Section 602. CONCRETE PAVEMENT CONSTRUCTION

602.01. Description. This work consists of constructing a jointed portland cement concrete pavement, unbonded concrete overlay, base course, or shoulder, with or without reinforcement. This work also includes submitting a concrete quality control plan in accordance with section 604 before beginning concrete production.

A. Classification. The term "pavement", as used in these specifications, may include the following:

Concrete Pavement. Concrete placed for mainline pavement, multiple lane ramps, and collector-distributor roadways. Typical sections consist of standard widths and of lengths conducive to production paving.

Concrete Overlay. Concrete pavement placed on an existing pavement section. Typical sections consist of standard widths and of lengths conducive to production paving.

Miscellaneous Concrete Pavement and Miscellaneous Concrete Overlay. Concrete placed for single lane ramps, acceleration/deceleration lanes, approaches, and intersections, and pavement gaps. Typical sections consist of variable widths and limited lengths not conducive to production paving.

Temporary Concrete Pavement. Concrete pavements constructed for temporary duration.

Concrete Pavement with Integral Curb. Pavement and curb constructed monolithically.

Concrete Base Course. Concrete pavement that will be surfaced with hot mix asphalt (HMA) or concrete overlay.

Concrete Shoulders. Concrete pavements placed as shoulders.

602.02. Materials. Provide materials in accordance with the following:

Concrete, Grades P1, P1M, P2 ............................................................ 601
Curing Materials .................................................................................. 903
Epoxy Coated Lane Ties .................................................................... 905
Steel Reinforcement ................................................................. 905
Bond Breaker Material ...................................................................... 914
Joint Materials ................................................................................... 914

Provide Grade P1 or Grade P1M for concrete pavement, miscellaneous concrete pavement, concrete overlay, and miscellaneous concrete overlay.
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Provide Grade P1, Grade P1M, or Grade P2 for concrete base course, concrete shoulders, and temporary concrete pavement.

The Engineer may approve Grade P1M for other applications.

Where concrete shoulders are cast monolithically with concrete pavement, provide the grade required for the concrete pavement.

Provide curing compounds in accordance with the following:

A. Transparent curing compound for base course concrete;
B. White or transparent curing compound for temporary concrete pavement; and
C. White curing compound for other pavement, shoulders, and curb surfaces.

Install epoxy coated lane ties or deformed bars in accordance with Standard Plan R-41 Series. For epoxy coated load transfer dowels delivered without the bond-breaking coating, submit written certification to the Engineer. Include the specification designation of the asphalt or equivalent material for the coating and certify that the material conforms to specification requirements.

602.03. Construction.

A. Equipment. Provide and maintain equipment necessary to complete the work.

1. **Fixed Forms and Back-Up Rails.** If paving with fixed forms, use back-up rails attached to the forms to raise equipment wheel flanges clear of previously cast pavement.

   Provide metal forms with section rigidity to support the paving.

   Use flexible or standard steel forms with flexible liners where the radius of the curve is less than 150 feet, except where temporary concrete pavement is required.

2. **Compactor.** Use mechanical compactors for constructing aggregate base under the concrete pavement.

3. **Concrete Spreader.** Use a Department-approved device to spread and strike off each layer of concrete and to finish the top layer of concrete. Provide a spreader with a weight and rigidity to strike off the concrete to the required grade and profile.

4. **Dowel Bar Inserter (DBI).** The Engineer may allow the use of a DBI in lieu of load transfer assemblies. Use a Department-approved mechanical DBI that automatically installs load transfer bars at the required depth and consolidates the surrounding concrete.
5. **Lane-Tie Installer.** Use a Department-approved manual or mechanical method for installing lane-ties.

6. **Reinforcement Bridge.** For reinforcement not placed on chairs or mechanically lifted off the grade, transfer the reinforcement from the hauling equipment to a movable bridge that spans the newly cast pavement. Provide a bridge that can carry the reinforcement load without deflecting the form or rutting the track line.

7. **Internal Vibrator.** Use mechanical internal vibrators, set in accordance with the manufacturer’s specifications, which provide concrete consolidation for a radius of 1 foot around the vibrator head.

   Provide a device to monitor the rate of vibration for each concrete vibrator. Verify that all vibrators are operating properly, each day prior to paving and periodically during daily paving operations. Replace any defective vibrators immediately. Connect the vibrators to start automatically with the forward movement of the equipment and stop automatically when the forward movement stops. Space and operate vibrators as recommended by the manufacturer.

8. **Floating and Finishing Equipment.** Shape, screed, and float the concrete to form a dense, homogeneous pavement, requiring only minimum hand finishing.

   Provide hand floats and 10-foot straightedges, rigid and free of warping. Provide handles with a length that will allow finishing half the width of the newly placed pavement. Provide box or channel hand floats with a floating face at least 6 inches wide.

   The Contractor may use a roller screed or other manual or semi-automated finishing equipment for one lane-width pavements. The Engineer may approve the use of a roller screed for wider pavements if the Contractor demonstrates methods and equipment are in accordance with subsection 602.03.A.3 and subsection 602.03.A.6.

9. **Straightedges for Testing Surface Smoothness.** Provide two 5-foot straightedges and one 10-foot straightedge, rigid and free from warping, for the Engineer’s use.

10. **Stencils.** Provide a template device for imprinting the pavement. Provide numerals that are 3 inches to 4 inches high and at least ¼ inch deep.

11. **Foot Bridges.** Provide at least one moveable bridge for use in finishing the pavement, installing monument boxes, performing wet checks, and crossing the pavement. Foot bridges spanning slab
widths of at least 16 feet must be equipped with wheels, unless they are an integral part of the paving equipment. Design and construct foot bridges to prevent contact with the concrete.

12. **Membrane Sprayer.** Use mechanical equipment to apply curing compound to exposed pavement surfaces. Provide fully atomizing, self-contained spray equipment that is self-supported on wheels or tracks located outside the newly placed pavement. Provide continuous stirring of the compound during application. Apply a continuous uniform film of curing compound to exposed concrete surfaces.

The Engineer may approve hand spraying equipment for small and irregular shapes of new concrete pavement. Ensure the sprayer is capable of applying a uniform film of atomized curing compound at the required rate.

Inspect curing compound application equipment before starting daily production to ensure its ability to apply the curing compound, as required.

13. **Concrete Saws.** Use a concrete saw for the required application and as recommended by the manufacturer.

14. **Joint Sealing Equipment.** For hot-poured rubber-asphalt type joint sealing compound, provide an indirect or double-boiler heating kettle, using oil as the heat transfer medium. Provide a thermostatically controlled heat source, built-in automatic agitator, and thermometers to show the temperature of the melted sealing material and the oil bath. The Engineer may require a demonstration that the equipment will consistently produce a joint sealant of required pouring consistency.

   Equip the kettle with a pressure pump, hose, and nozzle that can place the joint sealant to the full depth of the joint and completely fill the joint. Do not use direct flame heat on the nozzle.

B. **Base Preparation.** Construct and maintain the base to the required line, grade, and cross section, in accordance with subsection 302.03 before pavement placement. Prepare the base and allow the Engineer to test and accept the base before setting forms or slip-form paving.

Ensure that the paving equipment will maintain the grade tolerance specified for the pavement. Shape and finish the base in accordance with subsection 302.03. If the prepared base is damaged by construction equipment, reconstruct the grade and cross section, as
directed by the Engineer, before placing the concrete, at no additional cost to the Department.

C. Placing Forms. Trim the compacted base close to the staked grade using base preparation equipment. Check the base for line and grade, and correct irregularities before placing the forms. Compact the base outside the area to be paved, to support the forms.

Set forms and provide time for the Engineer to check them before placing concrete. Provide uniform bearing of the forms directly on the base throughout their length and width. Securely join, lock, and stake each form segment. During paving, do not allow vertical movement to exceed \( \frac{1}{8} \) inch, and horizontal movement to exceed \( \frac{1}{4} \) inch. Brace flexible forms to prevent movement during concrete placement.

After the forms are set and cleaned of hardened concrete or mortar, the Engineer will check them. If requested by the Engineer, fabricate string lines for checking line and grade. Adjust form lines that vary from the staked line by more than \( \frac{1}{8} \) inch, or from the staked grade by more than \( \frac{1}{8} \) inch.

Treat the inside of all forms with a release agent that will not discolor or adversely affect the concrete. Do not allow the release agent to come in contact with steel reinforcement, lane ties, or existing concrete surfaces.

D. Placing Concrete. Set structure castings to grade and alignment before, or during, concrete placement. The Engineer will allow the boxing-out method for concrete base course and temporary concrete pavement. Clean structure castings to allow adhesion of the concrete.

Place concrete on a moist base. Do not place concrete on a frozen base, or an unstable base caused by excessive moisture.

Keep the top of the forms clean and free of concrete during placing and finishing.

Inspect vertical surfaces of previously placed concrete and the adjacent grade, and remove material that would prevent the adjoining concrete pour from consolidating or conforming to the plan dimensions. Before placing an adjoining pavement, inspect the open-graded base for contamination from fines or debris. If the Engineer determines that contamination requires removal or replacement, remove and replace at no additional cost to the Department.

Where pavement is constructed on a base that could sustain damage from hauling units, mechanically transfer the concrete from the hauling units to the grade. Provide transfer equipment that is self contained, and
self supported, with wheels or tracks located outside the base for the concrete pavement.

Spread and strike off the concrete as soon as it is deposited on the base. Avoid segregation. Consolidate the concrete along the faces of fixed or sliding forms and next to transverse dowel bar assemblies with internal vibrators.

Where using the slip form method, vibrate concrete for the full width and depth of the pavement. Where placing the concrete in two layers, the consolidation may occur after placing the top layer.

Continually monitor the operation of vibrators mounted on the paving machine. Do not commence with paving until the Engineer has documentation that vibrators are operating in accordance with the manufacturer's specifications. If a vibrator malfunctions during paving, discontinue paving operations and correct the malfunction. Resume paving when malfunctions are corrected and the Engineer approves.

Cease vibration and tamping when the paving equipment stops.

Provide labor, materials, and equipment to ensure continuity of the paving operation. The Engineer may stop production if there is not sufficient equipment or labor to keep pace with the other paving operations. Where placing the concrete in two layers, place the top layer of concrete within 30 minutes of placing the bottom layer. For unavoidable interruptions of concrete placement, for longer than 30 minutes, place a transverse, end-of-pour joint, Symbol H.

Operate equipment to prevent damage to pavements and bridge decks and to maintain the required grade in transitioning from the pavement to the deck.

Do not allow vehicles or equipment, other than joint saws or ride quality measurement equipment, on new pavement, or portions of new pavement, until the concrete reaches a strength in accordance with subsection 104.11.

Keep existing pavements clean of materials that may interfere with finishing operations or cause damage to the concrete surface.

Where placing slip form pavement in two layers, the first layer may be cast from 3 inches to 6 inches narrower, on each side, than the width of the proposed pavement slab. Ensure the gaps on each side are at least twice the largest dimension of the concrete aggregate. Cast full depth pavement at the edges with the second layer.
Finish concrete placed each day during daylight, unless required artificial light is provided. Provide artificial light at no additional cost to the Department.

To maintain cross-traffic, provide gaps in the concrete pavement or place temporary bridges or pavement crossings in accordance with section 812 and as approved by the Engineer.

E. **Placing Pavement Reinforcement.** Place the reinforcement from a reinforcement bridge, or by other Department-approved methods that will not contaminate the concrete. Place reinforcement that is free of loose rust and other contaminants.

F. **Constructing Joints.**

1. **Longitudinal Lane Tie Joints with Straight Tie Bars (Symbol D and Symbol S).** Place tie bars at the required depth, parallel to the finished surface, at right angles to the joint, and at the spacing shown on the plans. Install lane tie bars, except in temporary concrete pavement, using Department-approved chairs or mechanical devices. Do not place lane tie bars in the concrete by hand methods.

   The Engineer will not require installation of lane tie bars and the sawing of joints for temporary concrete pavement, unless otherwise required by the contract.

   Pull-out resistance testing is not required for Symbol S joints.

2. **Longitudinal Bulkhead Joints (Symbol B).** Install epoxy coated bent bars parallel to the surface of the pavement and at right angles to the edge of the pavement. Install the bent bars to allow consolidation around the bars without causing concrete slumping at the edges. Straighten bent tie bars after the concrete has gained required strength. Straighten tie bars to run parallel to the surface of the pavement and perpendicular to the edge of the pavement. Ensure the epoxy coating is not torn or loosened within 6 inches of the joint face. Repair tears or loosening of the epoxy coating within 6 inches of the joint face using the coating material recommended by the coating manufacturer.

   Space and install lane ties to meet the pull-out resistance shown in Table 602-1. If the test results on the ties from the first day of placement meet the requirements of Table 602-1, the Engineer will determine the need for additional testing.

   If the average pull-out resistance is less than the minimum requirements in Table 602-1, install additional epoxy-anchored lane...
ties in accordance with Standard Plan R-41 Series, at no additional cost to the Department. Do not place adjacent pavement until the Engineer tests the additional lane ties.

The Engineer may waive verification tests for projects with less than 1,000 feet of longitudinal bulkhead joints.

<table>
<thead>
<tr>
<th>Table 602-1 Lane Tie Pull-Out Resistance</th>
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<tbody>
<tr>
<td>Distance From Joint Being Constructed to Nearest Free Edge of Completed Pavement (a)</td>
</tr>
<tr>
<td>≤12 ft</td>
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<tr>
<td>&gt;12 ft – 16 ft</td>
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<tr>
<td>&gt;16 ft – 23 ft</td>
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<tr>
<td>&gt;23 ft – 27 ft</td>
</tr>
<tr>
<td>&gt;27 ft – 35 ft</td>
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<tr>
<td>&gt;35 ft</td>
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a. Includes combinations of tied lane widths, valley gutter, curb and gutter, or concrete shoulder.
b. Slippage must not exceed 1/16 in.
c. Refer to Section D7 of the Materials Quality Assurance Manual for inspection procedure
d. As directed by the Engineer

3. **Transverse Joints.** Saw transverse contraction and expansion joints in accordance with subsection 602.03.N. Construct transverse plane-of-weakness joints in pavements without load transfer bars as shown on the plans.

Where placing pavement in partial-width slabs, place transverse joints in line with like joints in the adjacent slab. Where widening existing pavements, place transverse joints in line with like joints in the existing pavement and in line with "working" cracks that function as joints, if directed by the Engineer.

Provide load transfer assemblies manufactured in accordance with the Standard Plans. The Engineer will reject nonconforming load transfer assemblies. Stake the load transfer assemblies in place. Do not cut the shipping tie wires. Allow time for the Engineer to check the assemblies for condition, line, and grade before placing concrete. Permanently mark dowel bar locations on the vertical face of the plastic concrete pavement to accurately identify and locate joints for subsequent sawing.

For expansion joints, equip the free end of the bar with a close-fitting, Department-approved cap.
Where using more than one section of premolded joint filler in a joint, tightly butt the sections together. Place the bottom edge of the premolded filler in contact with the base and the top edge at the required depth below the surface of the pavement. Place the expansion joint filler perpendicular to the surface and the centerline of the pavement.

Construct an end-of-pour joint (Symbol H) if at least seven days will elapse between casting adjacent pours. If operations will resume before seven days, construct the joint at a contraction or expansion joint. Locate and form the joint by placing a bulkhead in the center of the load transfer device.

If using a Dowel Bar Inserter (DBI) to install load transfer bars, space the bars in accordance with Standard Plan R-40 Series for DBIs. Place and consolidate the pavement full-depth before inserting the dowel bars. Permanently mark dowel bar locations on the vertical face of the plastic concrete pavement for accurate identification and location of joints for subsequent sawing.

Insert dowel bars into the full-depth plastic concrete, and consolidate the concrete around the dowel bars, leaving no voids. Do not use hand-held vibrators. Align dowel bars in the vertical and horizontal planes to within ¼ inch for the entire length of the bar. Center dowels bars longitudinally within a tolerance of ±2 inches of the location of the transverse joint shown on the plans.

Verify the inserted dowels meet the required tolerances. The Engineer will witness these measurements. Provide documentation, if requested by the Engineer. Perform daily wet checks of the dowel bars as required by the concrete quality control plan. Mark and replace joints that are out of tolerance at no additional cost to the Department.

Locate the night header at the transverse joint location shown on the plans, or relocate if approved by the Engineer. Place a test joint beyond the night header. Saw the joint full-depth and remove for inspection of the dowel bar placement before restarting the concrete pavement operation. Install dowels in the night header by excavating into the plastic concrete or place them in drilled or preformed holes after removal of the test joint. If the Contractor uses a continuous paving operation that does not stop, the Engineer will establish the test joint location. The Engineer may waive the test joint requirements with documents showing three successive days of satisfactory performance.
G. **Screeding.** Screed and consolidate concrete pavement to achieve the final cross section shown on the plans. Use machine methods that avoid material segregation.

The Engineer may allow the use of manual methods for concrete pavement gaps less than 160 feet long and no greater than one lane width wide, or if the pavement is entirely concrete base course.

Do not use water to enhance finishing operations, unless otherwise directed by the Engineer. If the Engineer allows the use of water to enhance finishing operations, apply the water as a fog spray or fine mist.

H. **Finishing Surface.** Screed or extrude the finished surface to a smooth, sealed, and uniform appearance in accordance with the final cross section shown on the plans.

I. **Straightedge Testing, Surface Correction, and Edging.** While the concrete is still plastic, test the slab surface for compliance with the required grade and cross section using a 10-foot straightedge, or other method if approved by the Engineer.

If high or low spots exceed 1/8 inch over 10 feet, suspend paving operations and correct the finishing procedures. Correct high or low spots in pavements that exceed the tolerances and obtain the Engineer’s approval before resuming paving operation.

The Engineer will evaluate high or low spots, in hardened concrete, that exceed 1/8 inch over 10 feet, or 3/4 inch over 50 feet in accordance with subsection 104.04.

Correct edge settlement that exceeds 1/4 inch before the concrete hardens. Suspend paving if edge settlement exceeding 1/4 inch continues for at least 10 feet, and make corrections before resuming paving.

Do not leave overhanging projections on pavement edges, except on temporary concrete pavement.

Ensure the final elevation of drainage structure castings in accordance with this subsection. The Engineer will evaluate drainage structures not meeting the requirements of this subsection in accordance with subsection 104.04.

J. **Ride Quality.** Provide ride quality as required by the contract.

K. **Texturing.** When the pavement sets and will maintain a texture, drag the surface longitudinally using one or two layers of Department-approved damp fabric material. Maintain contact between the fabric and the concrete surface across the entire width of newly placed concrete.
Immediately after dragging, groove pavement surfaces, other than concrete base courses and shoulders. Unless otherwise shown on the plans, use a track machine to orient the grooves parallel to the longitudinal joint. Prevent noticeable wander, overlap, or wave pattern in the grooves. Ensure the groove edges do not exhibit slumping or severe tearing of the concrete surface. Place grooves with a width and depth of \( \frac{1}{4} \text{ inch} \pm \frac{1}{32} \text{ inch} \), spaced \( \frac{3}{4} \text{ inch} \pm \frac{1}{16} \text{ inch} \) on center. Do not texture the pavement surface within 1\( \frac{1}{2} \) inches of longitudinal joints. Provide a mean texture depth from 0.04 inch to 0.10 inch, in accordance with ASTM E 965.

For areas requiring turf-drag texturing, produce the texture by longitudinally dragging a Department-approved artificial turf material to produce a uniform pattern parallel to the centerline. Maintain continual and uniform contact with the plastic concrete over the entire area being textured. Periodically clean turf material to maintain uniform texture. Provide a mean texture depth at least 0.03 inch, in accordance with ASTM E 965.

For miscellaneous pavement, the Engineer will allow use of a manual texturing device with a texture rake at least the same width as the plastic concrete pavement.

In areas where the contract requires transverse texturing, orient the grooves perpendicular to the centerline and form the grooves in the plastic concrete. Do not allow the grooves to slump at the edges or severely tear the surface. Provide a surface texture consisting of \( \frac{1}{8} \) inch wide grooves spaced \( \frac{1}{2} \) inch on center, and \( \frac{1}{8} \) inch to \( \frac{1}{4} \) inch deep.

Texture the plastic concrete before applying curing compound. If the Engineer determines that the texturing operations are delaying the application of the curing compound, stop the texturing operation, and complete the application of curing compound.

If texturing is not complete before placing curing compound or if the pavement is not textured as required, complete the surface texturing of the hardened concrete, at no additional cost to the Department, after the pavement achieves the minimum required class design strength. Correct pavement surfaces by grooving the hardened concrete. Submit a corrective action plan, including collection and disposal of the residue from retexturing, for the Engineer's approval.

L. **Stenciling Pavement.** After texturing, stencil survey station numbers into the pavement surface. Stencil station numbers 16 inches from the edge of the pavement. Place numbers perpendicular to the centerline of the roadway, legible from a vehicle traveling in the direction
602.03

of traffic. On two-way roads, stencil station numbers to read in the direction of stationing.

Stencil the month, day, and year into the concrete pavement at the beginning and end of each day's pavement operation, near the edge of the slab opposite the edge used for stationing. Place the date so it can be read if facing in the direction of pavement placement.

Do not stencil concrete base courses and temporary pavements.

Mark underdrain outlets in concrete shoulders, in accordance with subsection 404.03.F. Stencil the marker into the concrete surface, after texturing.

M. Curing. Curing operation will take precedence over texturing in accordance with subsection 602.03.K.

Cure the concrete as soon as the free water leaves the surface of the pavement. Coat and seal the pavement surface and sides of slip-formed pavement with a uniform layer of membrane curing compound.

Apply one coat of curing compound on non-grooved surfaces and two coats on grooved surfaces. Apply at least 1 gallon per 25 square yards of surface for each coat. Apply the second coat after the first coat dries, but do not allow more than 2 hours between coats.

Maintain a thoroughly mixed compound in accordance with the manufacturer's recommendation. Do not thin curing compound.

For miscellaneous concrete pavement more than one lane wide, apply the compound from a foot bridge, if using a manually operated pressure-type sprayer.

Immediately reapply curing compound to surfaces damaged by rain, joint sawing, Contractor foot traffic, or other activities.

If fixed-forms are removed within the 7 day curing period, coat the sides of the pavement with curing compound immediately after removing the forms.

If using cold-weather protection during the curing period, curing compound may be omitted, if approved by the Engineer.

Repair or replace concrete showing injury or damage due to inadequate curing, at no additional cost to the Department.

N. Sawing Joints. Saw joints as shown on the Standard Plans. The Engineer will allow the use of a concrete saw on the pavement to saw the joints. The Engineer will not allow the water supply truck on the new
pavement until the pavement has attained the strength specified in subsection 104.11.

Immediately stop sawing operation if sawing causes raveling or spalling, and continue to monitor the concrete hardness before resuming sawing operation.

1. **Longitudinal Joints.** Saw Symbol D longitudinal joints. Start sawing operation after the concrete pavement hardens but before random cracks develop in the concrete pavement.

2. **Transverse Contraction and Expansion Joints.** Construct the joint groove in expansion joints as shown on the Standard Plans. Flush loose concrete and slurry from the groove and the immediate area.

   If the required seal is not installed within seven days of final sawing, temporarily seal the joint groove with a Department-approved material or device to prevent the infiltration of foreign material.

   Install either the permanent seal or a temporary seal before allowing vehicles to travel over the full width joint grooves.

   Saw joints in two stages, in accordance with the following:

   a. Place a relief cut directly over the center of the load transfer assembly or over the preformed joint filler. Make the relief cut after the concrete hardens and will not excessively ravel or spall, but before random cracks develop in the concrete pavement. Immediately stop sawing if sawing operation causes excessive raveling or spalling, and continue to monitor the concrete hardness before resuming sawing operations. Do not allow traffic over the expansion joint relief cuts.

   b. Center the joint groove over the relief cut. Adjust the groove width to compensate for change in the relief cut due to pavement contraction. Immediately stop sawing if sawing operation causes excessive raveling or spalling, and continue to monitor the concrete hardness before resuming sawing operations. Maintain the curing of the concrete near the joint, and if required, install the permanent joint sealant or place temporary cover material. Give second stage sawing of expansion joints priority over second stage contraction joint sawing, if higher pavement temperatures are forecast.

   If proposing an alternative method for sawing, submit a plan to the Engineer for approval. The Engineer will not allow spalling, raveling, and random cracks in the concrete pavement.
Repair raveling or spalling in accordance with subsection 602.03.P. Remove and replace random cracked panels as directed by the Engineer.

The standard plans will specify the location of the transverse joint in the pavement, shoulder, curb and gutter, valley gutter, or base course; if the joint requires a load transfer assembly, expansion joint filler, or both; and the type of sealant or seal required.

O. Coring Pavement. The Department will core for thickness and steel location in accordance with subsection 602.04. The Engineer will allow coring of the pavement for information on the day following casting, but will not test information-only cores. Information cores are for the Contractor's information only.

Prevent damage to the pavement by using portable, lightweight equipment. Extract cores with diameters no greater than 4 inches. The Engineer will allow no more than six cores per mile (one per slab), to monitor pavement thickness and steel location. Extract cores, fill core holes with fresh concrete, consolidate, and finish on the same day.

Reapply the curing compound on the pavement to core-hole locations.

P. Patching Transverse Joints. After sawing and cleaning the joints, inspect for spalls and voids. Remove loose, unsound, or damaged concrete as directed by the Engineer. Repair joints in concrete base course and temporary concrete pavement for intermediate and major spalls.

1. Minor Spalls. Minor spalls or voids are less than 36 square inches (length multiplied by width beyond joint face), and exceed the following limits:
   a. Spalls that extend more than ¼ inch from the joint face and over ½ inch below the surface of the pavement;
   b. Spalls that extend more than ¼ inch from the joint face and are at least 2 inches long, regardless of the depth; or
   c. Void areas with a diameter greater than ½ inch, in the upper 1 inch of the joint face, or greater than 1-inch diameter in any location.

Repair minor spalls by patching with a Department-approved epoxy mortar before installing the seal.

Sandblast or power wire brush the spalled concrete surface. The Engineer may allow hand wire brushing for limited amounts of patching. Blow the patch clean with a jet of oil-free compressed air. Insert a rigid polyethylene sheet, or other rigid material covered with
polyethylene film, into the joint groove and hold tightly against the joint face being patched.

Ensure clean and dry concrete at the time of the epoxy mortar placement. For concrete surfaces 32 °F or less, heat the surface to remove frost. Use a clean source of heat, preventing carbon deposits on the concrete. Heat gradually and evenly.

Use Type I epoxy binder for temperatures from 60 °F to 104 °F and Type II epoxy binder for temperatures from 36 °F to 60 °F, in accordance with subsection 914.05.

Mix two parts epoxy resin to one part curing agent, by volume, or in accordance with the epoxy manufacturer’s instruction. Unless using the entire contents of the original containers in one batch, use a mechanical volumetric dispensing device that dispenses each component with an accuracy within ±2 percent by volume. Obtain the Engineer’s approval of the dispenser.

Mix in a clean, metal or polyethylene vessel. Gradually add the curing agent to the epoxy resin, constantly stirring. Use a low-speed air or electrically driven mixer. Continue stirring for 2 minutes to 3 minutes to obtain a uniform mixture.

Mix the epoxy binder and retain a portion of the material for priming. Blend the dry masonry sand into the balance of the mixture, using 3½ parts dry sand, by volume, to 1 part mixed binder, to produce an epoxy mortar of stiff, but workable consistency.

Prime the spalled surface with the freshly mixed epoxy binder. Scrub the prime coat into the surface with a brush to ensure complete wetting and coverage of the spalled area. Immediately after priming, place the epoxy mortar in the spalled area and finish to the shape of the original pavement surface. If the initial bond coat loses tackiness, apply a second coat before placing the epoxy mortar. Form the edge of the patch to the adjacent joint groove. Sprinkle dry masonry sand onto the fresh epoxy mortar surface to eliminate gloss. Cure the epoxy mortar, and remove the polyethylene insert before sealing the joint.

2. **Intermediate Spalls.** Intermediate spalls are larger than 36 square inches and do not exceed either of the following:
   a. Extend below the reinforcement in reinforced pavement; or
   b. Greater than 4 inches deep in non-reinforced pavement.

Saw cut spalls parallel to the joint groove at the outer extremity of the spalled area. Cut at least 1 inch deep. Chip the concrete out to the
saw cut to form a vertical face at the back of the repair area. Cut the
two ends of the repair area to form vertical faces. Sandblast the
entire area to remove loose particles. Blow repair area clean with a
jet of oil-free compressed air to remove the sand and other loose
material. Flush the entire area with clean water. Remove excess
water with oil-free compressed air. Insert a rigid polyethylene sheet,
or other rigid material, covered with polyethylene film, into the joint
groove and hold tightly against the joint face being patched.

Prime the bottom and vertical faces of the repair area with Type R-1
gROUT with a creamy consistency. Scrub the prime coat into the
surface with a brush to ensure complete wetting and coverage of the
repair area and prevent pooling in the rough surfaces of the repair
area. Apply the prime coat immediately before placing the fresh
mortar.

Use a Type R-2 mortar with a stiff consistency, tamp into the primed
repair area, and finish flush with the pavement surface. Add a liquid
air-entraining admixture to maintain an air content from 8 percent to
11 percent. Make the edge of the patch at the joint face conform to
the rest of the joint groove. Spray white membrane curing
compound on the patch surface immediately after the mortar is
placed and finished. Remove the polyethylene form after 72 hours.

If a small number of intermediate spalls require patching, the
Engineer may approve the epoxy primer and mortar system used for
minor spalls in accordance with subsection 602.03.P.1, provided the
repair areas are saw cut and chipped as specified by this subsection
for intermediate spalls.

3. Major Spalls. Patch major spalls as directed by the Engineer.
Major spalls are those that exceed either of the following:
   a. Extend below the reinforcement in reinforced pavement; or
   b. Are greater than 4 inches deep in non-reinforced pavement.

Q. Repair of Longitudinal Joints and Edges. Patch spalls that occur
between adjacent lanes of concrete pavement in accordance with
subsection 602.03.P.1.

Where a concrete pavement abuts an HMA surface, patch spalls that
extend more than \( \frac{3}{4} \) inch from the joint face and more than \( \frac{1}{2} \) inch below
the surface of the pavement. If the cumulative total of spall lengths
exceeds 20 feet per mile of pavement joint, patch spalls less than \( \frac{3}{4} \) inch
from the joint face and more than \( \frac{3}{4} \) inch below the surface of the
pavement.
The Engineer will direct the repair of spalls greater than 36 square inches within 10 feet of longitudinal joint or edge. Remove and replace the pavement if directed by the Engineer, and at no additional cost to the Department.

R. Cleaning Joints. Clean joints, including the surface of the pavement next to the joint groove, with appropriate tools and equipment to remove slurry, stones, or other loose material.

Blast clean the faces of the joint that will contact the joint sealant, using a 1,500-psi to 3,000-psi water spray or a dry abrasive material. Allow joints to air-dry to the touch, with no visible signs of surface moisture, prior to placing joint sealant material.

Give joints a final cleaning with a jet of oil and water-free compressed air, with a pressure of at least 90 psi.

S. Sealing Joints. Seal longitudinal and transverse joints as shown on the plans.

The Engineer will not allow the use of artificial heat to dry joints before sealing.

Seal the joints immediately after cleaning. Ensure dry joint surfaces for sealing. Place sealant when the concrete temperature is at least 40 °F and rising without the use of artificial heat.

Melt sealant in a heating kettle; do not heat directly. Do not use sealants that are heated to more than the safe heating temperature recommended by the manufacturer.

Apply hot-poured joint sealant using a pressure applicator with a nozzle that extends into the groove. Remove sealant from the surface of the pavement. Before allowing traffic over the sealed joint, cure the sealant to resist pickup.

T. Weather and Temperature Limitations.

1. Protection Against Rain. Protect the concrete pavement from damage by rain.

2. Protection from Cold Weather. Protect the concrete pavement from freezing until it attains a compressive strength of at least 1,000 psi. Remove and replace concrete slabs damaged by cold weather, as directed by the Engineer, and at no additional cost to the Department.

3. Cold Weather Limitations. Do not place concrete pavement until the ambient air temperature away from artificial heat is at least 25 °F
and rising, unless otherwise approved by the Engineer. Do not place concrete pavement if portions of the base, subbase, or subgrade layer are frozen, or if the grade exhibits poor stability from excessive moisture.

4. **Hot Weather Limitations.** Protect concrete pavement during hot weather as required by the concrete quality control plan. Protect the concrete pavement if the rate of evaporation is equal to or greater than 0.20 psf per hour, in accordance with Figure 706-1.

Provide equipment, approved by the Engineer, for determining the relative humidity and wind velocity at the concrete pavement site.

5. **Concrete Temperature Limitations.** At the time of concrete placement, ensure a concrete temperature from 45 °F to 90 °F.

### 602.04. Measurement and Payment.

<table>
<thead>
<tr>
<th>Pay Item</th>
<th>Pay Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conc Pavt, Reinf, __ inch</td>
<td>Square Yard</td>
</tr>
<tr>
<td>Conc Pavt, Nonreinf, __ inch</td>
<td>Square Yard</td>
</tr>
<tr>
<td>Conc Pavt, Ovly, Furnishing and Placing</td>
<td>Cubic Yard</td>
</tr>
<tr>
<td>Conc Pavt, Ovly, Finishing and Curing</td>
<td>Square Yard</td>
</tr>
<tr>
<td>Conc Pavt with Integral Curb, Reinf, __ inch</td>
<td>Square Yard</td>
</tr>
<tr>
<td>Conc Pavt with Integral Curb, Nonreinf, __ inch</td>
<td>Square Yard</td>
</tr>
<tr>
<td>Conc Pavt, Misc, Reinf, __ inch</td>
<td>Square Yard</td>
</tr>
<tr>
<td>Conc Pavt, Misc, Nonreinf, __ inch</td>
<td>Square Yard</td>
</tr>
<tr>
<td>Conc Pavt, Ovly, Misc, Furnishing and Placing</td>
<td>Cubic Yard</td>
</tr>
<tr>
<td>Conc Pavt, Ovly, Misc, Finishing and Curing</td>
<td>Square Yard</td>
</tr>
<tr>
<td>Conc Pavt, Reinf, __ inch, Temp</td>
<td>Square Yard</td>
</tr>
<tr>
<td>Conc Pavt, Nonreinf, __ inch, Temp</td>
<td>Square Yard</td>
</tr>
<tr>
<td>Conc Base Cse, Reinf, __ inch</td>
<td>Square Yard</td>
</tr>
<tr>
<td>Conc Base Cse, Nonreinf, __ inch</td>
<td>Square Yard</td>
</tr>
<tr>
<td>Shoulder, Reinf Conc</td>
<td>Square Yard</td>
</tr>
<tr>
<td>Shoulder, Nonreinf Conc</td>
<td>Square Yard</td>
</tr>
<tr>
<td>Shoulder, Freeway</td>
<td>Square Yard</td>
</tr>
<tr>
<td>Joint, Contraction, (type)</td>
<td>Foot</td>
</tr>
<tr>
<td>Joint, Expansion, (type)</td>
<td>Foot</td>
</tr>
<tr>
<td>Joint, Plane-of-Weakness, (type)</td>
<td>Foot</td>
</tr>
<tr>
<td>Conc, Grade __</td>
<td>Cubic Yard</td>
</tr>
<tr>
<td>Pavt Gapping</td>
<td>Foot</td>
</tr>
</tbody>
</table>

A. **Concrete Pavement and Base Course.** The Engineer will measure, and the Department will pay for concrete pavement and base course by area, based on plan quantities in accordance with subsection 109.01. The Department will establish pay items based on the type of
pavement installed, the pavement thickness required, and whether reinforcement is required.

The Engineer will measure concrete pavement with integral curb by area, including the curbs.

The Engineer will measure transition areas between concrete valley gutter and concrete curb and gutter, and concrete valley gutter cast integrally with concrete pavement at the apex of gore areas, by dividing the area in half and measuring each half using the units of adjacent pay items.

The unit prices for other pavement and base course pay items include the cost of concrete headers abutting bridges and track crossings constructed by thickening the pavement.

The unit prices for Conc Pavt, Misc, Reinf and Conc Pavt, Misc, Nonreinf, of the thicknesses required, include the cost of additional concrete additives if concrete pavement for pavement gapping requires additives to meet minimum opening-to-traffic strength requirements.

B. Concrete Shoulder.

1. Shoulder, Reinforced Concrete and Shoulder, Non-reinforced Concrete. The Engineer will measure, and the Department will pay for Shoulder, Reinf Conc, and Shoulder, Nonreinf Conc by area, based on plan quantities in accordance with subsection 109.01.

2. Shoulder, Freeway. The Engineer will measure and the Department will pay for Shoulder, Freeway based on plan quantities in accordance with subsection 109.01. If the Contractor uses concrete for the shoulder, the unit price for Shoulder, Freeway includes the cost of the transverse joints in the shoulder and the external longitudinal pavement joints.

C. Concrete Overlay.

1. Concrete Pavement, Overlay Furnishing and Placing. The Engineer will measure, and the Department will pay for Conc Pavt, Ovly, Furnishing and Placing, on concrete pavements and shoulders, including providing and placing the concrete mixture, by volume. The Engineer will determine the volume based on in place quantities.

2. Concrete Pavement, Overlay Finishing and Curing. The Engineer will measure Conc Pavt, Ovly, Finishing and Curing in place. The unit price for Conc Pavt, Ovly, Finishing and Curing includes the cost of finishing and curing concrete pavements and
shoulders, finishing and curing the concrete overlays, and constructing longitudinal joints.

The Engineer will measure and the Department will pay for constructing transverse joints, in accordance with subsection 602.04.E, and for repairing and removing the existing pavement, in accordance with subsection 603.04.B.

3. **Concrete Pavement, Overlay, Miscellaneous Furnishing and Placing and Concrete Pavement, Overlay, Miscellaneous Finishing and Curing.** The unit prices for *Conc Pavt, Ovly, Misc, Furnishing and Placing*, and *Conc Pavt, Ovly, Misc, Finishing and Curing* include the cost of reconstructing ramps, ramp overlays, gore areas, and approach areas. The Engineer will measure, and the Department will pay for *Conc Pavt, Ovly, Misc, Furnishing and Placing* in accordance with subsection 602.04.C.1, and *Conc Pavt, Ovly, Misc, Finishing and Curing*, in accordance with subsection 602.04.C.2.

If the Engineer approves a substitution of a higher concrete grade for a lesser grade (e.g., P1 for P2), the Department will pay for the higher grade of concrete using the original bid and pay items.

D. **Pavement Gapping or Bridging.** The Engineer will measure **Pavt Gapping** by the length parallel to the centerline of the project from the beginning of concrete to the end of concrete, within the gapped section. The Engineer will measure each individual lane of gapped concrete pavement separately. The unit price for **Pavt Gapping** includes the cost of interrupting paving operations, moving back to pave the gap, and maintaining cross traffic.

The unit prices for other pay items include the cost of gapping curbs, curb and gutter, gutters, driveways, and sidewalks.

E. **Joints.** The unit prices for other pay items include the cost of transverse end-of-pour joints (Symbol H) and transverse plane-of-weakness joints (Symbol U). The Department will pay for other transverse joints by the length, based on plan dimensions, for the type of joint required.

The unit price for the transverse contraction, expansion, and plane-of-weakness joints include the cost of the following:

1. Providing required joint materials such as load transfer assemblies, expansion joint fillers, and joint seals or sealants;
2. Sawing, forming, and cleaning the joints;
3. Providing and applying bond breaker if required; and
4. Providing and placing poured joint sealant. 

The Engineer will measure and the Department will pay for expansion or contraction joints for concrete shoulders, shown on the plans, based on plan dimensions.

The unit prices for other pay items include the cost of internal and external longitudinal joints.

F. Concrete Accelerators. If the Engineer approves the use of concrete accelerator as extra work, the Department will pay the invoice cost plus 15 percent.

G. Price Adjustment for Pavement, Shoulder, and Base Course Based on Thickness and Depth of Reinforcement. The Engineer will core the concrete pavement before final acceptance to determine the thickness of the concrete pavement, and if required, the depth of reinforcement below the pavement surface. The Engineer will only measure the top layer of steel for depth of concrete cover for concrete pavements with two layers of required reinforcement.

The Engineer will not core the following:

1. Temporary concrete pavement,
2. Pavement within 4 feet of an obstruction,
3. Pavement areas less than 300 square yards, or
4. Pavement less than 3 feet wide.

The Engineer will determine concrete pavement units, core locations, and evaluate cores in accordance with MTM 201.

The Department will adjust the contract unit price for areas of concrete pavement where thicknesses or reinforcement locations exceed required tolerances.

Use Table 602-2 to classify cores and determine price adjustments according to concrete pavement thickness. Use either Table 602-3A, or Table 602-3B to classify cores and determine price adjustments according to steel depth. The Department will apply these adjustments cumulatively to the evaluated pavement unit.

1. Initial Core. The Engineer will classify each initial core with a one or two letter core-type code. The first letter (A, B or C) represents the thickness classification in accordance with Table 602-2 and the second letter (X, Y or Z), represents the steel depth classification in accordance with Table 602-3A.

If the Engineer classifies an initial core from a concrete pavement unit as Type AX, indicating both thickness and steel depth are within
required tolerances, the Department will not apply an adjustment and the Engineer will take no additional cores.

2. **Additional Cores.** If the Engineer does not classify an initial core from a concrete pavement unit as Type AX, the Engineer will take additional cores. The Department will only consider the dimensions not within the A or X range, for adjustment based on subsequent cores. The Engineer will decide whether to accept the work, make a price adjustment of up to 100 percent, or direct the Contractor to remove and replace concrete pavement, based on the initial and additional cores.

3. **Price Adjustment for Thickness.**
   a. **Initial Core Type A.** The Department considers a Core Type A to have a thickness within the required tolerances. The Engineer will not take additional cores to measure thickness, and the Department will not apply a price adjustment to the concrete pavement unit.
   
   b. **Initial Core Type B.** The Department considers a Core Type B to deviate from the design thickness as shown in Table 602-2. The Engineer will take two additional cores and measure the thickness.

   The Engineer will calculate the average thickness for the concrete pavement unit. In determining the average thickness, the Engineer will record measurements of individual cores that exceed the required pavement thickness by more than ¼ inch as the required thickness plus ¼ inch.

   The Department will determine the unit price adjustment using the average thickness rounded to the nearest 0.1 inch, and Table 602-2.

   c. **Initial Core Type C.** The Department considers a Core Type C to deviate from the design thickness by more than 1.1 inches.

   The Engineer will take straddler cores to determine the area of deficiency.

   The Engineer will establish a new initial core for the concrete pavement unit, excluding the deficient area, and repeat the evaluation and calculation for the concrete pavement thickness.

   Remove and replace deficient areas in accordance with subsection 602.04.G.5.
4. **Price Adjustments for Steel Locations Within the Pavement Structure.** The Department will consider two variables when considering price adjustments for steel depth — the steel location relative to the pavement surface and the deviation of the steel location from the allowable depth range. The Department will determine both and apply only the larger of the two deviations from the requirements in Table 602-3A and Table 602-3B.

   a. **Initial Core Type X.** The Department considers a Core Type X to have reinforcement placed within the required tolerances for depth from surface of pavement. The Engineer will not take additional cores, and the Department will not make a price adjustment to the concrete pavement unit for reinforcement placement.

   b. **Initial Core Type Y.** The Department considers Core Type Y to contain reinforcement that deviates from the design depth. The Engineer will take two additional cores and measure the depth of steel from concrete pavement surface for each core.

   The Engineer will calculate the average reinforcement depth.

   The Engineer will use the average reinforcement depth and Table 602-3A to determine the price adjustment based on the location of the steel from the concrete pavement surface.

   The Engineer will calculate the absolute deviation from the limits of the design depth range for each core, and the average absolute deviation from the required depth range.

   The Engineer will use the average absolute deviation and Table 602-3B to determine the contract price adjustment based on deviation from required depth of steel range.

   c. **Initial Core Type Z.** The Department considers Core Type Z to contain reinforcement that deviates from the design depth by more than the required tolerance.

   The Engineer will take straddler cores to determine the area of deficiency.

   The Engineer will establish a new initial core for the concrete pavement unit, excluding the deficient area, and repeat the evaluation and calculation of depth of steel.

   Remove and replace the deficient area in accordance with subsection 602.04.G.5.
602.04

5. **Remove and Replace.** If an initial core falls into either the Core Type C or Core Type Z category, the Engineer will delineate the deficient area by taking straddler cores at 5-foot intervals, longitudinally, in both directions from the initial core. The Department will consider defective areas separately from the remainder of the concrete pavement unit. The Contractor will remove and replace Core Type C and Core Type Z areas as directed by the Engineer. The Contractor will remove an area of pavement at least 10 feet long, for the full panel width. If the area designated for removal is within 15 feet of a transverse joint, the Contractor will remove the defective concrete pavement area to the joint. The Engineer will core and evaluate the replaced areas in accordance with subsection 602.04.G. If the concrete pavement is within the tolerances specified in Table 602-2, Table 602-3A, and Table 602-3B, the Department will pay for the replaced concrete pavement at the contract unit price.

<table>
<thead>
<tr>
<th>Initial Core Type</th>
<th>Deficiency in Thickness (in)</th>
<th>Price Adjustment (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>≤0.2</td>
<td>0</td>
</tr>
<tr>
<td>B</td>
<td>0.3</td>
<td>-5</td>
</tr>
<tr>
<td>B</td>
<td>0.4</td>
<td>-15</td>
</tr>
<tr>
<td>B</td>
<td>0.5</td>
<td>-25</td>
</tr>
<tr>
<td>B</td>
<td>0.6 – 1.0</td>
<td>-50</td>
</tr>
<tr>
<td>C</td>
<td>≥1.1</td>
<td>-100 (a)</td>
</tr>
</tbody>
</table>

*Table 602-2: Price Adjustment for Concrete Thickness Deficiency*

*a. Corrective action up to and including remove and replace pavement.*
Table 602-3A

<table>
<thead>
<tr>
<th>Core Type</th>
<th>Tolerance on Depth of Reinforcement for Uniform Plan Thickness (in) (a, b, c)</th>
<th>Price Adjustment (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Z</td>
<td>7.75 – 8.50 8.75 – 9.50 9.75 – 10.50 10.75 – 11.50 Shoulder</td>
<td></td>
</tr>
<tr>
<td>Y</td>
<td>1.0 – 1.9 1.0 – 1.9 1.0 – 2.4 1.0 – 2.4 0</td>
<td></td>
</tr>
<tr>
<td>X (d)</td>
<td>2.0 – 4.0 2.0 – 4.5 2.5 – 5.5 2.0 – 4.0</td>
<td></td>
</tr>
<tr>
<td>Y (d)</td>
<td>4.1 – 4.8 4.6 – 5.4 5.1 – 6.0 4.1 – 5.0 4.1 – 5.0</td>
<td>-25 (e)</td>
</tr>
<tr>
<td>Z (d)</td>
<td>≥6.5         ≥7.3         ≥8.1                          ≥8.9  —</td>
<td>-100 (e)</td>
</tr>
</tbody>
</table>

a. If the contract requires a pavement reinforced with two layers of reinforcement, the Engineer will only measure the depth of the top layer of steel.
b. To determine pavement thicknesses, use the same depth range as the pavement the shoulder is tied to. Use the average shoulder thickness, if tapered.
c. Pavement or base course.
d. If a core length measures at least 0.2 in over the plan thickness, increase the maximum depth range by one-half the excess core length over the plan thickness, round to the nearest 0.1 in, in accordance with ASTM E 29, and then add it to the range shown.
e. Corrective action up to and including removing and replacing pavement.
<table>
<thead>
<tr>
<th>Core Type</th>
<th>Allowable Average Absolute Deviation from Design Depth of Reinforcement per Uniform Plan Thickness (in) (a, b, c)</th>
<th>Price Adjustment (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>X (d)</td>
<td>(0.0 - 0.5) (0.0 - 0.5) (0.0 - 0.5) (0.0 - 0.5) (0.0 - 0.5) 0</td>
<td>0</td>
</tr>
<tr>
<td>Y (d)</td>
<td>(0.5 - 1.0) (0.5 - 1.0) (0.5 - 1.0) (0.5 - 1.0) (0.5 - 1.0) -10</td>
<td>-10</td>
</tr>
<tr>
<td>Y (d)</td>
<td>(\geq 1.0) (\geq 1.0) (\geq 1.0) (\geq 1.0) (\geq 1.0) -25</td>
<td>-25</td>
</tr>
<tr>
<td>Design Range</td>
<td>(2.0 - 4.0) (2.0 - 4.0) (2.0 - 4.5) (2.5 - 5.5) (2.5 - 6.0) —</td>
<td>—</td>
</tr>
</tbody>
</table>

a. If the contract requires a pavement reinforced with two layers of reinforcement, the Engineer will only measure the depth of the top layer of steel.
b. To determine pavement thicknesses, use the same depth range as the pavement the shoulder is tied to. Use the average shoulder thickness, if tapered.
c. Pavement or base course.
d. If a core length measures at least 0.2 in over the plan thickness, increase the maximum depth range by \(\frac{1}{2}\) the excess core length over the plan thickness, round to the nearest 0.1 in, in accordance with ASTM E 29, and then add it to the range shown.