Metric)

$$QI_{Thickness} = \frac{\text{Average Thickness}_{Measured} - (\text{Thickness}_{Plan} - 12.7)}{\text{Maximum Thickness}_{Measured} - \text{Minimum Thickness}_{Measured}}$$

4) Provided there is reasonable assurance that the pavement complies with the required thickness, the Engineer may waive sampling for thickness for the following situations:

a) When the day's operation is 2500 square yards (2500 m^2) or less.

b) When the mixture is being placed in irregular areas.

c) When the mixture is being placed next to structures.

5) When the quality index falls below 0.00, the Engineer may declare the lot or parts of the lot defective.

c. Smoothness.

Apply Section 2317 to HMA surface mixture bid items of a Primary project if any individual HMA mixture bid item is 1000 tons (1000 Mg) or greater or 5000 square yards (4200 m^2) or greater. Apply Section 2316 to all other Primary projects with a surface course and when specifically required for other projects.

5. Sampling and Testing.

a. General.

1) Maintain and calibrate the quality control testing equipment using prescribed procedures. Sample and test according to the specified procedures as listed in the applicable Materials I.M. and Specifications. When the results from a Contractor's

quality control lab are used as part of product acceptance, the Contractor's quality control lab is required to be qualified.

2) Identify, store, and retain all quality control samples and field lab gyratory specimens used for acceptance until the lot is accepted. The Contracting Authority will prescribe the method of securing the identity and integrity of the verification samples according to Materials I.M. 511. Store verification samples for the Contracting Authority until delivery to the Contracting Authority's lab.

3) Identify all samples using a system the Engineer approves.

b. Individual Materials and Loose Mixture.

1) Complete the following as designated by the Engineer:

- Identify samples of asphalt binder, aggregate, and tack coat material.
- Secure and promptly deliver the samples to the appropriate laboratory.

2) Take paired samples of loose HMA mixture (each box of the pair weighing at least 30 pounds (14 kg)) according to Materials I.M. 322.

3) Conduct quality control tests for mixture properties using representative portions of the mix from the quality control sample of each sublot.

4) Split samples for specimen preparation according to Materials I.M. 357.

5) Paired sampling may also be accomplished by taking a bulk sample and immediately splitting the sample according to Materials I.M. 322 on the grade.

6) Record and document all test results and calculations on data sheets approved by the Contracting Authority. Record specific test results on the Daily Plant Report the Contracting Authority provides. Also include a description of the quality control actions taken (adjustment of cold feet percentages, changes in JMF, and so forth) on the Daily Plant Report.

7) Facsimile, or deliver by other methods the Engineer approves, the Daily Plant Report to the Engineer and the designated laboratory daily. At project completion, provide the Engineer a copy of the electronic file containing project information generated during the progress of the work.

8) When sampling for AASHTO T 283, obtain a 50 pound (25 kg) sample according to Materials I.M. 322. The Engineer will select, at random, the sample location. Split the sample and deliver half to the Central Materials Laboratory.

c. Compacted Pavement Cores.

1) Cut and trim samples under the direction of and witnessed by the Engineer for tests of density, thickness, or composition by using a power driven masonry saw or by drilling a minimum 4 inch (100 mm) nominal diameter core.

2) Restore the surfaces the same day. Dry, fill with the same material, and properly compact core holes.

3) Pavement core samples will be identified, taken possession of by the Engineer, and delivered to the Contractor's quality control field laboratory.

4) The Engineer may either:
- Transport the cores directly to the lab, or
- Secure the cores and allow the Contractor to transport the cores to the lab.

5) The compacted HMA pavement will be tested in a timely manner by the Engineer's personnel who are Iowa DOT Certified to perform the test.

6) Prepare and test the cores according to Materials I.M. 320, 321, and 337.

d. Verification and Independent Assurance Testing.

1) The Contractor's quality control test results from paired samples will be validated by the Engineer's verification test results on a regular basis using guidelines and tolerances set forth in Materials I.M. 216 and 511.

2) If the Engineer's verification test results validate the Contractor's test results, the Contractor's results will be used for material acceptance. Disputes between the Contractor's and Engineer's test results will be resolved according to Materials I.M. 511.

3) The Engineer will randomly select, one or more of the daily hot mix production verification samples. Some or all of the samples selected will be tested in the materials laboratory designated by the Engineer. The Engineer will use the verification test results to determine if the Contractor's test results can be used for acceptance.

4) The Engineer will test each lot of cores. These will be tested at the Contractor's field quality control laboratory. Cores may also be tested by the Contractor, but the Contractor's test results will not be used for material acceptance.

5) Personnel and laboratories performing tests used in the acceptance of material are required to have participated in the statewide Independent Assurance Program according to Materials I.M. 208.

E. Quality Control for Small HMA Paving Quantities.

1. Mix Design.

Prepare the JMF. Prior to HMA production, obtain the Engineer's approval for the JMF. Comply with Article 2303.02 and Materials I.M. 510.

2. Plant Production.

a. Ensure HMA production plant calibration for the JMF is current and no more than 12 months old.

b. Use certified asphalt binder and approved aggregate sources meeting the JMF. Ensure the plant maintains an asphalt binder log to track the date and time of binder delivery. Ensure HMA delivery tickets identify the JMF.

c. Monitor the quality control test results and make adjustments to keep the mixture near the target JMF values.

3. Construction.

a. Take compacted mixture density measurements, except when Class II compaction is specified. Use the field quality control laboratory compaction for field density control, as specified in Article 2303.03, D. The Engineer may accept the density of the compacted layer based on cores or density gauge. The Engineer may waive density measurement provided the compaction has been thorough and effective. Take compacted mixture density measurements no later than the next working day following placement and compaction.

b. For small quantities, a lot will be the entire quantity of each HMA mixture bid item.

c. The quality index for density will not apply to small quantities.

4. Sampling and Testing.

a. Material sampling and testing is for production quality control only. Acceptance of mixture is based on Contractor certification. Perform a minimum of one aggregate cold-feed and one loose HMA test per lot. Sampling and testing of loose HMA is only required for mechanically placed mixture. Sample and test according to the Standard Specifications and Materials I.M.s using certified technicians and qualified testing equipment. The Engineer may approve alternative sampling procedures. Take the sample between the first 100 to 200 tons (100 to 200 Mg) of production. No split samples for agency verification testing are required.

b. Asphalt binder will be accepted based on the asphalt supplier's shipment certification. No binder sampling or testing is required.

c. Material sampling or testing is not required for daily HMA production of less than 100 tons (100 Mg) of any mixture on any project.

5. Certification.

a. Provide a certification for the production of any mixture in which the requirements in this article are applied. Place the test results and the following certification statement on the Daily HMA Plant Report (Form 800241).

> "The HMA mixture contains certified asphalt binder and approved aggregate as specified in the approved mix design and was produced in compliance with the provisions of Article 2303.03, E"

b. The Daily HMA Plant Report for certified HMA may be submitted at the end of the project for all certified HMA quantities, or submitted at intervals for portions of the certified quantity.

2303.04 METHOD OF MEASUREMENT.

A. Hot Mix Asphalt Mixture.

1. General.

a. Removal of fillets is incidental to the contract unit price for the mixture.

b. If the Contractor chooses to place intermediate or surface mixture in lieu of base for the outside shoulders, the quantity will be calculated from the pavement and shoulder template. If placed as a separate operation, the quantity will be calculated from scale tickets. If the substitute mixture placed on the shoulder is for an intermediate course fillet only, include the quantity in the fillet for payment in the quantity placed in the adjacent intermediate course.

c. Payment for the quality control requirements for small quantities will not be measured separately.

2. Measurement by Weight (Mass).

a. The quantity of the type specified, expressed in tons (megagrams), will be determined from the weight (mass) of individual loads, including fillets, measured to the nearest 0.01 tons (0.01 Mg).

b. Loads may be weighed in trucks, weigh hoppers, or from the weight (mass) from batch plants computed by count of batches in each truck and batch weight (mass). Article 2001.07 applies. Segregate the weights (mass) of various loads into the quantities for each pay item.

3. Measurement by Area.

a. The quantity of the type specified, expressed in square yards (square meters), will be shown in the contract documents to the nearest 0.1 square yard (0.1 m^2).

b. When constructing shoulders on a basis of payment of square yards (square meters), inspection of the profile and elevation will be based on the completed work relative to the pavement edge. The Contractor is responsible for the profile and elevation of the subgrade and for thickness.

B. Asphalt Binder.

1. Measure the amount of asphalt binder used from batch plants, continuous plants, or drum mixing plants by stick measurement in the Contractor's storage tank or in-line flow meter reading, according to Article 2001.07, B.

2. Compute the asphalt binder quantity added to the storage tank using a supplier certified transport ticket accompanying each load.

3. The quantity of asphalt binder not used in the work will be deducted.

4. When the quantity of asphalt binder in a batch is measured by weight (mass) and is separately identified by automatic or semi-automatic printout, the Engineer may compute the quantity of asphalt binder used from this printout. By mutual agreement, this method may be modified when small quantities or intermittent operations are involved.

5. The Engineer will calculate and exclude the quantity of asphalt binder used in mixtures in excess of the tolerance specified in Article 2303.03, D, 3, c.

6. When payment for HMA is based on area, the quantity of asphalt binder used will not be measured separately for payment.

C. Recycled Asphalt Pavement.

1. A completed Daily HMA Plant Report with the certification statement is required for measurement and payment for Contractor Certified HMA. The quantity of asphalt binder will be based on the approved JMF and any plant production quality control adjustments.

2. The quantity of asphalt binder in classified or unclassified RAP, which is incorporated into the mix, will be calculated in tons (megagrams) of asphalt binder in the RAP, based on the actual asphalt binder content determined for the mix design from the results of the Engineer's extraction test.

3. The quantity of asphalt binder in classified or unclassified RAP, which is incorporated into the mix, will be included in the quantity of asphalt binder used.

D. Anti-strip Agent.
Will not be measured separately. The quantity will be based on tons (megagrams) of HMA mixture with anti-strip agent added.

E. Tack Coat.
Will not be measured separately.

F. Fabric Reinforcement.
The quantity, in square yards (square meters) to the nearest 0.1 square yard (0.1 m^2), will be shown in the contract documents.

G. Adjustment of Fixtures.
The Engineer will count the number of fixtures adjusted to the finished grade.

H. Hot Mix Asphalt Pavement Samples.
Will not be individually counted for payment if furnished according to Article 2303.03, D, 5, or required elsewhere in the contract documents,

2303.05 BASIS OF PAYMENT.
The costs of designing, producing, placing, and testing bituminous mixtures and the cost of furnishing and equipping the QM-A field laboratory will not be paid for separately, but are included in the contract unit price for the HMA mixes used. The application of tack coat and sand cover aggregate are incidental and will not be paid for separately. Pollution testing is at the Contractor's expense. The installation of temporary Stop Sign Rumble Strips will not be paid for separately, but is incidental to the price bid for the HMA course for which it is applied.

The quality control requirements for small quantities are incidental to the items of HMA mixtures in the contract.

A. Hot Mix Asphalt Mixture.

1. Payment will be the contract unit price for Hot Mix Asphalt Mixture of the type specified per ton (megagram) or square yard (square meter).

2. Payment for surface course test strip placement in an intermediate lift will be the contract unit price for Hot Mix Asphalt Mixture, Surface Course, per ton (megagram).

3. Payment will be adjusted by the percentages in Table 2303.05-1 for the quality index for density determined for the lot:

Table 2303.05-1: Payment Adjustment

Quality Index (Density) 7 Samples [(a)]	Percent of Full Payment
Greater than 0.72	100
0.40 to 0.72	95
0.00 to 0.39	85
Less than 0.00	75 maximum
(a) or 6 samples and 1 outlier. Only one outlier will be allowed.	

4. When the basis of payment is by area, payment will be further adjusted by the appropriate percentage in Table 2303.05-2 below according to the quality index for thickness determined for that lot:

Table 2303.05-2: Payment Adjustment (by Area)

Quality Index (Thickness) 7 Samples	Percent of Payment (Previously Adjusted for Density)
Greater than 0.34	100
0.14 to 0.34	95
0.00 to 0.13	85
Less than 0.00	75 maximum

5. Payment for courses for which quality index (thickness) is not determined because of size or shape, and courses which are found to be deficient in average width, will be according to Article 1105.04.

6. When liquid anti-strip agent is used and production quality control testing for AASHTO T 283 is required, the payment for HMA will be adjusted according to Table 2303.05-3:

Table 2303.05-3: HMA Payment Adjustment

Percent TSR	Percent of Full
Greater than 79	100
70 to 79	90
Less than 70	75 maximum

B. Asphalt Binder.

1. Payment will be the contract unit price per ton (megagram) for the number of tons (megagrams) of asphalt binder used in the work.

2. Payment for asphalt binder will be for new asphalt binder and the asphalt binder in the RAP which is incorporated in the mixture. The quantity of asphalt binder in classified or unclassified RAP, which is incorporated into the mix, will be calculated in tons (megagrams) of asphalt binder in the RAP. This will be based on the actual asphalt binder content determined for the mix design from the results of the Engineer's extraction test.

3. When the basis of payment for HMA is in square yards (square meters), compensation for asphalt binder will be included in the contract unit price per square yard (square meter).

C. Recycled Asphalt Pavement.
RAP owned by the Contracting Authority will be made available to the Contractor for the recycled mixture at no cost to the Contractor other than loading, hauling, and processing as required for incorporation into the mix.

D. Anti-strip Agent.

1. When anti-strip agent is required according to Article 2303.02, E, 2, the incorporation of the anti-strip agent into the HMA mixture will be considered as extra work ordered by the Engineer. Payment will be made at the rate of $2.00 per ton (megagram) of HMA mixture in which the anti-strip agent is incorporated.

2. Payment will be full compensation for designing, adding, and testing for anti-strip agent.

E. Tack Coat.
Incidental to HMA.

F. Fabric Reinforcement.

1. Payment will be the contract unit price for Fabric Reinforcement per square yard (square meter).

2. Payment is full compensation for furnishing all materials, labor, and equipment necessary for installing the fabric as required, including the adhesive or heavy tack coat of asphalt binder used as the adhesive.

G. Adjustment of Fixtures.

1. Payment will be the contract unit price for each.

2. If the contract contains no price for Adjustment of Fixtures, this work will be paid for as provided in Article 1109.03, B.

H. Hot Mix Asphalt Pavement Samples.

1. Payment will be the lump sum contract price for cutting HMA Pavement Samples to determine density or thickness according to the specifications, when either of these is the responsibility of the Contractor, and elsewhere when required by the contract documents.

2. Payment is full compensation for furnishing all such samples for all courses or items of work, and for delivery of samples as specified in Article 2303.03, D, 5.

Section 2304. Detour Pavement

2304.01 DESCRIPTION.
Furnish and place a PCC or HMA surface to carry traffic during construction of permanent pavement.

2304.02 MATERIALS.
Use PCC or HMA for the detour pavement. Meet the following requirements.

A. PCC Option.

1. Meet the requirements of Section 2301 for Class A PCC Pavement. Use Class 2 durability coarse aggregate, or better, as defined in Article 4115.04.

2. For median crossovers, meet the requirements of Section 2301 for Class C PCC Pavement. Use Class 3 durability coarse aggregate, or better, as defined in Article 4115.04.

B. HMA Option.

1. For detour pavement carrying less than 10,000,000 total 20 year ESALs, use HMA 1,000,000 ESAL surface or intermediate course, 1/2 inch (12.5 mm) or 3/4 inch (19 mm), with PG 64-22 asphalt binder.

2. For detour pavement carrying more than 10,000,000 total 20 year ESALs, use HMA 10,000,000 ESAL surface or intermediate course, 3/4 inch (19 mm), with PG 64-22 asphalt binder.

3. For median crossovers, use HMA 10,000,000 ESAL surface or intermediate course, 3/4 (19 mm), with PG 64-22 asphalt binder. Apply Class 1B compaction. The surface lift requires L-4 friction aggregate.

2304.03 CONSTRUCTION.
Earthwork quantities are based on the PCC option and will not be adjusted for additional HMA depth. Additional cut material may be used as earth shoulder construction.

A. PCC Option.

1. Meet the requirements of Section 2301. Transverse joints, center tie bars, and sealing of the center longitudinal joint are not required.

2. Do not apply Articles 2301.03, H, 2, 3, and 4, unless stated otherwise in the contract documents.

3. Apply Article 2316.02, A, 7.

B. HMA Option.
Meet the requirements of Section 2303.

2304.04 METHOD OF MEASUREMENT.
Detour Pavement constructed, in square yards (square meters), will be the quantity shown in the contract documents.

2304.05 BASIS OF PAYMENT.

A. Payment for Detour Pavement will be the contract unit price per square yard (square meter).

B. Payment is full compensation for furnishing material, equipment, and labor to construct the detour pavement in accordance with the contract documents.

C. Payment for detour pavement removal will be according to Section 2510.

Section 2306. Bituminous Fog Seal (Pavement)

2306.01 DESCRIPTION.
Clean the pavement surface and apply diluted asphalt emulsion to the entire pavement surface using a bituminous distributor.

2306.02 MATERIALS.
Unless the Engineer directs otherwise, use asphalt emulsion grade CSS-1 or SS-1.

2306.03 CONSTRUCTION.

A. Equipment.
Use equipment meeting the requirements of Articles 2001.12 and 2001.14.

B. Cleaning.
Immediately prior to placing the emulsion, clean the entire pavement surface. Use scrapers, compressed air, or other approved methods.

C. Dilution.
Dilute the asphalt emulsion with water prior to application to the pavement surface. The dilution rate is one part of asphalt emulsion to four parts water.

D. General.
Calibrate the bituminous distributor to the specified target rate prior to start of work on the pavement surface.

E. Application.

1. Uniformly apply dilute asphalt emulsion at the rate of 0.12 gallon per square yard (0.5 L/m^2) of pavement surface. The application rate may be reduced if directed by the Engineer. For excessive application rates, the Engineer may require a light coat of sand. The Engineer may require brooming of ponded areas prior to placing traffic on the pavement.

2. Use safety and convenience to the public without soiling their vehicles as a controlling factor.

3. Apply asphalt emulsion at a width of one-half of the roadway plus an overlap of approximately 4 inches (0.1 m) at the middle of the road. Cover each width in one application while the opposite one-half of the roadway is left open to public traffic.

4. Do not apply asphalt emulsion to bridge decks or railroad rails and flangeways.

F. Limitations.

1. Do not place asphalt emulsion on a damp or wet surface unless the Engineer approves. Work will not be allowed on Sundays or holidays, according to Article 1108.03.

2. Apply asphalt emulsion during weather conditions which allow satisfactory application. Do not apply asphalt emulsion when either the pavement temperature or the air temperature is below 60°F (16°C). Do not apply asphalt emulsion after August 31 without the Engineer's permission.

3. A sand dam or other approved means may be necessary to prevent emulsion from running on to the pavement adjacent to the work area in areas of superelevated curves.

G. Traffic Control.

1. Asphalt emulsion applied over existing pavement markings will diminish their visibility. Install the signs of Paragraphs 3a, 3b, 3c, and 3d below.

2. Unless stated otherwise in the contract documents, furnish signs and mounting devices, including posts.

3. Furnish and install these signs as follows:
   a. **"NO PAVEMENT MARKINGS" and "NEXT_MILES" signs.**
      Place at the beginning and end of the project. They may be mounted on posts or skids.
   b. **"NO PAVEMENT MARKINGS" signs.**
      Place on each side of towns and on each side of intersections of Primary and County Roads. They may be mounted on posts or skids.

c. **"DO NOT PASS" signs.**
Place on the right-hand side of the road at the beginning of each no-passing zone. Mount on posts.

d. **"PASS WITH CARE" Signs.**
Place on the right-hand side of the road at the end of each no-passing zone. Mount on posts.

4. The Contracting Authority will place new pavement markings and remove the signs when the project is complete.

H. Scheduling.

1. A preconstruction conference will be required for this work. This will normally be a single conference for all work of this type in each residency.

2. At the preconstruction conference, provide the Engineer a probable schedule for work of this type in the District jurisdiction, including the sequence for each project.

2306.04 METHOD OF MEASUREMENT.

Measurement for the items involved in construction of Bituminous Fog Seal (Pavement) will be as follows:

A. Asphalt Emulsion for Fog Seal (Pavement).
Gallons (liters) of Undiluted Asphalt Emulsion as provided in Article 2307.04, B.

B. Sand.
Not measured for payment.

C. Traffic Control.
Article 2528.04 applies.

2306.05 BASIS OF PAYMENT.

Payment for the items involved in construction of Bituminous Fog Seal (Pavement), measured as provided above, will be as follows:

A. Asphalt Emulsion for Fog Seal (Pavement).

1. Contract unit price per gallon (liter) for Undiluted Asphalt Emulsion that is mixed and used on the project. Diluted asphalt emulsion that is delivered to the job site, but not applied to the roadway surface will not be considered for payment.
2. Payment is full compensation for:
   a. Cleaning the pavement surface.
   b. Furnishing and applying the diluted asphalt emulsion including water for dilution.
   c. Furnishing and applying sand cover.
   d. Brooming of ponded areas as necessary.
   e. Protecting the pavement adjacent to the work area in areas of superelevated curves.

B. Traffic Control.
Article 2528.05 applies.

Section 2307. Bituminous Seal Coat

2307.01 DESCRIPTION.
One or more applications of binder bitumen with one or more successive applications of cover aggregate.

2307.02 MATERIALS.
Use materials meeting the following requirements:

A. Aggregates.

1. Use cover aggregate meeting requirements of Section 4125 for the size designated. Unless designated otherwise, use sand for shoulders and winter seals, and use the 1/2 inch (12.5 mm) size crushed aggregate for other work. On Primary projects, when 1/2 inch (12.5 mm) size cover aggregate is specified, use crushed stone or crushed gravel.

2. For each contract, each load of each size of aggregate is to be similar in type and gradation. Source changes require the Engineer's approval.

3. For Primary projects, furnish the aggregate size designated in the contract. Do not use the 1/2 inch (12.5 mm) size when the 3/8 inch (9.5 mm) size is designated.

B. Bituminous Material.
Meet the requirements of Section 4140 or 4138.

1. **Emulsified Asphalt.**
Unless specified otherwise in the contract documents, use binder bitumen meeting the requirements for CRS-2P as specified in Section 4140.

2. **Cutback Asphalt.**
Furnish cutback asphalt with an approved anti-stripping additive as described in Article 4138.01.

3. **Asphalt Emulsion for Dust Control.**
Use grade CSS-1, CSS-1H, or SS-1H as specified in Section 4140. Dilute with water prior to application. Use an initial dilution rate of seven parts water to one part emulsion.

2307.03 CONSTRUCTION.

A. Equipment.
Use equipment meeting requirements of Section 2001 and the following:

1. **Aggregate Spreaders.**
   - **a.** Apply Article 2001.13, B, except that, when provided in the contract documents, an aggregate spreader meeting requirements of Article 2001.13, A, may be used.
   - **b.** Equip aggregate spreaders described in Article 2001.13, B, with a scalper or segregator screen (provided by the manufacturer) mounted below the feeder roll. Use scalper screen opening sizes recommended by the spreader manufacturer. When adjusted to the proper angle, the coarse fraction of the aggregate is placed first. Afterwards, the fine fraction is dropped through the screen on top of the larger particles. Adjust the screen angle as necessary on the project. Use of this screen is required.

2. **Equipment for Distributing Bitumen.**
   - **a.** Apply Article 2001.12.
   - **b.** When emulsion binder bitumen is used, use a distributor spray bar equipped with nozzles (furnished by the distributor manufacturer) which are specifically designed to apply emulsion. Before the work is started, provide the Engineer with a written statement indicating the size or part number of the nozzles recommended, and certifying that these nozzles are installed on the distributor.

3. **Brooms.**
   - **a.** Apply Article 2001.14.
   - **b.** When using a power broom to remove loose aggregate from a newly seal coated surface, ensure that it is capable of exerting uniform down pressure (for the full width of the broom and without vibration or bounce) sufficient to remove loose aggregate without dislodging particles which are stuck in the binder bitumen.

4. **Heating Equipment.**
   Apply Article 2001.11.

5. **Rollers.**
   - **a.** Use self propelled, pneumatic tired rollers meeting the requirements of Article 2001.05, C, to embed the cover aggregate.
   - **b.** One pneumatic tired roller will be required for work involving sand cover aggregate.
   - **c.** A minimum of two pneumatic tired rollers will be required for work involving other cover aggregate.

6. **Weighing Equipment.**
   Apply Article 2001.07.

B. Bituminous Seal Coat Construction.

The rates of application for binder bitumen and cover aggregate shown in the contract documents or specified herein are approximate. These rates may be varied as found desirable on the basis of laboratory or field tests.

1. **Surface Preparation.**
   - **a.** Immediately before bitumen is applied, clean the entire surface to be treated, as well as the adjacent gutters, of all foreign material, including dust.
   - **b.** Blade, clean, and perform incidental work required to produce a clean surface. If the power broom fails to remove dust from depressions and pockets, use hand brooms.
   - **c.** In rural areas, blade or sweep material removed from the road surface off the road surface. In cities and towns, remove the material according to Article 1104.08. This material becomes the property of the Contractor.
   - **d.** Priming, if required, will be specified in the contract documents.

2. **Heating Bituminous Materials.**
   - **a.** Heat bituminous materials to a temperature which will permit uniform spreading. Temperatures between the limits in Table 2307.03-1 should produce the desired viscosity:

Table 2307.03-1: Bituminous Material Temperatures

Designation	Temperature ºF* (ºC)
CRS-1 and 2 and CRS-2P	150-185 (65-85)
MC-800	175-255 (80-125)
MC-3000	215-290 (100-145)
MC-70	145-165 (60-75)
* Some temperatures listed may be above the flash point of the material. Use extreme caution when handling to reduce fire hazard.	

   - **b.** Material which has been damaged by overheating will be rejected.

3. **Spreading Bituminous Material.**
   - **a. General.**
     - **1)** Before spreading bituminous material, ensure the distributor:
       - Complies with recommendations of the manufacturer as to nozzle size, nozzle angle with the axis of the spray bar, and spray bar or nozzle height above the road surface.
       - Has been tested to assure uniform bitumen distribution on the road surface at the specified rate.
     - **2)** Minimize longitudinal overlap of adjacent bitumen applications. Spread between 95% and 105% of the bituminous material the Engineer prescribes. Correct the rate of application for temperature to deliver the desired volume at 60°F (16°C).
     - **3)** Use a suitable covering to protect the items below from being soiled by bitumen. Leave the protective covering in place until the bitumen has set and no splashing occurs under traffic.
       - Curbs and handrails of bridges.
       - Guardrails.
       - Headwalls of culverts.
       - Pavements.
       - Curbs and gutters.

- Utility accesses.
- Intakes.
- Water and gas valves.
- Railroad flangeways.
- Other installations requiring protection.

4) Place suitable covering, as required, to prevent cover aggregate from entering intakes or other similar structures during placement and while brooming excess cover aggregate.

5) Preserve the integrity of areas with rumble strip panels. This may include (at the Contractor's option and subject to the Engineer's approval):

- Placing a suitable covering over rumble strip panels which prevents filling with bituminous seal coat, or
- Using hand labor to restore uncovered rumble strip panels.

b. Binder.

1) Sweep the surface clean of loose aggregate and foreign material which may prevent adhesion of the binder to the surface on which it is applied. This applies to fillets at intersecting roads and drives only when specified.

2) Apply binder bitumen to the surface (including fillets at intersecting roads and drives when specified) at the rates and in the manner the Engineer specifies or designates.

3) When traffic must be maintained through the work while construction is in progress and the width is 24 feet (7.2 m) or less, place the bituminous seal coat in two passes. For the first course, spread the bitumen for the first lane approximately 12 inches (0.3 m) wider than one-half of the width of the pavement to be surfaced. For other courses, spread the bitumen for each lane approximately one-half the width of the pavement to be surfaced.

4) Progress in the direction from which aggregate is to be hauled to the spreader. Complete one side for one day's run before the seal coat is applied on the adjacent lane. Auxiliary lanes may be done on the same day. One side may be completed for the full length of a short project before the seal coat is applied to the other side. It is the intention that the maximum length of road with new seal coat on only one side would be limited to approximately 6 miles (10 km). This length may be increased with the Engineer's approval.

5) Limit the length of any spread to that which can be covered with aggregate and rolling completed within 30 minutes. Limit the distance between the bitumen distributor and the aggregate spreader to 150 feet (45 m). Maintain initial roller coverage as close to the aggregate spreader as possible, not to exceed 200 feet (60 m).

6) In any case where emulsion is used, cover the binder bitumen with aggregate and initially roll within 2 minutes after the bitumen has been spread. When the 2 minute requirement for emulsion or the 30 minute requirement for all work is not met,

the work may be considered not in reasonably close conformity according to Article 1105.04.

7) Apply bitumen for winter seals with limitations the Engineer deems appropriate. Apply other binder bitumen only when the road surface is free of moisture and has a temperature no less than 60°F (15°C). When the environment places a portion of the pavement in shade, use a shaded area to determine road surface temperature.

c. Joints.

1) Secure binder bitumen distribution at the specified rate of application using paper placed at the start of each distributor run. Use commercial grade building paper that is approved by the Engineer and is no less than 36 inches (0.9 m) wide.

2) When the end of the run joins newly placed seal coat, place paper at that joint also. Cut the joint straight along the off edge of the paper. Remove the seal coat material on the paper adjacent to the off edge from the roadbed surface. Ensure a smooth ride is obtained.

4. Spreading Cover Aggregate.

a. General.

1) Use specified mechanical spreaders to spread cover aggregate on the freshly applied bitumen. Avoid spillage or piling of aggregate. Correct spillage or piling using manual methods before rollers cover the area. Do not use the ballast in rollers for spreading aggregate. Vehicles other than those required to deliver aggregate to the spreader will not be permitted to pass over the treated area of the roadbed until after the aggregate has been spread and rolled.

2) Fillet surfacing at intersecting roads and drives may be placed subsequent to that on the roadbed itself, but shall promptly follow binder bitumen spreading.

b. Moisture.

At the time of spreading, ensure the surfaces of the cover aggregate are damp, but with no free water. This will be determined by visual inspection.

5. Rolling.

a. After the aggregate has been spread, promptly roll to secure early aggregate embedment in the bitumen. Complete rolling no later than 30 minutes after the bitumen is spread.

b. Do not apply succeeding applications of binder bitumen until the most recent one applied as been covered with aggregate and all rolling operations completed.

c. Satisfactory embedment usually will be secured by one roller coverage of sand cover and five roller coverages of other cover aggregate. One roller coverage is interpreted as the number of passes of the roller required to ensure that the entire area has been touched at least once by the entire roller.

d. Operate rollers at a speed of no more than 5 mph (8 km/h).

6. One Course Seal Coats.

In addition to requirements of Articles 2307.03, B, 4 and 5, apply the following:

a. Spreading Binder Bitumen.

Apply bitumen to the prepared base or surface at the rate the Engineer designates, usually within the ranges of Table 2307.03-2:

Table 2307.03-2: Bitumen Spreading Rates

Aggregate Size	Spreading Rate Gal. per Sq. Yds. (L/m^2)	Basic Rate[(a)] Gal. per Sq. Yds. (L/m^2)
Sand	0.15 - 0.20 (0.7 - 0.9)	0.15 (0.8)
3/8 inch (9.5 mm)	0.25 - 0.35 (1.1 - 1.6)	0.30 (1.4)
1/2 inch (12.5 mm)	0.35 - 0.45 (1.6 - 2.0)	0.40 (1.8)
(a) The basic rate will be used for design purposes.		

b. Spreading Cover Aggregates.

1) Uniformly spread cover aggregate of the size specified, over the treated area promptly after the spread of bitumen has been completed on any section.

2) Unless otherwise specified, use a rate of 10 pounds per square yard (5 kg/m^2) for shoulders, 15 pounds per square yard (8 kg/m^2) for winter seals, and 30 pounds per square yard (16 kg/m^2) for other applications.

3) When bituminous seal coat is placed on two lanes, spread the aggregate for the first lane to a width of 50% of the roadway to be treated.

7. Two Course Seal Coats.

In addition to requirements of Articles 2307.03, B, 4 and 5, apply the following:

a. First Course Construction.

1) Spreading Binder Bitumen.

Apply bitumen to the prepared base of surface at the rate of 0.35 gallon per square yard (1.6 L/m^2).

2) Spreading Cover Aggregate.

a) Uniformly spread cover aggregate of the size specified over the treated area at the rate of 30 pounds per square yard (16 kg/m^2) promptly after spreading bitumen on any section.

b) When bituminous seal coat is placed in each lane separately, spread the aggregate for the first lane to a width of 12 inches (0.3 m) greater than 50% of the width of the lane to be surfaced.

c) When the full width is surfaced integrally, spread the aggregate to a width such that the junction of the two aggregate spreads is offset 12 inches (0.3 m) from the center of the full width surface.

b. Second Course Construction.

1) Preparation of Roadbed.

a) After completing the first course, prepare roadbed for the second course by either:
- A vacuum machine, or
- By lightly brooming the full surfaced width with the power broom to remove loose material.

b) After cleaning, roll the entire surface once with the steel roller.

c) Complete the preparation of the roadbed in sections just prior to application of bitumen for the second course.

2) Spreading Binder Bitumen.
Spread bitumen on the prepared surface at the rate of 0.30 gallon per square yard (1.4 L/m^2).

3) Spreading Cover Aggregate.

a) Spread cover aggregate of the size specified over the treated area at the rate of 25 pounds per square yard (14 kg/m^2) promptly after spreading bitumen on any section of roadbed.

b) For two lane roadways, place the two aggregate spreads so the seam between the two spreads is near the centerline.

8. Maintenance During Construction Period.

a. If bleeding occurs during construction, the Engineer may order additional aggregate placed at the contract unit price for cover aggregate. Additional compensation will not be allowed for incidental rolling.

b. On Primary projects and where specified on other projects, gently sweep the surface free of loose cover aggregate using a rotary broom. Perform this sweeping early the next morning while the bituminous binder is hard and stuck particles will not be disturbed. Other means of removing the loose particles, such as vacuum machines or air blast, may be used with the Engineer's approval.

c. In areas with curb and gutter sections or storm sewer intakes, in addition to sweeping the surface, collect loose particles and haul them off the project. The Engineer may also designate that loose particles be hauled off the project in additional areas within municipal corporate limits, such as entrances or shallow drainage ditch locations.

d. The Engineer may require additional sweeping to remove loose cover aggregate from the surface throughout the project duration.

e. When the contract includes an item for asphalt emulsion for dust control, apply the dust control following the removal of loose particles and before other work continues, according to Article 2307.03, B, 9.

9. Dust Control Treatment.

a. On Primary Road projects where limestone or crushed gravel cover aggregate is used, apply diluted asphalt emulsion to the completed bituminous seal coat surface to control dust. Uniformly spread diluted asphalt emulsion at the initial rate of 0.12 gallon per square yard (0.5 L/m^2).

b. On non-Primary Road projects, apply dust control as specified in the contract documents.

c. Apply dust control following the removal of particles and before other work continues. Apply dust control within 24 hours after bituminous seal coat placement unless directed otherwise by the Engineer.

d. Broom off loose material and apply dust control on the calendar day following placement of bituminous seal coat.

10. Traffic Control.

a. When the road is not closed for construction, maintain normal traffic on the project. No detour will be provided. Do not delay traffic unnecessarily. Refer to the contract documents for traffic maintenance during work on shoulders of multilane pavements.

b. Traffic control setups which cause unnecessary stopping or turning movements generally will not be allowed.

c. Unless otherwise stated in the contract documents, furnish the signs and mounting devices, including posts.

d. Furnish and install the signs as follows:

1) **"NO PAVEMENT MARKINGS NEXT __ MILES" signs.**
Place at each end of the area where pavement markings have been obliterated, on each side of towns, and on each side of all intersections with Primary and Secondary Roads.

2) **"LOOSE STONE - REDUCE SPEED" signs.**
Place, along with a 35 mph advisory speed plate, approximately 500 feet (150 m) in advance of the "No Pavement Markings" signs.

3) **"DO NOT PASS" signs.**
Place on the right-hand side of the road at the beginning of each no-passing zone.

4) **"PASS WITH CARE" signs.**
Place on the right hand side of the road at the end of each no-passing zone.

e. Mount signs on posts.

f. The Contracting Authority will place new pavement markings and remove the signs when the project is complete.

g. Provisions for handling other traffic are as follows:

1) Direct traffic through restricted portions of the project using pilot cars described in Article 2528.03, D. Furnish pilot cars and pilot car signs.

2) Station one flagger immediately ahead of the application of the bitumen, one immediately behind the bitumen, and one immediately behind the section being rolled. Display suitable warning, speed limit, and fresh oil signs. Move the signs forward with the flagger as the work progresses.

3) After the bituminous seal coat has been spread, smoothed, rolled, and cured for a minimum of 2 hours, the road may be open to traffic.

4) In some areas it is more practical to place the bituminous seal coat in short sections and to allow traffic to use the completed bituminous seal coat immediately after the surface treatment has been completed. In these areas, control traffic on the

newly placed bituminous seal coat to a speed of no more than 25 mph (40 km/h) for a minimum of 2 hours. The Engineer will specifically authorize such areas. The Engineer may extend the minimum 2 hour period due to low temperature and visually observed damage to the bituminous seal coat under traffic or when turning movements may damage the bituminous seal coat. (The intent of traffic modifications is to not allow traffic on completed bituminous seal coat sections until satisfactorily cured. This requires a minimum of 2 hours, depending on climatic conditions.)

11. Limitations.

a. The Engineer may prohibit construction if the weather is unfavorable for the embedment of cover aggregate in the binder bitumen as specified in Article 2307.03, B, 3.

b. Limit the area on which binder is spread to that which can be covered with aggregate, and the rolling completed, within daylight hours of the same working day. When traffic is being carried through the work, keep the entire roadbed free of construction equipment, according to Article 1107.08.

c. Except for winter seals, do not apply seal coats after September 1 on Primary projects or after September 15 on other projects. When the entire project cannot be completed by the specified cutoff date, do not complete placement on one side only for the full length of the project. Instead, complete both sides to the same location by the specified cutoff date.

d. When this contract includes pavement marking, complete traffic line construction within 72 hours after the seal coat has been completed to the full width at that location, weather permitting.

e. When dust control treatment is required, allow it to cure prior to allowing traffic on the roadway.

12. Surfacing Intersecting Roads, Driveways, and Turnouts.

a. Use seal coat applied at the same rate provided for the roadway to cover the area of any fillets of base courses constructed at driveways to farmsteads and commercial establishments, unless otherwise specified in the contract documents.

b. Surface remaining areas within the right-of-way on earth or gravel surfaced approach roads and driveways and turnouts for mail boxes according to Section 2315. These areas will be measured and paid for according to Section 2315.

C. Finishing and Opening to Traffic.

Restore to an acceptable condition any portion of the roadway disturbed by operations related to bituminous seal coating. After the bituminous seal coat has been spread, smoothed, rolled, and cured as specified in Article 2307.03, B, the road may be opened to traffic.

2307.04 METHOD OF MEASUREMENT.

Unless otherwise provided, winter seal will not be measured for payment. Measurement for the quantities of the various classes of other work involved in bituminous seal coat, satisfactorily constructed, will be as follows:

A. Aggregate.
Tons (megagrams), except as provided in this specification, from the net weight (mass) of individual loads weighed on scales furnished by the Contractor, according to Article 2001.07. Includes fillets at intersecting roads, drives, and turnouts. At locations where the quantity of aggregate required for a single section of road is less than 300 tons (300 Mg), volume measurement will be permitted.

B. Binder Bitumen.
Gallons (liters) computed from field measurements of distributors or from tank cars or transport trucks as provided in Article 4100.03. Includes bitumen for fillets at intersecting roads, drives, and turnouts. When quantities computed from field measurements check within 1.0% of the billed gallons (liters), payment will be based on billed gallons (liters). When quantities computed from field measurements differ from billed gallons (liters) by more than 1.0%, payment will be based on the quantity from field measurements. From these quantities, any amount used by the Contractor as fuel, left in cars, or otherwise not delivered to the road surface will be deducted. The Engineer will advise the Contractor promptly, in writing, of the quantities deducted.

C. Driveway Surfacing Material.
Computed as and provided in Section 2315, for granular surfacing placed at intersecting roads, drives, and turnouts. Excavation required for placing this surfacing is considered incidental to the work and will not be measured for payment.

D. Asphalt Emulsion for Dust Control.
Undiluted asphalt emulsion measured as provided in Article 2307.04, B.

E. Traffic Control.
Article 2528.04 applies.

2307.05 BASIS OF PAYMENT.

For the various items of work involved in bituminous seal coat, measured as provided above, payment will be the contract unit price as described below. Payment for additional rolling the Engineer requires will be according to Article 1109.03, B.

A. Aggregate.

1. Per ton for the number of tons (megagrams) of roadway cover aggregate placed in accepted portions of the work.

2. Payment for roadway cover aggregate is full compensation for furnishing, delivering, and spreading the aggregate, for all brooming, rolling, final cleanup, and incidental work necessary to complete the project and not paid for as other items.

B. Binder Bitumen.
Per gallon (liter) for the quantity of binder bitumen spread on accepted portions of the road and the quantity used in making trial runs for adjustment of distributors.

C. Driveway Surfacing Material.
As provided in Section 2315 for the quantity of granular surfacing placed at intersecting roads, drives, and turnouts.

D. Asphalt Emulsion for Dust Control.

1. Per gallon (liter) for the number of gallons (liters) placed.

2. Payment is full compensation for sweeping, furnishing, mixing with water and applying the asphalt emulsion, and curing of the dust control material.

E. Traffic Control.
Article 2528.05 applies.

Section 2308. Bituminous Fog Seal (Shoulders)

2308.01 DESCRIPTION.
Apply diluted asphalt emulsion to the shoulder surface using a bituminous distributor.

2308.02 MATERIALS.
Use asphalt emulsion grade CSS-1 or SS-1 meeting the requirements of Section 4140, unless directed otherwise by the Engineer.

2308.03 CONSTRUCTION.

A. Equipment.
Meet the requirements of Section 2001.

B. Cleaning.
Immediately prior to placing the emulsion fog seal, clean the shoulder surface of foreign material.

C. Dilution.
Dilute the asphalt emulsion with water prior to application to the shoulders. The dilution rate is one part of asphalt emulsion to two parts of water. The Engineer will require documentation that the dilution is done properly.

D. Application.

1. Uniformly apply the diluted asphalt emulsion at the rate of 0.20 gallon per square yard (0.9 L/m^2) of shoulder surface. The application rate may be reduced as directed by the Engineer.

2. Use safety and convenience to the public without soiling their vehicles as a controlling factor.

3. Apply diluted asphalt emulsion so the entire shoulder surface is covered in one application.

4. Do not apply asphalt emulsion to bridge decks, PCC gore areas, or adjacent paved surfaces and painted edge lines. Replace edge lines obliterated by this operation at no additional cost to the Contracting Authority.

E. Limitations.

1. Do not apply asphalt emulsion on damp or wet surfaces without the Engineer's approval. Work will not be allowed on Sundays or holidays, according to Article 1108.03.

2. Apply asphalt emulsion during weather conditions which allow satisfactory application. Do not apply asphalt emulsion when either the pavement temperature or air temperature is below 60°F (16°C). Do not apply asphalt emulsion after August 31 without the Engineer's permission.

3. A sand dam or other approved means may be necessary to prevent emulsion from running on the pavement in areas of superelevated curves.

F. General.
The asphalt emulsion as applied shall have an appearance satisfactory to the Engineer. Dilution rate and application rate may need to be adjusted to accomplish desired results.

G. Traffic Control.
Place traffic control according to Article 1107.09 and the appropriate traffic control detail.

2308.04 METHOD OF MEASUREMENT.

Measurement for the items involved in construction of Bituminous Fog Seal (Shoulders) will be as follows:

A. Asphalt Emulsion for Fog Seal (Shoulders).
As provided in Article 2307.04, B, for undiluted Asphalt Emulsion for Fog Seal (Shoulders).

B. Sand.
Not be measured for payment.

C. Traffic Control.
Lump sum for the contract.

2308.05 BASIS OF PAYMENT.

Payment will be for the contract unit price as follows for the quantity of items involved in construction of Bituminous Fog Seal (Shoulders):

A. Asphalt Emulsion for Fog Seal.

1. Per gallon (liter) for undiluted Asphalt Emulsion for Fog Seal (Shoulders) that is mixed and used on the project. Diluted asphalt emulsion that is delivered to the job site, but not applied to the roadway surface will not be considered for payment.

2. Payment is full compensation for:
- **a.** Cleaning the shoulder surface.
- **b.** Furnishing and applying the diluted asphalt emulsion.
- **c.** Mixing water.
- **d.** Furnishing and applying sand cover.
- **e.** Protecting the adjacent pavement and edge lines, including special protection and dams in areas of superelevated curves.

B. Traffic Control.

1. Lump sum.

2. Payment is full compensation for furnishing signs, barricades, flaggers, and other traffic control devices required for this work.

Section 2309. Surface Recycling by Heater Scarification

2309.01 DESCRIPTION.

A. Recycle the existing asphalt pavement surface by heater scarification, and resurface with HMA.

B. Heater scarification and resurfacing is part of a multi-step process of asphalt surface rehabilitation. This rehabilitation consists of:

1. Preparing the existing asphalt surface,

2. Softening the surface with heat,

3. Scarifying the surface, and

4. Thoroughly stirring or tumbling and leveling the mixture in preparation for an asphalt surface course overlay.

C. The work includes furnishing and placing the new surface course.

2309.02 MATERIALS.

Use surface course materials that meet the requirements for the type of mixture specified.

2309.03 CONSTRUCTION.

A. Equipment.

1. **Heater Scarifier.**
   a. Use a heater scarification operation consisting of preheater and heater scarification unit, capable of processing at a rate of at least 1500 square yards per hour (1250 m^2/h) over a minimum one lane width of 12 feet (3.6 m).
   b. Use an equipment type for preheating, heating, and scarifying that has either:
      - Operated successfully on similar work for the Contracting Authority, or
      - Has proven through test results or other previous experience, or both, that it is satisfactory to the Engineer.
   c. Equipment test results and other previous experience may be submitted to the Engineer prior to the letting for review.
   d. Use preheating and heater scarification equipment designed for the purpose of pavement heating and capable of producing at least 10 million BTUs per hour (10 GJ/h). Apply heat under an enclosure or shielded hood.
   e. Accomplish scarifying with pressure loaded rakes or scarifiers. Where scarifying to an existing curb and gutter line is required, equip the scarifying unit to scarify, and move away from gutter aprons, a 1/2 inch (13 mm) by 4 foot (1.2 m) path of existing material. Use a scarifier that will ensure continuous and undiminished pavement contact without damaging utility accesses and valve boxes.
   f. Use a leveling unit capable of:
      - Distributing the heated and scarified material over the width being processed to produce a uniform cross section, and
      - Windrowing excess material to one side for removal when necessary.

2. **Hot Mix Asphalt Construction Equipment.**
   For batching, mixing, hauling, placing, and compacting the surface course, use equipment meeting the requirements for the type of mixture specified.

B. Paving Plant Operation.
Meet the requirements for the type of mixture specified.

C. Construction.

1. **Surface Preparation.**
   a. Complete base repair, if required, according to Section 2212. Locations of full depth patches will be designated by the Engineer.
   b. Prepare the surface to be heater scarified by cleaning trash, debris, earth, or other deleterious substances present in sufficient quantity to interfere with the work.

2. **Heating and Scarifying.**
   a. Evenly heat and scarify the pavement surface (as a continuously moving operation) for the full width designated in the contract documents. Ensure this combination will not char or otherwise

damage the existing pavement material through exposure to heat or fire. Rate of delivery of the overlay mixture may limit the processing rate.

b. Control the heating operation to prevent open flame from exiting from under the heater. The Engineer may require that the operation be stopped when:
- The prevailing wind velocity exceeds approximately 10 mph (16 km/h) and a potential hazard exists, or
- Heating and scarifying are not possible.

c. Scarify to a minimum depth of:
1) 3/4 inch (20 mm) at the highest points, such as the edge and the high point between the wheel paths.
2) 1/2 inch (15 mm) at the lowest points, such as the wheel paths.

d. The required depth of scarification may be changed by the contract documents. Scarify to at least the depth specified with pressure loaded scarifiers that plow through the pavement and loosen it without fracturing or segregating the aggregates.

e. Ensure the surface temperature of the old pavement is below 475°F (245°C) during heating. Ensure the heated material has a temperature in a range between 220°F to 260°F (105°C to 125°C), measured immediately behind the heater scarifier. Uniformly and evenly heat the remixed layer throughout. Uncontrolled heating, causing differential softening of the upper surface, will not be permitted. Extend the heating operation at least 4 inches (100 mm) beyond the width of the scarification on both sides.

f. When a heater scarifier pass is being made adjacent to a previously placed mat, remove all damaged material and replace.

3. Leveling.

a. Following the heater scarification, level the surface to provide a uniform cross slope.

b. Use a method that consists of either of the options below, following the scarifier as closely as possible, to redistribute and level the scarified material:
- An approved system of augers with a strike off plate or screed which is an integral part of the scarifying machine, or
- An asphalt paving machine meeting the requirements of Article 2001.19.

4. Hot Mix Asphalt Surface Course Overlay.

a. After reshaping the scarified mix and before the temperature drops below 170°F (77°C), place a uniform layer of new surface course material at the rate shown in the contract documents. The Engineer may direct additional mixture to be added to correct irregularities.

b. Use equipment that meets the requirements of Article 2001.19 for placing and finishing the new surface. A non self propelled paving machine attached to the heater scarifier may be used provided the screeding unit complies with the requirements of that specification.

c. When a self propelled paving machine is used, place the new surface within 400 feet (120 m) of the scarification operation or

before the surface temperature cools to 170 ºF (77 ºC), whichever occurs first.

d. Provide for alignment and control of the scarification operation. Obtain the Engineer's approval for the method used.

D. Compaction of Mixture.

After the new surface course is spread, promptly and thoroughly compact all the mixture according to Article 2303.03, C, 5, c.

E. Joints.

Construct joints according to the requirements of Article 2303.03, C, 6, and as shown in the contract documents.

F. Finished Surface.

1. Ensure the finished pavement elevations comply with the requirements of the contract documents, and the finished cross slope is a plane surface with a slope as shown.

2. Ensure all edges, radii, and handwork have a neat and finished appearance.

G. Safety Procedures.

1. Prior to construction in cities, towns, or built up areas; contact the fire chief to solicit a recommended safety procedure to be followed. Follow these recommendations. In addition to any other recommendations, follow the procedure below:

a. Ensure owners of underground utilities in the areas have checked the areas for possible gas leaks in or around their lines.

b. Ensure the city has checked storm sewers and sanitary sewers in the area for accumulations of sewer gas.

c. Ensure service stations and other businesses handling flammable fuels have been advised not to dispense these fuels while the heater burner is being operated within 100 feet (30 m) of their business places.

d. Plan the operation so as to be as safe as possible for persons and property adjacent to the work, including the traveling public. Keep this route open to traffic. Limit the operation so as to provide for this traffic. Work may need to be conducted during periods of light traffic.

2. Take such additional precautions as is reasonable for the safety of the operation.

3. The Contractor shall hold the Contracting Authority and the State harmless for any damage or loss resulting from an accident, during the heating operation, caused by failure to fulfill the obligations as outlined in these requirements.

H. Limitations.

Apply Article 2303.03, C, 4.

2309.04 METHOD OF MEASUREMENT.
Measurement will be as follows:

A. Surface Recycling by Heater Scarification.
Computed as provided in Article 2303.04, A, 3, for the areas satisfactorily prepared, heated, scarified, leveled, and resurfaced (new mix excluded).

B. Hot Mix Asphalt Mixture.
As provided in Article 2303.04 for the type specified.

2309.05 BASIS OF PAYMENT.
Payment will be as follows:

A. Surface Recycling by Heater Scarification.

1. Contract unit price for the square yards (square meters) measured as provided above.

2. Payment is full compensation for furnishing labor and materials for surface recycling by heater scarification as described above.

B. Hot Mix Asphalt Mixture.
As provided in Article 2303.05 for the type specified.

Section 2310. Portland Cement Concrete Overlay

2310.01 DESCRIPTION.
Overlay an existing pavement with one of the following types of PCC overlay:

A. Bonded overlay: a PCC overlay over an existing PCC pavement.

B. Unbonded overlay: a PCC overlay over an existing pavement where a stress relief layer is placed on top of the existing PCC pavement or an existing PCC pavement that has been overlaid with HMA (composite pavement).

C. Whitetopping: a PCC overlay over an existing, full depth asphalt pavement.

2310.02 MATERIALS.

A. Concrete.
Meet the requirements of Article 2301.02.

1. Use Class C concrete for PCC Overlays as specified in Materials I.M. 529, except use a C-3WR or C-4WR mix design for Bonded Overlays. Allowable substitutions shall comply with Article 2301.02, B.

2. For coarse aggregate, meet the requirements of Section 4109.02, Aggregate Gradation Table, Gradation No. 3 or 5 of the Appendix. Ensure the nominal maximum coarse aggregate size is no greater than one-third the overlay thickness.

3. Unless otherwise specified, use coarse aggregate for bonded overlays that is the same type of aggregate as the existing pavement.

B. Hot Mix Asphalt Stress Relief Course.

1. Use an HMA stress relief course for unbonded overlays consisting of a nominal 1 inch (25 mm) course of HMA meeting the requirements of Section 2303.

2. Use PG 58-28 asphalt binder.

3. Use a mixture meeting the following:
   - **a.** 300,000 ESAL, 3/8 inch (9.5 mm) HMA mix requirements.
   - **b.** Target air voids of 3.0%.
   - **c.** No maximum film thickness restriction and no minimum filler/bitumen ratio restriction.
   - **d.** Type B Aggregate with no percent crushed particle requirements and gradation falling below the restricted zone.

2310.03 CONSTRUCTION.

Apply the requirements of Section 2301 to this work with the modifications for each type of work identified below.

A. Equipment.

Use preparation equipment approved by the Engineer and complying with the following:

1. **Scarifying or Shotblasting Equipment.**
   Use power operated equipment capable of uniformly scarifying or removing the existing surface in a satisfactory manner and to depths required. Other types of removal devices may be used if their operation is suitable and if they can be demonstrated to the satisfaction of the Engineer. The contract documents will include a pay item for such work.

2. **Sand Blasting Equipment.**
   Use sand blasting equipment capable of removing rust, oil, and concrete laitance from the existing surface of the pavement.

B. Preparation of Surface.

1. **General.**
   - **a.** If full depth base repair is included in the project, complete it prior to surface preparation.
   - **b.** Include the entire surface to be resurfaced in surface preparation. Materials removed in the preparation operation may be placed in the shoulder area unless specified otherwise in the contract documents.

2. **Bonded Overlays.**
   a. Prepare the surface by shot blasting, or scarifying followed by either shot blasting or sand blasting. Scarify to a nominal depth of 1/4 inch (5 mm).
   b. Ensure preparation removes all dirt, oil, foreign materials, laitance, or loose material from the surface and edges against which new concrete will be placed.

3. **Unbonded Overlays.**
   a. When jointing is specified in which panels are smaller than a normal lane width, scarify the entire surface to create a roughened surface. This will not apply when a new HMA stress relief layer is constructed as a part of the contract.
   b. At the direction of the Engineer, trim high spots found in the existing HMA pavement. This work will be accomplished during the scarification operation, only at isolated locations, and will be considered incidental to the surface preparation.

4. **Whitetopping.**
   a. When jointing is specified in which panels are smaller than a normal lane width, scarify the entire surface using a cold-milling operation to create a roughened surface.
   b. At the Engineer's direction, trim high spots found in the existing HMA pavement. This work will be accomplished during the scarification operation, only at isolated locations, and will be considered incidental to the surface preparation.

C. **Placing and Finishing Overlay.**

1. **General.**
   a. Apply Section 2317 to all PCC Pavement bid items of a Primary project if any individual PCC Pavement bid item for that project is 5000 square yards (4200 m^2) or greater. Apply Section 2316 to all other Primary projects and when specifically required for other projects.
   b. Control the placing equipment to the proper elevation by string line. Take cross sections and establish a grade line. The Engineer will review and approve the new grade lines. Information detailing the pavement design thicknesses at the various survey points and material quantities will also be provided. During construction, do not alter these grades solely to account for concrete overruns. Some overrun is normal, and only with the Engineer's approval will they be adjusted.

2. **Bonded Overlays.**
   a. **Surface Cleaning.**
      Clean the entire surface with an air blast prior to placing concrete. After cleaning, no traffic will be permitted on the cleaned surface except that necessary for overlay construction.
   b. **Surface Condition.**
      Ensure the prepared surface is dry in order to allow some absorption of the concrete mortar.

c. Joints.

1) Use a reliable method to exactly locate and identify on both sides of the road:

a) Each contraction and expansion joint in the existing pavement.

b) The joint to be sawed at each full depth patch.

2) Saw joints in the resurfacing directly over existing transverse joints. Saw transverse joints to the full depth of new resurfacing concrete, including depressions created in the existing surface and as specified in the widening areas. Saw transverse joints as soon as possible without causing excessive raveling. Saw joints directly over existing longitudinal joints to a depth of one-half the overlay thickness, with a maximum depth of 3 inches (75 mm).

3. Unbonded Overlays.

a. Hot Mix Asphalt Stress Relief Course.

Compact according to Article 2303.03, C, 5, Class II Compaction, except use only static steel wheeled rollers.

b. Surface Cleaning.

Clean the existing surface of all loose or adhering foreign material prior to placement of the PCC over HMA pavement. Normally this will be accomplished with a power broom. Make this broom available during paving operations to clean any loose material that the construction equipment may track onto the surface.

c. Surface Condition.

Ensure the prepared surface is dry when concrete is placed on the surface of the HMA pavement in order to allow some absorption of the concrete mortar. If the surface of the HMA is above 110ºF (40ºC), the Contractor may apply water to the surface of the HMA ahead of the paving operation in order to cool the surface. Apply water far enough in advance of the paving operation so that the surface will dry from evaporation before concrete is placed. Do not apply water to the surface of the pavement when the HMA surface temperature is below 100ºF (38ºC).

d. Joints.

When jointing is specified in which panels are smaller than a normal lane width, construct the joints to be 1/8 inch (3 mm) wide. No cleaning or sealing is required.

4. Whitetopping.

a. Surface Cleaning.

Clean existing surface of loose or adhering foreign material prior to placement of the PCC over HMA pavement. Normally this will be accomplished with a power broom. Make this broom available during paving operations to clean any loose material that the construction equipment may track onto the surface.

b. Surface Condition.

Ensure the prepared surface is dry when concrete is placed on the surface of the HMA pavement in order to allow some absorption of the concrete mortar. If the surface of the HMA is above 110ºF (40ºC), the Contractor may apply water to the surface of the HMA

ahead of the paving operation in order to cool the surface. Apply water far enough in advance of the paving operation so that the surface will dry from evaporation before concrete is placed. Do not apply water to the surface of the pavement when the HMA surface temperature is below 100ºF (38ºC).

c. Joints.
When jointing is specified in which panels are smaller than a normal lane width, construct joints /8 inch (3 mm) wide. No cleaning or sealing is required.

D. Limitation of Operations.

1. At forecasted air temperatures below 55°F (13°C) use the maturity method to determine the opening time. Do not place resurfacing concrete when the air or pavement temperature is below 40°F (4°C).

2. The Contractor may use the shoulders for construction activities. It will be the Contractor's responsibility to repair the shoulders, as the Engineer deems necessary, to restore the shoulders to a condition acceptable for shoulder work. This work shall be done at no additional cost to the Contracting Authority. The Contractor may elect to limit the use and vehicle loadings to minimize this work and its cost.

3. Place bonded concrete overlays between June 1 and September 30.

4. Do not place unbonded overlay or whitetopping materials on HMA when the pavement surface temperature exceeds 120° F (50°C).

2310.04 METHOD OF MEASUREMENT.

Measurement for the various items of work involved in the construction of PCC overlay will be as follows:

A. Portland Cement Concrete Overlay, Furnish Only.
Cubic yards (cubic meters) using a count of batches incorporated. Includes concrete placed in widening sections and partial depth patches.

B. Portland Cement Concrete Overlay, Placement Only.
Square yards (square meters) shown in the contract documents. Area will be determined from the longitudinal surface and the nominal pavement width, including widening sections.

C. Surface Preparation.
Square yards (square meters) shown in the contract documents. Area will be determined from the longitudinal surface and the nominal width of existing pavement.

D. Hot Mix Asphalt Stress Relief Course.

1. Measurement by Weight (Mass).
a. HMA will be measured according to Article 2303.04, A.
b. Asphalt binder will be measured according to Article 2303.04, B.

2. **Measurement by Area.**
   a. HMA will be measured according to Article 2303,04, A, 2.
   b. Asphalt binder used will not be measured separately for payment.

2310.05 BASIS OF PAYMENT.

Payment will be at the contract unit price as follows for the performance of acceptable work, measured as provided above.

A. Portland Cement Concrete Overlay, Furnish Only.

1. Per cubic yard (cubic meters).

2. Payment is full compensation for furnishing raw materials, proportioning, mixing, and delivery of concrete to the paving machine.

B. Portland Cement Concrete Overlay, Placement Only.

1. Per square yard (square meter).

2. Payment is full compensation for:
   a. Furnishing all materials, labor, and equipment necessary to place, finish, texture, and cure the concrete.
   b. Placement of tie bars for widening, if required.
   c. Sawing, cleaning, and sealing the joints, if required.
   d. Surface cleaning.

C. Surface Preparation.

1. Per square yard (square meter).

2. Payment is full compensation for preparation of the existing pavement, sandblasting or shot blasting, and for removal of the existing pavement surface material according to Article 1104.08.

D. Hot Mix Asphalt Stress Relief Course.

1. **Measurement by Weight (Mass).**
   a. Article 2303.05 applies.
   b. Payment is full compensation for furnishing and placing the HMA stress relief course.
   c. Asphalt binder will be paid for separately according to Article 2303.05, B.

2. **Measurement by Area.**
   a. Article 2303.05 applies.
   b. Payment is full compensation for furnishing and placing the HMA stress relief course, including the cost of the asphalt binder.

Section 2312. Granular Surfacing

2312.01 DESCRIPTION.

A. Deliver granular material, consisting of crushed stone or pit run or screened gravel, along the shoulder of an existing road in the quantity specified in the contract.

B. Apply this specification to new construction or to resurfacing of a previously surfaced road.

2312.02 MATERIALS.

Use material that either meets requirements of Section 4120 for the class of material specified, or is pit run material from designated locations.

2312.03 CONSTRUCTION.

A. General.

1. Unless otherwise specified, furnish granular material to be spread by the Contracting Authority and consolidated under traffic. The Contracting Authority may furnish granular material from designated pits.

2. Spread all material furnished as Granular Surfacing on Road and intended as:
- **a.** Temporary surfacing.
- **b.** Temporary winter surfacing.
- **c.** Temporary surfacing of drives and side roads.
- **d.** Surfacing for local access.

3. Blading and shaping, as well as any other work in preparation for or maintaining a suitable surface will be required. This may include some excavation adjacent to paved surfaces. Place material used for local access at the locations the Engineer designates. The intention is to provide continuous, all weather access as needed and as directed by the Engineer. Payment for this work is incidental to the payment for the item of Granular Surfacing on Road. The Contractor is not responsible for continuing this work when the operation is suspended during the winter.

4. Special Winter Granular Surfacing is intended to be the same type of material furnished for Granular Surfacing on Road. The material is to be placed in a stockpile prior to winter suspension in an amount and at a location within the project limits as designated by the Engineer. With reasonable notice, the Engineer may require additional material to be added to the stockpile while the Contractor's operation is suspended during the winter.

B. Contract Schedule.

1. A contract may involve any of the following:

a. Furnishing and delivering surfacing material to the road.
b. Preparing and delivering material to the road furnished by the Contracting Authority at locations specified in the contract documents.
c. Preparing material furnished by the Contracting Authority at locations specified in the contract documents. If hauling is required, it shall be bid in 1 mile (1 km) units of haul.

2. Prepare material the Contracting Authority furnishes by:
- Removing the material from the deposit, and
- Sorting, crushing, screening, and washing (as may be necessary) to produce finished material which will comply with the specifications for the class of material required by the contract documents.

3. Delivering or hauling includes loading, transporting, and depositing the prepared material.

4. In gravel furnished by the Contracting Authority, crush particles 7 inches (175 mm) or less in diameter to pass a 3/4 inch (19 mm) sieve. The Contractor may remove particles greater than 7 inches (175 mm) in diameter or crush them to pass a 3/4 inch (19 mm) sieve.

5. When the Contracting Authority furnishes material in deposits, furnish right-of-way necessary for a suitable road from the deposit to a public highway. The Contractor assumes responsibility for any construction or maintenance work that may be required on the road from the deposit to the public highway.

C. Equipment.
Use equipment meeting the requirements of Section 2001 and the following:

1. Weighing Equipment.
Apply Article 2001.07.

2. Spreading.
Apply Article 2001.13.

D. Preparation of Subgrade.
Unless otherwise specified, the Contracting Authority will shape the subgrade. The subgrade will be shaped to a smooth surface having proper grade and cross section.

E. Stripping and Removal of Unsuitable Material.

1. Remove materials not permitted in the surfacing material from the materials the Contracting Authority furnishes. Removal includes removing and transporting material:
- Which occurs intermingled with satisfactory surfacing material, and
- Which is removed from the surfacing material in the process of preparation.

2. Stripping includes removal and disposition of material:
   - Not permitted in the prepared surfacing material, and
   - Occurs in the material deposited in continuous layers 6 inches (150 mm) or more in thickness overlying, or included between layers of, satisfactory surfacing material.

3. When stripping overburden from material taken from pits controlled by or through the Contracting Authority (whether stripping is included as a pay item or not), conduct the operation as directed by the Engineer. Construct slopes so that when the excavation is complete the slopes will maintain themselves without caving or sloughing. Leave material removed for surfacing, below the stripped area, with slopes that provide stability to the overburden.

4. When stripping deposits, do not produce an unsightly appearance of the land. Remove stripped material and transport as directed by the Engineer.

F. Combining Materials on Road.

Under normal conditions, material delivered to the road will be a finished mixture meeting requirements for the class of material specified in the contract documents. With approval of the Engineer, pit run gravel which does not comply with the specified gradation may be furnished and combined on the road with coarser gravel or crushed stone to produce a mixture which complies with the specified gradation. Deliver these combinations according to the following provisions:

1. **Measurement.**
   Whether the contract unit of measurement is 1 ton (1 Mg) or 1 cubic yard (1 m^3), weigh both materials. If the unit of measurement is 1 cubic yard (1 m^3), the Engineer will determine the weight (mass) per unit volume of the mixture as follows:
   - **a.** Representative samples of the two materials are to be thoroughly mixed in the proportions in which they are to be delivered to the work.
   - **b.** The weight (mass) per unit volume of the mixture shall be determined by the rodding procedure and by the shoveling procedure described in AASHTO T 19M.
   - **c.** The average of the two values thus determined shall be taken as the weight (mass) per unit volume of the mixture. Use this value when converting the total weight (mass) of material delivered to cubic yards (cubic meters).
2. **Quality.**
   - **a.** Use materials from each separate source meeting the requirements of Section 4120 for the kind of material used, except the gradation.
   - **b.** In addition to the gradation specified, blend the final mixture to be well graded from coarse to fine.
   - **c.** Ensure the percent passing the No. 30 (600 µm) sieve is no more than 2/3 the percent passing the No. 8 (2.36 mm) sieve.

3. **Proportioning.**
   a. From tests of representative samples of the two materials, the Engineer will compute the quantity of each material required to produce a mixture within the specified gradation. Neither material shall be less than 10% of the total quantity.
   b. Deliver the materials in the proportions established.

4. **Delivery.**
   Deliver each material into a separate windrow. Make each windrow uniform using a motor grader or windrow equalizer.

5. **Mixing.**
   a. Mix the windrows by blading one windrow against the other and blading the single windrow formed across the roadbed at least once.
   b. Coordinate delivery and mixing of materials so there will not be more than 2 miles (3 km) of roadway in a partially completed state.
   c. Leave mixed material in a windrow near one shoulder of the road, as directed by the Engineer.

2312.04 METHOD OF MEASUREMENT.

The Engineer will determine the work involved for granular surfacing as follows:

A. Granular Surfacing on Road.

1. The quantity of granular surfacing of the class specified, delivered on the road, in cubic yards (cubic meters) or in tons (megagrams), will be measured as indicated in the contract documents.

2. Measurement may be converted from tons to cubic yards (megagrams to cubic meters) or cubic yards to tons (cubic meters to megagrams) with the Engineer’s approval. The Engineer will determine the conversion factor.

3. When measurement is the cubic yard (cubic meter), level all loads and fill corners at the loading point. Measurement will be checked at the point of delivery. Deductions will not be made for natural settlement in transit. The tops of end gates on transporting vehicles are not to be lower than the adjacent sides.

4. Weight (mass) measurements are to be on Contractor's weighing equipment, according to Article 2001.07. Load vehicles to prevent loss of material between the scales and the point of delivery. Deduction will not be made for the weight (mass) of moisture naturally occurring in the material. When the unit of measurement is cubic yards (cubic meters) and these materials are mixed on the road surface, the Engineer will compute the number of cubic yards (cubic meters) to be paid for as outlined in Article 2312.03, F, 1.

B. Preparing and Hauling Granular Surfacing Material Furnished by the Contracting Authority.

1. Determined according to Article 2312.04, A.

2. When the contract provides compensation to the Contractor on the basis of 1 mile (1 km) haul units in addition to the contract price for preparation, the haul will be measured over the shortest practical route from point of loading to point of delivery. Beginning at the loading point, each mile (kilometer) section will be numbered consecutively toward the point of delivery.

3. The number of additional mile (kilometer) units of haul will be computed by multiplying the number of units of material (cubic yards or tons (cubic meters or megagrams)) delivered in each mile (kilometer) section by the number of that section and adding the products thus obtained.

C. Stripping (Overburden).

1. Will not be measured for payment unless the contract involves a unit price for stripping. Stripping, to be paid for as a separate item, will be measured by cross sectioning before and after excavation. The volumes will be computed by the average-end-area method.

2. Payment will not be made for material excavated prior to cross sectioning by the Engineer.

3. When removal and transportation of stripping involves a haul of more than 1000 feet (300 m), overhaul will be computed and paid according to Section 2108.

2312.05 BASIS OF PAYMENT.

Payment for the quantities of various items of work, as measured above, will be at the contract unit price as described below. Payments are full compensation for furnishing all tools, equipment, and labor and for performance of work necessary to complete the contract in conformance with the contract documents.

A. Granular Surfacing on Road.

1. Per cubic yard or ton (cubic meter or megagram), as specified in the contract for furnishing and delivering granular surfacing material on the road.

2. Payment is full compensation for furnishing, preparing, handling, transporting, and depositing the material on the road according to the contract documents.

B. Preparing and Hauling Granular Surfacing Material Furnished by the Contracting Authority.

1. Per cubic yard or ton (cubic meter or megagram) for preparing and hauling material furnished at locations by the Contracting Authority.

2. Payment is full compensation for removing, sorting, crushing, screening, washing, and transporting the material according to the contract and these specifications. The number of additional 1 mile (1 km) haul units, computed as specified above, will be paid for at the contract unit price.

C. Stripping (Overburden).

1. No payment. Incidental to the contract unit price for preparing and hauling the material.

2. If the contract provides a separate contract unit price for stripping, payment will be for the cubic yards (cubic meters) of excavation and the number of station-yards (cubic meters per metric station) of overhaul, computed as specified above.

D. Removal and Transportation.
Removal and transportation of materials which are not permitted in surfacing material will not be paid for as a separate item. This material shall be included in the payment for preparing and hauling the material.

Section 2314. Surface Application of Calcium Chloride

2314.01 DESCRIPTION.
Furnish and apply calcium chloride, with or without water furnished by the Contractor, as provided in the contract documents and according to the following provisions.

2314.02 MATERIALS.
Meet the following requirements:

A. Water.
Use water clear and free of suspended matter.

B. Calcium Chloride.
Unless otherwise provided in the contract documents, the Contractor has the option of providing calcium chloride in any of the forms meeting the requirements of Article 4194.01.

2314.03 CONSTRUCTION.

A. Equipment.
Meet the requirements of Section 2001 and the following:

1. **Equipment for Applying Water or Calcium Chloride Solution.**
Apply Article 2001.09.

2. **Equipment for Applying Calcium Chloride in Solid Form.**
Use equipment capable of calibration and control such that the quantity of calcium chloride applied in any 25 foot (10 m) length of road does not vary more than 10% from the intended quantity of material in that unit of length.

3. **Belt or Spiral Flight Conveyors.**
So the rate of delivery may be accurately calibrated, provide a conveniently located revolution counter for belt or spiral flight conveyors used to handle bulk shipments of solid form calcium chloride to be applied in solution.

4. **Weighing Equipment.**
Apply Article 2001.07.

B. Application.

1. Calcium chloride may be applied to the road surface:
   - As a liquid,
   - In a solid form with the water applied separately, or
   - In a solid form made into a solution and applied to the road surface.

2. Do not apply calcium chloride during rain or when, in the opinion of the Engineer, the weather is unsuitable for the application.

3. Unless otherwise provided in the contract documents, when calcium chloride is to be applied to the road in the solid form, first uniformly apply water to the center portion of the roadbed at a rate sufficient to produce the desired condition of moisture on the road surface to be treated. This will require an anticipated 10,000 gallons (23.5 kL) of water per mile (kilometer) of road. This rate may be increased or decreased in increments of 1000 gallons per mile (1 kL/km) at the Engineer's direction.

4. Unless otherwise provided in the contract documents, spread the solid form at a rate which will deliver to the road surface 1 pound (0.5 kg) of calcium chloride per square yard (square meter), computed on the anhydrous basis. When calcium chloride is applied in solid form, spread it uniformly over the road within 1 hour after application of water to that section. Ensure the total quantity of calcium chloride applied on each mile (kilometer) of road is within 5% of the specified quantity.

5. When calcium chloride is applied in solution, thoroughly mix water and calcium chloride into a uniform solution completely dissolving any solid material before the solution is spread on the road. Control the concentration of the solution and the rate of distribution of the solution on the road surface to deliver to the road surface the quantity of calcium chloride specified above.

6. Unless results of laboratory analysis of samples of material actually used are available, the rate of distribution may be computed on the percentages in Table 2314.03-1 for the respective material:

Table 2314.03-1: Assumed % Calcium Chloride

Material	Assumed % Calcium Chloride by Weight (Mass) (Anhydrous Basis)
Regular Flakes	77.0%

Conc. Flakes, Pellets, or other gran. form	94.0%
Calcium Chloride Liquor	32.0 %[(a)]
(a) Total Calcium Chloride. The percentage may be modified with the Engineer's approval.	

2314.04 METHOD OF MEASUREMENT.
Measurement for the work involved in surface application of calcium chloride will be as follows:

A. Calcium Chloride Applied.

1. Without water: tons (megagrams) applied computed on the anhydrous basis from the percentage of calcium chloride contained in the material.

2. With water: tons (megagrams) applied, to the nearest 0.1 ton (0.1 Mg), computed on the anhydrous basis from the percentage by weight (mass) of calcium chloride contained in the liquid.

B. Water for Surface Application of Calcium Chloride.
Thousands of gallons (kiloliters) in the transporting vehicle or by metering the supply.

2314.05 BASIS OF PAYMENT.
Payment for the work of surface application of calcium chloride will be the contract unit price as described below. Payment is full compensation for furnishing water and calcium chloride in a solid or liquid form and for handling, mixing, transporting, and application of materials to the road surface.

A. Calcium Chloride Applied.
Tons (megagrams) of calcium chloride in solid or liquid form applied to the road surface.

B. Water for Surface Application of Calcium Chloride.
Per 1000 gallons (kiloliters) of water applied to the road with surface application of calcium chloride.

Section 2315. Driveway Surfacing

2315.01 DESCRIPTION.
Furnish and place gravel or crushed stone on earth or gravel surfaced intersecting roads, driveways, and turnouts, as directed by the Engineer and according to the following provisions.

2315.02 MATERIALS.
When there is a contract item for granular surfacing of shoulders, use aggregate for driveway surfacing. When there is no contract item for that work, use one of the following materials:

A. Class C Gravel.
Class C gravel meeting requirements of Article 4120.03, except no less than 5% or more than 12% passing the No. 200 (75 µm) sieve.

B. Class A Crushed Stone.
Class A crushed stone meeting requirements of Article 4120.04 and if specifically designated, Class B crushed stone meeting requirements of Article 4120.05.

C. Other Aggregate.
Other aggregate meeting requirements of Section 4127, with 100% passing the 1 inch (25 mm) sieve.

2315.03 CONSTRUCTION.

A. Before surfacing material is placed, excavate to prepare a uniform subgrade, to provide for a finished surface at the general elevation of the shoulder, and to ensure drainage away from the roadbed. Spread the surfacing material to a uniform thickness.

B. The areas to be surfaced for various types of surfacing under contract are described as follows:

1. For Flexible Base and Bituminous Surface Construction.

a. The contract documents may require the construction for flexible base of wedge shaped fillets at intersecting earth or granular surfaced roads and at driveways to homesteads and commercial establishments. The contract documents may require bituminous surface construction for the surfacing of these fillets with the corresponding type of surfacing.

b. Surface the remaining areas of earth or granular surfaced intersecting roads and driveways within the right-of-way and all turnouts for mail boxes with materials specified.

2. For Portland Cement Concrete Pavement.
Use one of the materials specified in Article 2315.02 to surface turnouts for mail boxes, entrances, and the unpaved areas of intersections along roads surfaced with PCC.

2315.04 METHOD OF MEASUREMENT.

Measurement of Driveway Surfacing placed as directed by the Engineer will be as indicated in the contract documents and according to Article 2312.04, A.

2315.05 BASIS OF PAYMENT.

Payment for Driveway Surfacing material placed will be the contract unit price per ton (megagram).

Section 2316. Pavement Smoothness

2316.01 DESCRIPTION.

A. Apply this specification when Section 2317 does not apply.

B. Test and evaluate pavement smoothness. Perform surface correction if required.

2316.02 TESTING AND EVALUATION.

A. General.

1. Evaluate pavement smoothness for all Interstate and Primary main line pavement surfaces, and all other road surfaces included on Primary projects, except when specifically excluded or modified by the contract documents. Main line pavement is defined as all permanent pavement for traffic lanes, including:

- Tapers to parallel lanes or through lanes at intersections,
- Tapers to climbing lanes, and
- Tapers to ramps and loops.

2. Evaluate pavement smoothness for all interchange ramps and loops.

3. For non-Primary projects, do not evaluate pavement smoothness unless specified in the contract documents.

4. If this specification is required by contract documents on non-Primary projects let by the Department, it will be added in its entirety. Selected portions of the specification will not be deleted.

5. Bridge approach sections which are a part of the paving contract will be tested according to Section 2428.

6. Smoothness Requirements:

a. Apply Table 2316.02-1 to all projects when specified. Smoothness requirements in inches per mile (millimeters per kilometer) are listed in Schedules A and B.

b. For through traffic which requires matching the surface of the new pavement to the surface of an existing old pavement, an Average Base Index (ABI) will be calculated as shown in Table 2316.02-1 on lanes wider than 8.5 feet (2.6 m). This will be the smoothness base in inches per mile (millimeters per kilometer) for payment for the new pavement unless specified otherwise. The requirements are shown in Schedule C.

Table 2316.02-1: Schedule for Identification of Pavements

Pavement	Schedule by Posted Speed (mph) (Existing or Proposed)	
	45 or less	over 45
Mainline, curbed (one or both sides of roadway	B	A
Mainline, not curbed	A	A
Ramps and Collector Distributor Roads	A[c]	A[c]
Loops	B	B
Side Roads	B	A
Grade Separations[a]	B	A
Pavement adjacent to existing pavement (added lane)	C[b]	C[b]

(a) Including municipal or Secondary Roads therein.

(b) $ABI = \frac{PI + X}{2}$

where:
PI = the profile index of the edge line of the abutting lane. If the computed ABI is less than X, use an ABI equal to X

X = 7 inches/mile (110 mm/km) if Schedule A, or 22 inches/mile (345 mm/km) if Schedule B.

(c) When a ramp or collector distributor road terminates at an intersection with a traffic signal or stop sign, the 700 feet (215 m) nearest the intersection will be evaluated under Schedule B.

7. Exclusions:
- **a.** Areas excluded from smoothness testing are detour pavement, crossovers, shoulders, and sections less than 50 feet (15 m) long.
- **b.** The Engineer will check all excluded areas with a surface checker. Excluded areas are not to exceed 1/8 inch in 10 feet (3 mm in 3 m).

B. Measurement.

1. General.

- **a.** Provide and operate an Ames or California type profilograph to produce a profilogram (profile trace) of the surface tested, according to Materials I.M. 341. Other types of profilographs or profilers that produce compatible results and meet the requirements of Materials I.M. 341 may be used.
- **b.** When a pavement for which smoothness is to be tested is adjacent to an existing old pavement, smoothness must also be tested on the old pavement 3 feet (1 m) from the adjacent edge for ABI

calculation. Should the surface of the old pavement be specified for correction, perform smoothness testing for ABI calculation after correction.

c. Remove all objects and foreign material on the pavement surface, including protective covers if used, prior to testing. If appropriate, properly replace protective covers after testing.

d. Produce a profilogram for each segment of 50 feet (15 m) or more. Include the 16 feet (5 m) beyond the ends of the section in the profilogram.

2. Pavements.

a. The pavement surface will be divided into sections that represent continuous placement.

b. A section will terminate at a day's work joint (header), a bridge, similar interruption, or when continuous placement crosses to a section with a different smoothness designation.

c. Sections longer than 778 feet or 0.147 miles (240 m) placed without interruption will be separated into segments of 0.1 mile (160 m). The terminating segment may be shorter than 0.1 mile (160 m) and greater than 250 feet (80 m) and still be considered a segment. A segment is to be in only one traffic lane. Each traffic lane will be tested and evaluated separately. Gaps for temporary crossings or similar construction sequencing which are placed in otherwise continuous sections will be tested, when placed, and included in the adjacent section evaluation.

3. Bridge Approach Sections.

Bridge approach sections will not be considered a part of a pavement segment, section, or project.

C. Profilograph Testing.

Perform testing and provide the Engineer with the profilogram results. Ensure testing and evaluation are done by a trained and certified person. Ensure the evaluation is certified according to Materials I.M. 341.

1. Test each segment within 48 hours following placement. Provide the Engineer the index for each segment of paving by the end of the next day worked following the placement until there has been 3 consecutive days of paving where the index for all segments would result in 100% payment or better.

2. Should any following day be evaluated to receive less than 100% payment, immediately notify the Engineer, and take corrective action to modify paving methods and equipment to achieve 100% payment or better.

3. Submit all final profilograph test reports and profile traces to the Engineer within 14 calendar days following completion of paving on the project. Selected reports and traces may be requested by the Engineer in advance of paving completion for purposes of validating the Contractor’s test results. Incentive payments for qualifying segments will

be made following receipt of appropriate documentation of certified smoothness results.

4. The Engineer will perform verification testing to validate the contractor's certified quality control testing. If the Engineer's verification test results validate the Contractor's test results, the Contractor's results will be used for acceptance. Disputes between the Contractor's and Engineer's test results will be resolved according to Materials I.M. 341. The Engineer may test the entire project length if it is determined that the Contractor certified test results are inaccurate, and the Contractor will be charged for this work at a rate of $400.00 per mile ($250.00 per kilometer), per profile track, with a minimum charge of $800.00. Furnishing inaccurate tests may result in decertification of the Contractor's certified operator.

D. Profile Index.

1. Calculate a profile index for each segment from the profilogram, according to Materials I.M. 341, except for:
- **a.** Side road connections less than 600 feet (180 m) in length.
- **b.** Single lift pavement overlays 2 inches (50 mm) or less in thickness unless the existing surface has been corrected by milling or scarification.
- **c.** Storage lanes and turn lanes.
- **d.** Pavement less than 8.5 feet (2.6 m) in width.
- **e.** The 16 feet (5 m) at the ends of the section when the Contractor is not responsible for the adjoining surface.
- **f.** Runout tapers on HMA overlays at existing pavement, bridges, or bridge approach sections when the thickness is less than the design thickness.

2. If there is a segment 250 feet or 0.047 mile (80 m) long or less at the end of a section, include the profilograph measurements for that segment in the evaluation of the adjacent segment in that section.

3. Identify bumps and dips separately on all profilograms. These appear as high or low points on the profilogram and correspond to high points (bumps) or low points (dips) on the pavement surface. They are identified by locating vertical deviations exceeding 0.5 inches for a 25 foot (12.7 mm for a 7.6 m) span for both bumps and dips as indicated on the profilogram.

2316.03 SURFACE CORRECTION.

A. General.

1. Surface correction for pavement smoothness may be required, which includes bumps or dips. Complete the correction before the determination of pavement thickness.

2. Perform bump, dip, and smoothness correction work for the full lane width of the paved surface.

3. Obtain the Engineer's approval for all correction work. After all required correction work is completed, determine the final profile index.

B. Pavements.

1. Portland Cement Concrete Pavement.

a. Accomplish PCC pavement surface correction by grinding the pavement with a diamond grinder, by PCC resurfacing, or by replacement.

b. Use grinding and texturing equipment that meets the requirements of Section 2532. Use a cutting head that is a minimum of 24 inches (600 mm) wide.

c. Perform surface correction parallel to lane lines or edge lines as directed by the Engineer. Make each pass parallel to the previous passes. Ensure the ground surface is of a uniform texture.

d. Do not allow adjacent passes to overlap more than 1 inch (25 mm) or have a vertical difference of more than 1/8 inch (3 mm) as measured from bottom of groove to bottom of groove.

e. Begin and end smoothness correction at lines normal to the pavement lane lines or edge lines within any one corrected area. Proceed from the center line or lane line toward the pavement edge to maintain pavement cross slope.

2. Hot Mix Asphalt Pavements.

a. Accomplish asphalt pavement surface correction by:

- Diamond grinding,
- Overlaying the area,
- Replacing the area, or
- Inlaying the area.

b. For diamond grinding, perform the same work and use the same equipment specified for PCC pavement. Cover the surface that has been ground with a seal coat according to Section 2307 with the following modifications:

- The binder bitumen may be the same material used for tack coat, applied at a rate of 0.10 gallon per square yard (0.45 L/m^2). Hand methods may be used for spraying.
- Apply a cover aggregate consisting of sand at a rate of 10 pounds per square yard (5 kg/m^2). Hand methods may be used for spreading. Apply the sand slightly damp, but with no free moisture, as determined by visual inspection. Embed with at least one complete pneumatic roller coverage.
- This seal coat is intended to be placed immediately after the diamond grinding is completed in the travel lane. Complete this work when the road surface temperature is above 60ºF (16ºC).
- Labor, equipment, and materials used for this seal coat will not be paid for separately, but are incidental to the items for which correction is required.

c. If the surface is corrected by overlay, replacement, or inlay, begin and end the surface correction with a transverse saw cut normal to the pavement lane lines or edge lines within any one area. Ensure

the profile of the surface is smooth with no bumps or dips at the beginning or end of correction. Overlay correction must be for the entire pavement width. Maintain pavement cross slope through the corrected areas.

C. Bumps and Dips.

Evaluate bumps and dips, including those at headers, on all pavements for which pavement smoothness is designated. Correction work will be required according to the criteria in Paragraphs 1, 2, and 3 below. For areas excluded from profilograph testing, correct deviations exceeding 1/8 inch in 10 feet (3 mm in 3 m).

1. Bumps.

a. For all pavements evaluated, if the Engineer does not assess a price adjustment, correct all bumps exceeding 0.5 inch (12.7 mm) within a 25 foot (7.6 m) span, as indicated on the profilogram, except as stated in Article 2316.03, C, 3.

b. Corrected bumps will be considered satisfactory when measurement by the profilograph shows that the bumps are 0.3 inch (8 mm) or less in a 25 foot (7.6 m) span.

c. When a through traffic lane over 8.5 feet (2.6 m) wide is constructed adjacent to an existing old pavement, bump correction or price adjustment to the Contractor for a bump will not apply if a bump exists at that location in the adjacent existing old pavement.

2. Dips.

a. On all pavements, if the Engineer does not asses a price adjustment, correct dips of 0.5 inch to 1.0 inch (12.7 mm to 25 mm) in a 25 foot (7.6 m) span, as indicated on the profilogram, except as stated in Article 2316.03, C, 3. Replace the pavement in areas with dips over 1.0 inch (25 mm). Corrected dips will be considered satisfactory when the profilogram shows the dips are less than 0.3 inch (8 mm) in a 25 foot (7.6 m) span.

b. When a lane over 8.5 feet (2.6 m) wide is constructed adjacent to an existing old pavement, correction of a dip or price adjustment to the Contractor for a dip will not be required if a dip exists at that location in the adjacent existing old pavement.

3. Exceptions.

When the Contractor is not responsible for the adjoining pavement, the Engineer will evaluate bumps and dips exceeding 0.5 inches (12.7 mm) located within 16 feet (5 m) either side of the end of a section. The Contractor will not be price adjusted for bumps and dips in this area. When the Engineer instructs to repair these bumps and dips, the Contractor will be paid according to Article 1109.03, B.

2316.04 SMOOTHNESS.

Pavement smoothness will be compensated by adding to (incentive) or subtracting from (price reduction) the price bid for pavement a determined amount for each segment. These amounts are identified in the appropriate schedule of Article 2316.05.

A. Pavement Where Schedule A Smoothness is Required.

1. For the appropriate categories of highway, as shown in Schedule A, incentives for pavement smoothness will be paid for each segment of pavement with an initial index per mile (kilometer) per segment of 3.0 inches (48 mm) or less.
2. For segments with an initial index of 7.1 to 10.0 inches per mile (111 mm/km to 160 mm/km), the Contractor will be assessed a price reduction.
3. For segments with an index of 10.1 inches per mile (161 mm/km) and greater, grind the surface to a final index of 7.0 inches per mile (110 mm/km) or less.

B. Pavement Where Schedule B Smoothness is Required.

1. For all highways, incentives for pavement smoothness will be paid for each segment of pavement with an initial index of 12 inches per mile (190 mm/km) per segment or less.
2. For all segments with an initial index of 22.1 to 30.0 inches per mile (346 mm/km to 475 mm/km), the Contractor will be assessed a price reduction.
3. For segments with an index of 30.1 inches per mile (476 mm/km) and greater, grind the surface to a final index of 22.0 inches per mile (345 mm/km) or less.

C. Pavement Adjacent to Existing Pavement.

1. Smoothness will be evaluated by the Average Base Index (ABI) as defined in Article 2316.02, A, 6 or 7, for each segment of new pavement 8.5 feet (2.6 m) wide or more, and over 600 feet (180 m) in length, which is to be matched to the surface of an existing pavement.
2. Surface correction is required for smoothness exceeding ABI + 12 (190) when Schedule A is required and exceeding ABI + 30 (470) when Schedule B is required. Payment will be based on results after correction according to Schedule C.
3. Longitudinally check areas not included in the profilograph test with a 10 foot (3 m) straight edge. Ensure the surface does not deviate from a straight line by more than 1/8 inch in 10 feet (3 mm in 3 m). Meet requirements of Article 2316.03 for all corrections needed.

D. Bridge Approach Sections.
Smoothness of bridge approach sections will not be used in the calculations for incentive or price reduction of pavement segments, sections, or the project.

2316.05 SCHEDULE OF PAYMENT.

A. For each traffic lane of main line pavement and each traffic lane of interchange ramps and loops evaluated for smoothness, as defined in Article 2316.02, A, the Engineer will determine the length of each segment in miles (kilometers).

B. For roadways, the Contractor may receive an incentive payment or be assessed a price reduction based on the number of qualifying segments and the initial profile index.

C. Pavement segments excluding repair work that are subject to profilograph testing, as defined in Article 2316.02, D, will be considered for additional payment as a smoothness incentive or price reduction. For a segment to be qualified for incentive, there must be no grinding within that segment.

D. Surface correction (grinding) of bridge approach sections, and as stated in Article 2316.03, C, 3, will not count as surface correction on adjacent pavement segments and will not detract from possible incentive payments on those segments.

E. Single lift pavement resurfacing 2 inches (50 mm) thick or more that has milling or scarification of the original pavement will be rated using the multi-lift schedules.

F. A $900 price adjustment will be assessed for each dip not corrected in each pavement lane under Schedule A and B, except as stated in Article 2316.03, C, 3. In addition, a $900 price adjustment will be assessed for each bump not corrected under Schedule A and B, except as stated in Article 2316.03, C, 3. Bumps and dips not corrected will also be included in the evaluation for the segment smoothness.

G. The cost of certified smoothness and associated traffic control is incidental to the cost of the pavement.

H. These payments or assessments will be based on the following schedules:

1. Schedule A Smoothness Requirements.
Pavement segments which are designated for Schedule A smoothness will be evaluated for incentive or price reduction assessments as follows:

Table 2316.05-1: Incentives for Pavement Smoothness

Initial Profile Index	Single Lift Pavements		Multi-Lift Pavements	
Inches Per Mile (mm / km)	Primary	Non-Primary	Primary	Non-Primary

Per Segment [a]	Dollars Per Segment	Dollars Per Segment	Dollars Per Segment	Dollars Per Segment
0-1.0 (0-16) 1.1-2.0 (17-32) 2.1-3.0 (33-48) 3.1-7.0 (49-110)	700 600 450 Unit Price	300 250 200 Unit Price	250 200 150 Unit Price	125 100 50 Unit Price
[a] For each segment of pavement that has an initial index, within the limits listed, with no grinding, the Contractor will receive an incentive payment as shown in the tabulation for the appropriate category.				

Table 2316.05-2: Price Reduction for Pavement Smoothness

Initial Profile Index	Single Lift Pavements		Multi-Lift Pavements	
Inches Per Mile (mm / km) Per Segment [a]	Primary	Non-Primary	Primary	Non-Primary
	Dollars Per Segment	Dollars Per Segment	Dollars Per Segment	Dollars Per Segment
3.1-7.0 (48-110) 7.1-10.0 (111-160) 10.1 & Over[a] (161 & Over)[a]	Unit Price 200 Grind Only	Unit Price 100 Grind Only	Unit Price 100 Grind Only	Unit Price 50 Grind Only
[a] For segments with an initial index of 10.1 (161) and over, grind the surface to a final index of 7.0 (110) or better. In lieu of grinding the surface to a final index of 7.0 (110) or better, the Contractor may elect to replace part or all of the segment.				

2. Schedule B Smoothness Requirements.

a. Pavement segments designated for Schedule B smoothness and indexed in segments greater than 50 feet (15 m) will be evaluated for incentive or price reduction as shown in Tables 2316.05-3 and 2316.05-4.

b. No price reduction assessment will be made for individual segments shorter than 50 feet (15 m) properly corrected if required.

Table 2316.05-3: Incentives for Pavement Smoothness

Initial Profile Index	New Pavements	Resurfaced Pavements
Inches Per Mile (mm / km) Per Segment [a]	Dollars Per Segment	Dollars Per Segment
0-4.0 (0-65) 4.1-8.0 (66-130) 8.1-12.0 (131-190) 12.1-22 (191-345)	600 500 400 Unit Price	300 250 200 Unit Price
(a) For each segment of pavement that has an initial index, within the limits listed, with no grinding, the Contractor will receive an incentive payment as shown in the tabulation for the appropriate category.		

Table 2316.05-4: Price Reduction for Pavement Smoothness

Initial Profile Index	New Pavements	Resurfaced Pavements
Inches Per Mile (mm / km) Per Segment [(a)]	Dollars Per Segment	Dollars Per Segment
12.1-22.0 (191-345) 22.1-30.0 (346-475) 30.1 & Over (476 & Over) [(a)]	Unit Price Grind Grind Only	Unit Price Grind Grind Only
(a) For segments with an initial index of 30.1 (476) and over, grind the surface to a finish index of 22.0 (345) or better. In lieu of accepting a price reduction and grinding the surface to a final index of 22.0 (345) or better the Contractor may elect to replace part or all of the segment.		

3. **Schedule C Smoothness Requirements (Pavement Adjacent to Existing Pavement).**
For new pavement which has been matched to an existing old pavement for which an Average Base Index (ABI) was calculated, the pavement will be evaluated for a price reduction for each segment based on Schedule A or Schedule B payment.

Table 2316.05-5: Initial Profile Index or Profile Index after Correction

Schedule A Inches Per Mile (mm / km) Per Segment	Schedule B Inches Per Mile (mm / km) Per Segment	Dollars Per Segment
0 to ABI ABI + 0.1 (1) to ABI +4 (65) incl. ABI + 4.1 (66) to ABI +8.0 (130) incl. ABI + 8.1 (131) to ABI +12 (190) incl. Greater than AGI + 12 (190)	0 to ABI ABI + 0.1 (0.1) to ABI + 10 (160) incl. ABI + 10.1 (161) to ABI + 20 (315) incl. ABI + 20.1 (316) to ABI + 30 (475) incl. Greater than ABI + 30 (470)	0 300 500 800 Grind Only

4. **Bridge Approach Sections.**
Correct bridge approach sections for smoothness as specified in Section 2428.

Section 2317. Primary and Interstate Pavement Smoothness

2317.01 GENERAL.

A. Evaluate pavement smoothness for all Interstate and Primary main line pavement surfaces, and all other road surfaces included on Primary projects, except when specifically excluded or modified by the contract documents. Main line pavement is defined as all permanent pavement for through lanes. Exclusions from profilograph testing are detour pavement, shoulders, crossovers, and individual sections of pavement less than 50 feet (15 m) in length.

B. The Engineer may determine the pavement smoothness according to Materials I.M. 341 using a 10 foot (3 m) straightedge or rolling straightedge on surfaces excluded from profilograph testing. The variation of the surface from the testing edge of the straightedge is not to exceed 1/8 inch (3 mm) between any two contacts, longitudinal or transverse. Correct all irregularities exceeding the specified tolerance using equipment and methods approved by the Engineer. After the Contractor has corrected an irregularity, the Engineer may perform monitor testing of the area to verify compliance with the specified tolerance.

2317.02 EQUIPMENT.

A. Provide and operate an Ames type or California type profilograph to produce a profilogram (profile trace) of the surface tested according to Materials I.M. 341. Other types of profilographs or profilers that produce compatible results and meet the requirements of Materials I.M. 341 may be used. Ensure the operator is trained and certified to operate the profilograph as required by the Contracting Authority.

B. If the profilograph has a mechanical recorder, provide automated trace reduction equipment according to Materials I.M. 341. If it has a computerized recorder, the trace produced will be evaluated without further reduction.

2317.03 SURFACE TOLERANCES, TESTING, AND EVALUATION.

A pavement segment is defined as a continuous area of finished pavement 0.1 mile (161 m) in length and one lane (10 to 12 foot (3.0 to 3.7 m) nominal) in width. A partial segment resulting from an interruption of the continuous pavement surface (in other words, bridge approaches, side road tie-ins, the cessation of the daily paving operations, and so forth) is subject to the same evaluation as a whole segment.

A. Tolerances.

Produce pavement with an average profile index per 0.1 mile (161 m) segment as shown in Table 2317.03-1.

Table 2317.03-1: Tolerance for Average Profile Index per 0.1 Mile (161 m) (0 inch (0 mm) blanking band)

Surface Type	Profile Index For greater than 45 mph	Profile Index For 45 mph or less and ramps
	Inches per mile (mm / km)	Inches per mile (mm / km)
PCC Pavement	40.0 or less (630 or less)	65.0 or less (1025 or less)
HMA Pavement	35.0 or less (550 or less)	45.0 or less (710 or less)

B. Testing.

1. Determine the pavement profiles for each lane according to the procedures for one lane, as shown in Materials I.M. 341 except for main line traffic lanes which will be tested in the wheel paths. Round the trace scallops to the nearest 0.01 inch (0.1 mm). The wheel paths are defined as the 3 feet (0.9 m) and 9 feet (2.7 m) from the center line or lane line. Average the two wheel path profile indexes for each segment.

Additional profiles may be taken only to define the limits of an out-of-tolerance surface variation.

2. The Engineer may use a 10 foot (3 m) straightedge (or other means) to detect irregularities outside the required trace paths. The Engineer may also use the straightedge to delineate the areas that require corrective action.

3. Test bridge approaches according to Section 2428.

C. Evaluation.

1. Determine a profile index based on the 0 inch (0 mm) blanking band following the same procedures shown in Materials I.M. 341 for each segment of finished pavement surface except for:

- **a.** Primary side road connections less than 600 feet (180 m) in length.
- **b.** Non-primary side road connections, which are to be evaluated according to Section 2316.
- **c.** Bridge approaches (evaluated according to Section 2428).
- **d.** Storage lanes, turn lanes, and other auxiliary lanes less than 600 feet (180 m).
- **e.** Pavement less than 8.5 feet (2.6 m) in width.
- **f.** The 16 feet (5 m) before and the 16 feet (5 m) beyond the ends of the section when the Contractor is not responsible for the adjoining surface.
- **g.** Single lift pavement overlays 2 inches (50 mm) thick or less, unless the existing surface has been corrected by milling or scarification.
- **h.** Runout tapers on HMA overlays at existing pavement, bridges, or bridge approach sections where the thickness is less than the design thickness.

2. For the following situations, the profile index will be evaluated. If the average profile index exceeds the tolerances listed in Article 2317.03, A, the Contractor may elect to eliminate that area from the profile index for the day's paving operation and evaluate the area using a 10 foot (3 m) straightedge as outlined in Article 2317.01.

- **a.** Horizontal curves with a centerline radius of less than 1000 feet (300 m) and the pavement within the superelevation transition of such curves.
- **b.** Crest and sag vertical curves with an L/A < 100 where L is the length of curve in feet and A is the grade change in percent (L/A < 30.5 where L is the length in meters and A is the grade change in percent).

3. Determine a daily average profile index for each day's paving operation. A day's paving operation is defined as a minimum of 0.1 mile (161 m) segment of pavement placed in a day. If less than 0.1 mile (161 m) segment is paved, the day's production will be grouped with the next day's production. If the production of the last day of project paving is less than 0.1 mile (161 m) segment, it will be grouped with the previous day's production.

4. Test each segment within 48 hours following placement. Furnish the profile index for each segment of paving to the Engineer by the end of the next day worked following the placement until there has been 3 consecutive days of paving where the index for all segments would result in 100% payment or better. Should any following day be evaluated to receive less than 100% payment, immediately notify the Engineer and take corrective action to modify paving methods and equipment to achieve 100% payment or better.
5. If the day's average profile index exceeds the values in Table 2317.03-1, notify the Engineer and suspend the paving operation until corrective action is taken. When the paving is resumed, the paving operations will be evaluated with the start-up testing procedures in the preceding paragraph.

6. Submit all final profilograph test reports and profile traces to the Engineer within 14 calendar days following completion of paving on the project. The Engineer may request selected reports and traces in advance of paving completion for purposes of validating the Contractor's test results. Incentive payments for qualifying segments will be made following receipt of appropriate documentation of certified smoothness results.

2317.04 CORRECTIVE ACTIONS.

A. General.

1. The pavement will be evaluated in 0.1 mile (161 m) segments using the profilograph, to determine pavement segments where corrective work or pay adjustments will be necessary. Each individual profilograph trace will be evaluated (not the average of multiple traces) to determine the areas where corrective action on 0.5 inch (12.7 mm) bumps and dips is needed.

2. Within each 0.1 mile (161 m) segment, correct all areas representing high points (bumps) or low points (dips) with deviations in excess of 0.5 inches (12.7 mm) in a length of 25 feet (7.6 m) or less regardless of the profile index value. Evaluate pavement segments excluded from profile index evaluation in Article 2317.03 for high points and low points with deviations in excess of 0.5 inches (12.7 mm) in a length of 25 feet (7.6 m) or less. Take corrective action.

3. Separately identify bumps and dips equal to or exceeding 0.5 inches (12.7 mm) in a length of 25 feet (7.6 m) or less.

4. On lanes over 8.5 feet (2.6 m) in width, for through traffic which requires matching the surface of the new pavement to the surface of an existing pavement, an Average Base Index (ABI) will be determined according to Section 2316.

B. Roadways with a posted speed greater than 45 mph.

Correct all 0.1 mile (161 m) segments, including bumps, having an initial average profile index of greater than those tolerances shown in Article

2317.05. Correct these segments to reduce the average profile index to those shown in Table 2317.04-1 below. The Contractor has the option to replace these segments. On segments where corrections are made, test the pavement to verify that corrections have met the average profile index as shown in Table 2317.04-1 below.

C. Roadways with a posted speed of 45 mph, or less, and ramps.
Correct all 0.1 mile (161 m) segments, including bumps, having an initial average profile index of greater than those tolerances shown in Article 2317.05. Correct these segments to reduce the average profile index to those shown in Table 2317.04-1 below. The Contractor has the option to replace these segments. On segments where corrections are made, test the pavement to verify that corrections have met the average profile index as shown in Table 2317.04-1 below.

Table 2317.04-1: Average Profile Index per 0.1 Mile (161 m) after Corrections (0 inch (0 mm) blanking band)

Surface Type	Profile Index For greater than 45 mph	Profile Index For 45 mph or less and ramps
	Inches per mile (mm / km)	Inches per mile (mm / km)
PCC Pavement	40.0 or less (630 or less)	65.0 or less (1025 or less)
HMA Pavement	40.0 or less (630 or less)	50.0 or less (790 or less)

D. Bridge Approach Sections.
Correct bridge approach sections according to Section 2428.

E. Corrective Work.
Corrective work is at the Contractor's expense except for the 16 feet (5 m) before and the 16 feet (5 m) beyond the end of the section when the Contractor is not responsible for the adjoining surface. Complete the corrective work prior to determining pavement thickness. Do not use bush hammers or other impact devices.

1. PCC Pavement.
On PCC pavement, make corrections using an approved profiling device or by removing and replacing the pavement. Apply corrective methods to the full lane width. Ensure, when completed, the corrected area (full lane width) has uniform texture and appearance, with the beginning and ending of the corrected area squared normal to centerline of the paved surface. Where surface corrections are made, grooving will not be required.

2. HMA Pavement.

a. On HMA pavement, make corrections by diamond grinding, by overlaying the area, by replacing the area, or by inlaying the area. If the surface is corrected by diamond grinding, perform the same work and use the same equipment as specified for PCC pavement, except cover the ground surface with a seal coat according to Section 2307, with the following modifications:

1) The binder bitumen may be the emulsion or cutback asphalt used for tack coat, applied at a rate of 0.10 gallon per square yard (0.7 L/m^2). Hand methods may be used for spraying.

2) Apply a cover aggregate consisting of sand (slightly damp, but with no free moisture as determined by visual inspection) at a rate of 10 pounds per square yard (5 kg/m^2). Hand methods may be used for spreading. Embed cover aggregate with at least one complete pneumatic roller coverage.

3) This seal coat is intended to be placed immediately after the diamond grinding is completed in the travel lane. The Engineer may approve this construction when road surface temperatures are below 60ºF (16ºC).

4) Labor, equipment, and materials used for this seal coat are incidental to other items and will not be paid for separately.

b. If the surface is corrected by overlay, replacement, or inlay, begin and end the surface correction with a transverse saw cut normal to the pavement lane lines or edge lines within any one area. The profile of the surface must be smooth with no bumps or dips at the beginning or end of correction.

c. Overlay correction must be for the entire pavement width. Pavement cross slope must be maintained through the corrected areas.

F. Verification Testing.

1. The Engineer will perform verification testing to validate the Contractor's certified quality control testing. If the Engineer's verification test results validate the Contractor's test results, the Contractor's results will be used for acceptance. Disputes between the Contractor's and Engineer's test results will be resolved according to Materials I.M. 341.

2. The Engineer may test the entire project length if it is determined that the Contractor certified test results are inaccurate, The Contractor will be charged for this work at a rate of $400.00 per mile ($250.00 per kilometer), per profile track, with a minimum charge of $800.00.

3. Furnishing inaccurate tests may result in decertification of the Contractor's certified operator.

2317.05 PAY ADJUSTMENTS.

A. General.

1. Pay adjustments will be based on the initial average profile index determined for the segments prior to performing any corrective work. Areas excluded from the profilograph testing and bridges approaches will not be subject to price adjustments.

2. If the Contractor elects to remove and replace the segments, the Contractor will be paid the price adjustment that corresponds to the initial average profile index obtained on the pavement segments after replacement.

3. When the plans dictate that an area of pavement is to be hand finished, the area will not be subject to reduced payment. However, the area is to be profiled and corrected as necessary to meet these specifications.

1. PCC Pavement.
The payment will be adjusted as shown in Table 2317.05-1 according to the posted or proposed speed.

Table 2317.05-1: Schedule for Adjustment Payment for PCC Pavements (0 inch (0 mm) blanking band)

Profile Index For greater than 45 mph	Profile Index For 45 mph or less and ramps	Dollars per 0.1 mile (161 m) segment per lane	
Inches per mile (mm / km)	Inches per mile (mm / km)	Interstate & Multi-Lane Divided Segments	Other Primary Segments
22.0 or less (345 or less)	25.0 or less (395 or less)	+950.00	+850.00
22.1 to 23.5 (346 to 370)		+800.00	+650.00
23.6 to 26.0 (371 to 410)	25.1 to 30.0 (396 to 475)	+600.00	+450.00
26.1 to 40.0 (411 to 630)	30.1 to 65.0 (476 to 1025)	0.00	0.00
40.1 to 45.0 (631 to 710)	65.1 to 70.0 (1025 to 1105)	-600.00	-450.00
45.1 or more (711 or more)	70.1 or more (1105 or more)	0.00*	0.00*
* These segments must be corrected to the levels shown in Table 2317.04-1.			

2. HMA Pavement.
The payment will be adjusted as shown in Table 2317.05-2 according to the posted or proposed speed.

Table 2317.05-2: Schedule for Adjustment Payment for HMA Pavements (0 inch (0 mm) blanking band)

Profile Index For greater than 45 mph	Profile Index For 45 mph or less and ramps	Dollars per 0.1 mile (161 m) segment per lane	
Inches per mile (mm / km)	Inches per mile (mm / km)	Interstate & Multi-Lane Divided Segments	Other Primary Segments
10.0 or less (160 or less)		+850.00	+750.00
10.1 to 11.5 (161 to 180)	15.0 or less (235 or less)	+650.00	+500.00
11.6 to 13.5 (181 to 215)		+500.00	+350.00
13.6 to 15.5 (216 to 245)	15.1 to 20.0 (236 to 315)	+350.00	+200.00
15.6 to 35.0 (246 to 550)	20.1 to 45.0 (316 to 710)	0.00	0.00
35.1 to 40.0 (551 to 630)	45.1 to 50.0 (711 to 790)	-350.00	-200.00
40.1 or more (631 or more)	50.1 or more (791 or more)	0.00*	0.00*
* These segments must be corrected to the levels shown in Table 2317.04-1.			

Section 2318. Cold In-Place Recycled Asphalt Pavement

2318.01 DESCRIPTION.

Cold in-place recycling (CIR) consists of:

- Milling existing asphalt pavement,
- Processing and mixing RAP with an asphalt stabilizing agent and water (if required), and
- Placing and compacting the mixture.

2318.02 MATERIALS.

A. Asphalt Stabilizing Agent.

Use one of the following asphalt stabilizing agents, as specified in the contract documents:

1. Standard Asphalt Emulsion (HFMS-2s) meeting the requirements of Section 4140 shall be used on Primary and Interstate projects. CSS-1 emulsion meeting the requirements of Section 4140 may be used in place of HFMS-2s on other projects.

2. Foamed Asphalt using PG 52-34 or PG 46-34 asphalt binder meeting the requirements of Section 4137 may be used on Interstate, Primary, Secondary, and local projects.

B. Recycled Asphalt Pavement.

The processed RAP is intended to comply with the following gradation. The gradation may be revised with the approval of the Engineer. Ensure the top size of the material does not exceed 50% of the depth of the compacted recycled mat.

Sieve Size	% Passing
1 1/2 inch (37.5 mm)	98 to 100
1 inch (25 mm)	90 to 100

C. Mix Design.

1. Unless stated otherwise in the contract documents, do not perform a mix design process for standard asphalt emulsion or foamed asphalt. Use the following application rates per square yard per inch (per square meter per mm) of compacted thickness when no mix design is performed.

Asphalt Stabilizing Agent	Application Rate (/yd^2/in)	(/m^2/25 mm)
Standard Asphalt Emulsion	0.30 gallons (emulsion)	1.325 L
Foamed Asphalt	0.0011 tons (asphalt binder)	1.175 kg

2. When a mix design is required by the contract documents, apply the following provisions:

Provide the Engineer a representative 150 pound (22 kg) bulk sample of the existing pavement surface as directed by the Engineer following the

sampling options in Materials I.M. 504, and 10 gallons (38 L) of the intended asphalt stabilizing agent. The Engineer will provide the details of the mix design no later than 6 weeks after receiving the samples. The Central Materials Laboratory will perform the mix design and will establish the amount of asphalt binder to incorporate into the RAP. The mix design shall determine the target asphalt temperature and percent of water injected into the asphalt to achieve optimum foaming.

2318.03 CONSTRUCTION.

Except in specific cases when permitted by the Engineer, CIR will only be allowed between May 1 and October 1. Do not perform recycling operations when:

- The ambient temperature is below 60°F (15°C),
- The weather is foggy or rainy, or
- Weather conditions are such that proper mixing, placing, and compacting of the recycled material cannot be accomplished.

A. Equipment.

1. Furnish a self-propelled machine equipped with automatic depth control. Ensure it is capable of:
- Milling the existing asphalt pavement to the depth shown in the contract documents in one pass.
- Maintaining a constant cutting depth and width, uniform grade, and uniform slope.
- Producing the properly sized RAP or additional screening.
- Crushing the RAP.

2. Furnish equipment capable of mixing the RAP and asphalt stabilizing agent into a homogeneous CIR mixture. Ensure the equipment meets the requirements of Article 2001.22, F. Ensure it also provides a positive means, including visual display, for accurately controlling the rate of flow and total delivery of the asphalt stabilizing agent into the mixture in relation to the quantity of RAP being recycled. Ensure the asphalt stabilizer application system is capable of adjusting for the width of recycling so that overlapped CIR mixture maintains the designed asphalt stabilization content.

3. When foamed asphalt stabilizing agent is used, ensure the asphalt foaming system accurately and uniformly injects the specified percent of water into the hot asphalt binder. Fit the equipment with a test nozzle to provide field samples of foamed asphalt. Equip tankers supplying hot asphalt binder with a thermometer to continuously measure temperature of the asphalt in the bottom third of the tank.

4. Place CIR material using a bituminous paver meeting the requirements of Article 2001.19 (heating the screed will not be permitted).

5. Compact CIR material using rollers meeting the requirements of Article 2001.05. As a minimum, have the following available for use:
- A self-propelled double drum vibratory steel roller (may be used in either the static or vibratory mode).

- A self-propelled 25 ton (25 Mg) or greater pneumatic tire roller.

B. Preparation.

Prior to initiating the recycling operation, clear all vegetation and debris within the width of pavement to be recycled according to Article 2212.03, B, 1.

C. Milling the Existing Pavement.

1. Mill the existing pavement to the specified constant depth and width in one pass. Process RAP to the required gradation. When specified in the contract documents or if the Engineer approves, the pavement surface may be pre-milled to the slope specified in the contract documents. Remove pre-milling RAP from the project.

2. When the plans note that the milling operation will encounter a paving fabric, make necessary adjustments in equipment or operations so no fabric piece has any dimension exceeding a length of 4 inches (100 mm). Remove RAP containing over-sized pieces of paving fabric.

D. Mixing the Recycled Material.

1. During recycling operations, apply asphalt stabilizing agent to the RAP at the specified application rate. The Engineer may vary the application rate of the asphalt stabilizing agent as required by existing pavement conditions.

2. Determine the amount of additional water needed to facilitate uniform mixing with the asphalt stabilizing agent and to achieve a stable pavement layer above the minimum specified density. The water may be added prior to or concurrently with the asphalt stabilizing agent. Ensure adding water, to facilitate uniform mixing, does not adversely affect the asphalt stabilizing agent.

E. Placement of the Recycled Material.

1. Deposit CIR mixture in a windrow, into a spreader or paver (as required by Article 2318.03, A), or load into trucks, without segregation.

2. Place and finish CIR mixture in one continuous pass, without segregation. Ensure the surface of the CIR lift has a uniform cross-slope as specified in the contract documents. Ensure lift thickness is a minimum of 2 inches (50 mm). If using a pick-up machine to feed the windrow into the paver hopper, ensure it is capable of picking up the entire windrow to the underlying material.

F. Compaction and Density.

1. Comply with the following minimum field densities:

- Interstate and Primary Roads: 94% of laboratory density based on the dry weight of compacted material according to Materials I.M. 504.

- All other roads: 92%.

2. Perform initial rolling with a pneumatic tired roller. Perform final rolling using steel wheel rollers, either in static or vibratory mode, to eliminate pneumatic tire marks.

3. If rolling results in cracking, movement, or other types of pavement distress, discontinue until such time that the problem can be resolved.

4. If there is a significant change in mix proportions, weather conditions, or other controlling factors, the Engineer may require construction of test strips to check target density.

G. Opening CIR Layer to Traffic.

1. After compaction is complete, determine when CIR layer is stable enough to open to traffic.

2. The Contractor has 14 calendar days after the CIR layer is complete and initially achieves allowable moisture content to place the first lift of HMA overlay or specified surface treatment. If the first lift is placed after the 14 calendar day period and CIR layer shows damage, correct the damage, at no additional cost to the Contracting Authority, before placing the lift.

H. Placement of Surface Course.

Subsequent HMA overlay or surface treatment will not be allowed until moisture content of the CIR layer is no more than 0.3% above the residual moisture content or 2.0%, which ever is greater. The Engineer may adjust this drying period depending on field conditions. The CIR shall be retested until the moisture content is at or below the limits stated above.

I. Quality Control.

1. The Contractor is responsible for quality control of the materials and CIR process. Perform testing according to Materials I.M. 204. Take samples and deliver them to the District Materials Laboratory according to Materials I.M. 504. A lot, for quality control sampling and testing, is defined as each day of CIR operation.

2. Sample and test the asphalt stabilizing agent according to Materials I.M. 204.

3. Apply asphalt stabilization agent at the target application rate within ± 0.06 gallon per square yard per inch (0.25 L/m^2/25 mm) for standard emulsion and within ± 0.000165 tons per square yard per inch (0.175 kg/m^2/25 mm) for foamed asphalt.

4. When foamed asphalt is used, maintain asphalt binder at a temperature within ± 20°F (10°C) of 310°F (155°C) or the optimum temperature established by the mix design. Maintain the injection water at the target

± 0.5%. Foaming characteristics of each new tanker load will be verified by measuring a sample from the equipment's test nozzle.

5. If required by the Engineer, measure the profile of the center of each lane of the compacted CIR mat with a profilograph. Correct, at no additional cost to the Contracting Authority, bumps and dips in the profile greater than 1 inch (25 mm) in 25 feet (7.6 m). Ensure the cross-slope of the compacted CIR mat is within 0.4% of the desired slope. Payment will be $400 per lane-mile ($250/lane-km) for profiling the length directed by the Engineer.

6. Perform nuclear gauge moisture and density tests according to Materials I.M. 504 within 24 hours of completing each lot at locations determined by the Engineer. During each lot of CIR production, furnish a 40 pound (18 kg) sample of loose CIR mixture, sealed in plastic, from a location the Engineer determines. Each day, deliver the sample as soon as possible after sampling to the District Materials Laboratory for density determination. The Quality Index for density does not apply. Recompact sublots that do not achieve the minimum required density. Recompact them within 2 calendar days after the CIR layer was placed to meet the target density.

2318.04 METHOD OF MEASUREMENT.

Measurement will be as follows:

A. Cold In-Place Recycled Asphalt Pavement.
Square yards (square meters) computed from the measured longitudinal length of pavement and the width of pavement specified in the contract documents.

B. Asphalt Stabilizing Agent.
Gallons (liters) at 60°F (15°C) for standard emulsion, or tons (megagrams) for asphalt binder, through a calibrated pump used for metering the total delivery of the agent or through delivery ticket quantity.

2318.05 BASIS OF PAYMENT.

Payment will be the contract unit price as follows:

A. Cold In-Place Recycled Asphalt Pavement.

1. Per square yard (square meter) for Cold In-Place Recycled Asphalt Pavement.

2. Payment is full compensation for all labor, material (including mixing water), and equipment necessary for:
- Obtaining and delivering bulk sample for mix design,
- Quality control, and
- Milling, mixing, spreading, placing, shaping, and compaction of the completed Cold In-Place Recycled Asphalt Pavement.

B. Asphalt Stabilizing Agent.

1. Per gallon (liter) or ton (megagram) for Asphalt Stabilizing Agent.

2. Payment is full compensation for all labor, materials, and equipment necessary for furnishing the stabilizing agent.

Section 2319. Slurry Leveling, Slurry Wedge, and Strip Slurry Treatment

2319.01 DESCRIPTION.

Evenly spread a properly proportioned mixture of emulsified asphalt, mineral aggregate, and water on a prepared surface as specified in the contract documents. When crack cleaning and filling is a part of this work, that work will be covered by a separate specification.

A. Slurry Leveling: use fine slurry mixtures to fill shallow depressions in the pavement and adjacent to cracks.

B. Slurry Wedge (Edge Rut Treatment): place a fine or coarse slurry mixture in a narrow wedge-shaped strip to correct the differential elevation between the pavement edge and the shoulder, as designated in the contract documents.

C. Strip Slurry Treatment: longitudinal applications of fine or coarse slurry mixtures as designated in the contract documents.

2319.02 MATERIALS.

A. Asphalt Emulsion.
Use a Grade CSS-1H or SS-1H emulsified asphalt meeting the requirements of Section 4140.

B. Aggregate.
Use a mineral aggregate consisting of crushed stone or a combination of crushed stone and mineral filler meeting the below requirements. The use of other crushed aggregates will be allowed when the Engineer approves. This may require the addition of an approved anti-strip additive to the slurry mixture.

1. **Crushed Stone.**
Use crushed aggregates meeting the requirements of Section 4124.

2. **Mineral Filler.**
Mineral filler may be required to obtain the desired mixture consistency and the addition rate will be established by the Engineer, based on laboratory or field trials. Use mineral filler meeting the requirements for Type I Portland Cement.

3. **Gradation.**
Use composite aggregate, excluding mineral filler, that complies with the following gradation limits for the specified slurry mixture required:

a. Fine Slurry Mixture.
Use aggregate meeting the requirements for Gradation No. 22 of the Aggregate Gradation Table in Section 4109.

b. Coarse Slurry Mixture.
Use aggregate meeting the requirements for Gradation No. 23 of the Aggregate Gradation Table in Section 4109.

C. Water.
Use fresh water which is free of sediment and salt contaminants. If the water is not compatible with the slurry mixture, the Contractor may be required to use water from another source.

2319.03 CONSTRUCTION.

A. Slurry Mixture

1. Composition and Quality of Mixture.

a. Aggregate proposed for use on the project will be sampled by representatives of the Contracting Authority to determine a job-mix formula. After consulting with the Contractor, the Engineer will establish a job-mix formula for the mixture on the basis of gradation, asphalt content, durability, stability, and asphalt compatibility. This formula remains in effect until modified in writing by the Engineer. When noncomplying results or other unsatisfactory conditions make it necessary, the Engineer will establish a new job-mix formula, after consulting with the Contractor. Should a change in sources of materials be made, set a job-mix formula before the new material is used.

b. Provide the Engineer with a copy of the certified gradations of aggregate proposed for use.

2. Asphalt Binder Content.
Requirements:

a. Estimated asphalt residue content: 7% to 14% of the dry weight (mass) of the aggregate.

b. Mixture design film thickness: 7.5 microns (190 μm) (target value) with a ± 0.75 microns (29 μm) permissible range.

B. Handling and Sampling Slurry Materials.

1. Stockpiling of Aggregate.

a. Take precautions to prevent stockpile contamination with oversized rock, clay, silt, or moisture in excess of that which would interfere with the amount of asphalt emulsion required in producing the desired homogeneous slurry mixture.

b. Place the stockpile in a well drained area. Do not allow the aggregate to become segregated.

c. Control the moisture in the aggregate to be within ± 1.5% of the moisture content of the aggregate at the time of calibration.

2. Storage.

a. Provide suitable storage facilities for the asphalt emulsion. Use a container equipped to prevent water from entering the emulsion.

b. Provide suitable and adequate heat to prevent freezing and to facilitate handling of the asphalt emulsion.

3. Sampling.
Furnish samples of materials during the process of the work as directed by the Engineer.

C. Equipment.
Obtain the Engineer's approval for all equipment, tools, and machines and maintain in satisfactory working order at all times.

1. Slurry Mixing Equipment.

a. Use a continuous flow mixing unit capable of:
- Accurately delivering a predetermined proportion of aggregate, water, and asphalt emulsion to the mixing chamber, and
- Discharging the thoroughly mixed product on a continuous basis.

b. Pre-wet the aggregate immediately prior to mixing with the emulsion. Use a pugmill capable of thoroughly blending all ingredients together.

c. Use a mixing machine equipped with an approved fines feeder that provides an accurate metering device, or method, to introduce a predetermined proportion of mineral filler into the mixer at the same time and location that the aggregate is fed. Use a fines feeder to add mineral filler when required as part of the aggregate blend.

d. Use an aggregate feed to the mixer equipped with a revolution counter or similar device so the amount of aggregate used may be determined at any time.

e. Use a positive displacement type emulsion pump equipped with a revolution counter or similar device so that the amount of emulsion used may be determined at any time.

f. For adding water to the mixer, use a pump equipped with a valve to establish the required water flow.

g. Mechanically tie all controls to ensure accurate proportioning of all materials at all times, including starts and stops. On some machines, this can be a simultaneous start and stop of all materials. On other machines, depending on where the materials are introduced into the mixing chamber, the feeds must be properly synchronized.

h. Use a one-lever or one-button operation with no means for the operator to adjust the mix proportions, except for the water.

i. Use revolution counters that count 0.1 revolutions on mechanisms which turn less than 100 rpm.

j. Attach a metering device to the slurry machine for the addition of additive to the mixture or any component material. Use a device that has positive, quick-acting controls, is easily calibrated, and maintains accurate and uniform flow.

k. Provide a means for calibrating the mixer. Calibrate and properly mark the controls for proportioning each material to be added to the mix. Use equipment with controls placed so they are readily accessible for calibration and so the Engineer may determine the amount of each material being used at any time. A minimum of

three aggregate gate settings will be required for calibration and, if changes in emulsion delivery are necessary, a minimum of three pump changes will be required.

I. Use a mixing machine that:

- Is equipped with a water pressure system and fog type spray bar adequate for complete fogging of the surface preceding spreading equipment,
- Is controllable to an application range of 0.05 gallon per square yard (0.25 L/m^2), and
- Provides sufficient machine storage capacity to properly mix and apply a minimum of 5 tons (4.5 Mg) of the slurry, except when the mixing machine is operated in a continuous manner and is supplied by separate nurse type equipment.

2. Slurry Spreading Equipment.

a. Slurry Wedge, Strip Slurry Treatment.

1. Use a mixer machine with an attached mechanical type squeegee distributor equipped with flexible material in contact with the surface to prevent loss of slurry from the distributor. Maintain the squeegee to prevent loss of slurry on varying grades and crown. Include a steering device and a flexible strike off.

2. Use a spreader box capable of placing the slurry mixture to the width specified in the contract documents. Use a spreader box equipped with vertical adjustment devices attached to horizontal support devices (such as runners) located a minimum of 6 inches (150 mm) inside both ends at the side of the box. This is to ensure uniform distribution on varying grades and crowns. Use vertical adjustment devices of sufficient weight (mass) to keep the horizontal support devices in contact with the roadway surface during operation. Use flexible strike off material of sufficient stiffness to produce the desired texture and rate of application.

3. Keep the spreader box clean. Do not allow build up of asphalt and aggregate on the box.

b. Slurry Leveling.

Use metal lutes of varying widths for spreading the slurry mixture in the depressed areas. Ensure the face of each lute is indented (arched) slightly (1/8 inch to 3/16 inch (3 mm to 5 mm)) to aid in controlling the spread. The Contractor may contact the Office of Maintenance Operations concerning design of these lutes.

3. Cleaning Equipment.

Use power brooms, power blowers, air compressors, water flushing equipment, or hand brooms for cleaning the surface and cracks.

4. Auxiliary Equipment.

Furnish hand squeegees, shovels, and other equipment as necessary to perform the work.

5. **Screening Unit.**
Use a screening unit to remove objectionable oversize and foreign material that may be encountered. Screen material before loading the slurry machine and/or weighing for payment.

D. Preparation of Surface.

1. Clean all loose material, soil tracked on the roadway surface, vegetation, and other objectionable material from the surface and cracks immediately prior to applying the slurry material. Clean cracks to a depth of 1 inch (25 mm) if they have not been completely filled prior to applying the slurry treatment.

2. Any standard cleaning method used to clean pavements, such as power brooms, compressed air, high-pressure water, and hand tools will be acceptable.

3. Water flushing will not be permitted in areas where considerable cracks are present in the pavement surface.

4. Obtain the Engineer's approval for surface preparation.

E. Tack Coat.

1. After surface preparation, tack coat the surface using a diluted emulsion of the same type and grade used in the slurry mixture. Dilute the emulsion (3 parts water to 1 part emulsion) and apply to the surface at a rate between 0.05 to 0.10 gallon per square yard (0.25 L/m^2 to 0.45 L/m^2).

2. Obtain the Engineer's approval for the rate of application used.

3. Apply the tack coat the same day as the slurry seal.

F. Composition Rate and Application of the Slurry Mix.

1. Blend the amount of asphalt emulsion with the aggregate as determined by the laboratory mix design and after final adjustment.

2. Water may be added as necessary to obtain a fluid and homogeneous mixture.

3. Obtain the Engineer's approval for the mixture design application methods and rate of application.

G. Application of the Slurry Material.

1. **General.**
   a. The Engineer may direct that the surface of the pavement be fogged with water, approximately 0.05 gallon per square yard (0.25 L/m^2), immediately preceding the pass of the spreader. Ensure the mixture is of a consistency such that it "rolls" in the spreader in a

continuous mass. Slurry that segregates in the spreader box so that flowing of liquids (water and emulsion) is evident is not acceptable, so do not apply to the surface.

b. Do not allow the total time for mixing aggregate and emulsion to exceed 4 minutes. Ensure a sufficient amount of slurry is present in the spreader at all times to ensure that complete coverage is obtained. Lumping, balling, or unmixed aggregate will not be permitted. Do not allow emulsion and aggregate fines to become segregated from the coarse aggregate. If the coarse aggregate settles to the bottom of the mix, remove the slurry from the pavement.

c. Keep breaking of the emulsion in the spreader box to a minimum to allow for a uniform distribution of the slurry mixture on the pavement. Do not leave streaks, such as those caused by over-sized aggregate, in the finished surfaces.

d. Apply Strip Slurry Treatment parallel to the center line, edge line, or other reference using a guide extending at least 3 feet (1 m) ahead of the application equipment.

e. A mechanical device, such as an auger, may be used to distribute the slurry in the spreader box. The use of a mechanical device in the slurry distribution box for strip slurry treatment and slurry wedge application will generally not be required. The contract documents will state if a mechanical device is required.

2. Mix Consistency.

a. To obtain a workable mix consistency and to eliminate overwatering, test the mix consistency according to Iowa Test Method 508, using Procedure B.2, Slurry Flow Test. The Engineer will determine the maximum flow for each slurry mixture.

b. Once the maximum flow has been established, remove all slurry mix from the roadway that is found to exceed this maximum and replace with an approved mixture, at no additional cost to the Contracting Authority.

c. Testing for consistency will be at the Engineer's discretion. The Engineer will inform the Contractor of the boundaries represented by the test sample when a change in the mixture is apparent.

3. Joints.

a. Excessive build-up or unsightly appearance will not be permitted on longitudinal or transverse joints. Obtain the Engineer’s approval for the use of burlap drags or other types of drags.

b. A stringline will be required to obtain a neat appearing, straight line, longitudinal alignment. The Engineer will establish reference points. Set, follow, maintain, and remove the stringline. The stringline may be referenced to the mixing machine or the spreader box.

4. Hand Work.

Use approved squeegees to spread slurry in areas inaccessible to the slurry mixer. Do not leave an unsightly appearance from hand work.

5. **Curing and Opening to Traffic.**
   a. Allow the treated area to cure until it may be opened to traffic without pick-up or raveling of the slurry mixture.
   b. Repair any damage caused to the slurry surface by premature opening to traffic at no additional cost to the Contracting Authority.

6. **Application of Slurry Leveling.**
   a. Ensure the surface to which the slurry leveling is to be applied is moist and clean of dust and foreign material. Scraping and brooming may be necessary.
   b. Spread the slurry leveling mixture in depressions at and adjacent to cracks in the pavement. Spread to the full width of the depression. Level the slurry with a metal lute of the proper width to provide a smooth riding surface. Ensure the slurry leveling is neat in appearance. Do not allow spillage around and between leveled areas. Keep excess material at the pavement edge to a minimum. Scatter excess material across the adjacent shoulder.
   c. Allow the slurry leveling to cure until such time as the area may be open to traffic without pick-up or raveling of the leveling mixture.
   d. Ensure the cured slurry has a homogeneous appearance and a uniform texture, fills all cracks in the application area, and adheres to the surface.

H. Limitations.

1. Schedule slurry placement to ensure the traffic lanes are opened to traffic 30 minutes before sundown of the same working day. When traffic is maintained, keep the entire roadbed free of construction equipment during non-working hours.

2. Work will not be permitted on days described in Article 1108.03.

3. Do not place slurry mixture when the temperature on a shaded portion of the road is less than 50°F (10°C). Do not place slurry mixture after October 1 without written permission from the Engineer.

4. When this work is done in conjunction with crack cleaning and filling, clean and fill cracks before performing slurry work. The application of slurry and the crack cleaning and filling activity may be done as one coordinated operation.

5. When placing a strip slurry treatment, both edges of the slurry box must run on the pavement surface. Replace all pavement markings the day they are obliterated. Payment for pavement markings will be at contract unit price for this work.

6. When the installation of strip slurry treatment is required at a pavement centerline or lane line, the Engineer may require such placement in two separate applications.

7. When performing slurry wedge placement, one edge of the slurry box must run on the edge of the pavement surface. Do not allow this work to

obliterate the pavement edge line. Replace all obliterated pavement markings the day they are obliterated and at no additional cost to the Contracting Authority.

I. Maintenance of Traffic.

1. Maintain Traffic Control according to the contract documents.

2. Repair damage to uncured slurry due to traffic at no additional cost to the Contracting Authority.

2319.04 METHOD OF MEASUREMENT.

Measurement will be as described below. Materials used for calibration purposes will be included in quantities measured for payment. These amounts are not to exceed 5 tons (5 Mg) of aggregate and 100 gallons (400 L) of asphalt emulsion.

A. Slurry Leveling.
Computed from the number of centerline miles (kilometers), measured to the nearest 0.1 mile (0.1 km), of slurry leveling based on the two-lane pavement width which exists in the limits of the work area. Application of slurry leveling work to auxiliary lanes within the limits of the project will not be measured for payment.

B. Slurry Wedge.

1. Slurry Wedge Aggregate.
- **a.** Tons (megagrams) of the type specified, measured to the nearest 0.1 ton (0.1 Mg), will be the quantity by weight (mass) of individual loads of aggregate used in accepted portions of the work.
- **b.** Deduction will not be made for moisture naturally occurring in the aggregate.
- **c.** The quantity of mineral filler will be included with the aggregate quantity.

2. Surface Preparation for Slurry Wedge.
Shoulder miles (kilometers) measured to the nearest 0.1 mile (0.1 km).

C. Strip Slurry Treatment.

1. Aggregate for Strip Slurry Treatment.
- **a.** Tons (megagrams) of the type specified, measured to the nearest 0.1 ton (0.1 Mg), will be the quantity by weight (mass) of individual loads of aggregate used in accepted portions of the work.
- **b.** Deduction will not be made for moisture naturally occurring in the aggregate.
- **c.** The quantity of mineral filler will be included with the aggregate quantity.

2. Surface Preparation for Strip Slurry Treatment.
Miles (kilometers) placed.

D. Asphalt Emulsion for Slurry Leveling, Slurry Wedge, and Slurry Treatment.

1. Gallons (liters). This volume will be computed using a calibrated tank stick or by the weight (mass) of asphalt emulsion used.

2. No deduction will be made for water in approved emulsion.

3. The gallons (liters) will be corrected for temperature to 60°F (16°C).

E. Tack Coat for Slurry Wedge and Strip Slurry Treatment.
The undiluted asphalt emulsion used for tack coat is incidental to asphalt emulsion, and will not be measured separately for payment.

2319.05 BASIS OF PAYMENT.

Payment will be the contract unit price as follows:

A. Slurry Leveling.

1. Per mile (kilometer).

2. Payment is full compensation for furnishing all the materials for the slurry mixture except the asphalt emulsion. It includes surface preparation, mixing, placing the mixture, and furnishing all equipment, tools, and labor.

B. Slurry Wedge.

1. Slurry Wedge Aggregate.
a. Per ton (megagram) of aggregate of the type specified used measured as provided above.
b. Payment is full compensation for furnishing all materials except the asphalt emulsion and tack coat. It includes all equipment and labor necessary to mix and apply the slurry.

2. Surface Preparation for Slurry Wedge.
Per mile (kilometer) for the number of miles (kilometers) of surface preparation satisfactorily completed.

C. Strip Slurry Treatment.

1. Aggregate for Strip Slurry Treatment.
a. Per ton (megagram) of aggregate of the type specified used measured as provided above.
b. Payment is full compensation for furnishing all materials except asphalt emulsion and tack coat. It includes all equipment and labor necessary to mix and apply the slurry.

2. Surface Preparation for Strip Slurry Treatment.
Per mile (kilometer) for the number of miles (kilometers) of surface preparation satisfactorily completed.

D. Asphalt Emulsion for Slurry Leveling, Slurry Wedge, and Slurry Treatment.

1. Per gallon (liter) for the number of gallons (liters) of asphalt emulsion used, measured as provided above.

2. Payment is full compensation for furnishing the asphalt emulsion.

E. Tack Coat for Slurry Wedge and Strip Slurry Treatment.
The undiluted asphalt emulsion used for tack coat is incidental to asphalt emulsion and the cost is to be included in the contract unit price for asphalt emulsion.