SECTION 500—RIGID PAVEMENTS

SECTION 501—REINFORCED OR PLAIN CEMENT CONCRETE PAVEMENTS

501.1 DESCRIPTION—This work is construction of normal strength or high early-strength (HES) cement concrete pavement, plain or reinforced, on a prepared surface, as indicated.

501.2 MATERIAL—

- Class AA Cement Concrete—Section 704
- High Early Strength Cement Concrete—Section 704
- Reinforcement—Sections 709.3 and 709.4
- Expansion Joint Filler—Section 705.1
- Longitudinal Joint Material—Section 705.2
- Load Transfer Units—Sections 705.3(a) and (b)
- Joint Sealing Material—Section 705.4(a), (b), or (d)
- Graphite Lubricant—Section 705.6
- Concrete Curing Material—Sections 711.1, 711.2(a), Type 2, and 711.2(b)
- Concrete Admixtures—Section 711.3
- Mortar—Section 705.7(b)
- Tape Bond Breaker—An acceptable self-adhesive tape the width of the sealant reservoir.
- Epoxy Bonding Compound – Section 706.1
- Joint Backing Material—Section 705.9
- Fiberglass Dowel Sleeve—An approved type as listed in Bulletin 15.
- Pre-Mixed Nonshrink Grout – An approved type as listed in Bulletin 15.

501.3 CONSTRUCTION—

(a) General. Construct pavements in one or two traffic lane widths as shown on Standard Drawings RC 20M, 21M, 23M, 24M, 25M, 26M, and 27M, unless otherwise directed. Use one-lane construction if two-lane construction interferes with traffic.

1. Field Operation QC Plan. Prepare a paving operation QC Plan, as specified in Section 704.1(d)1.a, for field control and evaluation of concrete paving operations for the Representative's review. Do not start paving until after the Representative reviews the QC Plan.

(b) Weather Restrictions.

1. Cold Weather. Unless otherwise permitted in writing, discontinue concreting operations when the descending air temperature, away from artificial heat, falls to 4 °C (40F). Do not resume operations until the air temperature, away from artificial heat, rises above 4 °C (40F). Do not let water with a temperature above 32 °C (90F) to come in direct contact with the cement, until the cement has been mixed with the aggregates. Place concrete when the concrete temperature is between 10 °C and 32 °C (50F and 90F). Do not use materials containing frost, lumps, or crusts of hardened materials. Do not place concrete on frozen base, subbase, or subgrade.

2. Hot Weather. When the air temperature in the immediate vicinity of concrete operations rises to 30 °C (85F), take thermometer readings of the plastic concrete, at 1/2-hour intervals and at the conclusion of the mixing cycles. Discontinue concrete operations if the plastic concrete temperature exceeds 32 °C (90F) after mixing. When the plastic concrete temperature rises to 32 °C (90F), cool the mixing water or aggregates to maintain a plastic concrete temperature within 10 °C to 32 °C (50F to 90F) at the time of placing.

(c) Concrete Mixture. Do not use mixtures from volumetric mixing plants or mobile mixers, unless approved by the District Executive in writing. For slip-form paving, the Contractor may use plant mixed cement concrete, volumetric mixing plants or mobile mixers as specified in Section 704.1(a).

(d) Forms. Use steel forms for concrete pavement except as specified herein. Use forms not less than 3 m (10 feet) in length, with form depth and base width equal to pavement depth. Do not exceed 3 mm (1/8 inch) in 3 m (10 feet) from the true plane of the face or top. The Contractor may use forms with a base of not less than 150 mm (6 inches) in width and meeting all other requirements for narrow strips of widening if approved by the District Executive in writing.

Use forms of an approved section without horizontal joints, and with flange bracing extending outward on the base not less than two-thirds of the form height. Use forms that do not deflect or deform more than 0.25 mm (0.01 inch) when a center load of 7 550 N (1,700 pounds) is applied within a 1.2 m (4-foot) span. Use form sections equipped with three stake pockets, each of which have positive non-detachable wedges, and positive interlocking devices, which form a neat tight joint. Use a sufficient quantity of steel pins to securely hold the forms in place and provide the necessary rigidity.

For curves with a radius of less than 45 m (150 feet), the Contractor may use wood forms. Use two 25 mm (1-inch) (nominal) seasoned, surfaced planks properly joined together. Brace all wood forms with steel pins. Do not exceed 600 mm (24 inch) spacing between pins.

Clean and oil forms before each concrete placement. Cut and firm the subbase under the forms true to grade, and set forms accurately to line and grade for their entire length and width. Forms may be shimmed provided that the material used to shim the forms creates continuous contact between the form and the base course surface. The forms and shimming material must result in a full vertical face of concrete when removed. If concrete extrudes outside the shims or forms, remove this extruded concrete, as directed, before placing the adjacent concrete.

(e) Preparation and Protection of Base Course. When placing concrete on the completed base course do not disturb the form line after final testing. Remove accumulation of material adjacent to forms, to full depth of forms, in conjunction with final testing. If the prepared area is disturbed by any operations, or by traffic, check and correct before placing concrete.

Thoroughly sprinkle water on the base course before paving, if necessary to ensure a moist base course and to cool the surface temperature of treated permeable base courses below 46 C (115 F). Discontinue paving operations if the surface temperature of treated permeable base courses can not be maintained below 46 C (115 F). Do not create water puddles or mud. Sprinkle the base course with as much water as it readily absorbs, well in advance of paving.

(f) Placement and Initial Strike-Off of Concrete. For pavement construction around manholes, inlets, valve boxes, and similar appurtenances, place premolded expansion joint filler not less than 13 mm (1/2 inch) in total thickness, for the full depth of the pavement, around the outer sides of structures within the paved areas. Where pavements adjoin other rigid structures, bridges, or culverts, place premolded expansion-joint filler, not less than

19 mm (3/4-inch) thick, adjacent to the structures. Before placing pavement adjacent to railway tracks, fill the spaces along the web and below the head and top flange of the rail with mortar. If construction crosses railway tracks, place a minimum 20 mm (3/4-inch) thick expansion joint filler against the mortar-filled rails. If constructing along tracks, place a minimum 6 mm (1/4-inch) thick expansion joint filler along each mortar-filled rail.

Do not use concrete that has developed an initial set.

If implanting dowel bars by mechanical means, the Contractor may deposit the concrete directly on the subgrade or prepared surface in front of the paver. Spread concrete as close as possible to joint assemblies to ensure proper concrete consolidation without disturbing the joint. Do not damage the prepared surface while transporting or depositing concrete ahead of the paver. If the prepared surface is an asphaltic leveling course on rubblized concrete, treated base course of cement or asphalt, or an aggregate subbase, travel on the prepared surface only in the immediate area of the paving operation for the purpose of depositing concrete ahead of the paver. Do not use the prepared surface for hauling. Satisfactorily repair or replace any damaged areas at no additional cost to the Department.

Use vibrators capable of transmitting vibration to concrete with a frequency of not less than 100 impulses per second. Operate the vibrator around, but not in contact with transverse or longitudinal joint assemblies. Do not cause segregation when vibrating. Do not operate manual vibrators in one place more than 5 seconds. Use vibrators only to consolidate concrete after it has been properly placed. Do not use vibrators to move or spread concrete. Remove and discard segregated concrete, as directed. Maintain sufficient reserve vibratory equipment to prevent shutdown due to failure of equipment.

(g) Slip-Form Paving Method.

1. Equipment. Use a fully energized, self-propelled, slip-form paving machine, equipped with side forms to support concrete laterally to prevent edge slumping. Use a paver that vibrates or tamps concrete for the full width and depth of the layer being placed.

2. Line and Grade. Unless otherwise specifically shown on the construction drawings, construct pavement so the longitudinal joints do not traverse a driving lane or conflict with the final pavement markings. Construct longitudinal joints parallel to and within 300 mm (12 inches) of final pavement markings unless otherwise detailed on the construction drawings.

3. Placing Concrete. Place the concrete and spread in one or more layers, provided the concrete is fully consolidated, the reinforcement is satisfactorily embedded, and a satisfactory finished surface is obtained.

Operate the slip-form paver in a continuous forward movement. Coordinate operations of mixing, delivering, placing, and spreading concrete to provide uniform progress with stopping and starting of the paver held to a minimum. If the paver's forward movement is stopped, immediately disengage vibrating and tamping elements.

4. Joints. When load transfer units are used, stake in place in advance of paving operations, at the designated locations. Implanting of dowel bars by mechanical means is permitted. Accurately mark the dowel-bar locations to ensure sawing the transverse joints over the center of dowels. Saw, cure, and protect transverse and longitudinal contraction joints, as specified in Sections 501.3(i) and (j).

5. Edge Slumping.

5.a During Paving Operations. Test the pavement surface for edge slumping with a 3.0 m (10-foot) straightedge, before the concrete becomes non-plastic. Strive to avoid edge slump. Edge slump not exceeding the following will be acceptable:

- 3 mm (1/8 inch) between adjacent lanes, and lanes and ramps.
- 6 mm (1/4 inch) between lanes and shoulders, and ramps and shoulders.

Measure edge slump for the 150 mm (6-inch) width contiguous to the pavement edge.

Suspend paving operations after 61 m (200 feet) if edge slumping can not be prevented or controlled within the above stated acceptable limits. The pavement within this 61 m (200-foot) section will be evaluated as specified in Section 501.3(g)5.b.

5.b After the Concrete Hardens. Test the pavement surface with a 3.0 m (10-foot) straightedge to ensure the requirements of Section 501.3(g)5.a have been met.

If testing confirms edge slumping exists in the hardened concrete, submit methods for correction to the District Executive for review. Make corrections according to the reviewed methods to eliminate the edge slumping. Remove and replace pavement determined defective, as specified in Section 501.3(u), at no additional cost to the Department.

(h) Handling and Placing Reinforcement. Use reinforcement free of rust, dirt, oil, grease, or other foreign substances, which impair bond of steel with concrete. A light, powdery coating of rust, formed during project storage, does not require cleaning. Remove loose, scaly, or thick rust by suitable methods. The Representative will reject reinforcement with rust that has caused detectable reduction in cross-sectional area.

If placing reinforced concrete pavement in two layers within fixed forms, strike off the entire bottom layer and lay the reinforcement full length on the concrete, in its final position, without further manipulation. Place reinforcement directly upon the concrete and place, strike-off, and screed the top layer of concrete. Remove and replace bottom-layer portions of concrete placed more than 1/2 hour without being covered with the top layer of freshly mixed concrete.

If placing reinforced concrete pavement in one layer, position mesh reinforcement on acceptable supports as specified in Section 1002.3(d)2 in advance of concrete placement. If a mechanical installer is used, avoid segregation of concrete or displacement of reinforcement.

(i) Transverse Joints. In new multilane pavements, place transverse joints perpendicular to centerline to form a continuous joint across the entire pavement width and locate dowels as shown on Standard Drawing RC 20M, except where paving operations must cease temporarily due to unavoidable conditions.

Before paving, apply graphite bond-breaker lubricant to one-half of the length of Type B coated dowel bars, unless a bondbreaker lubricant has been applied in the shop. Stir the lubricant well and apply to the free end of dowels by daubing, mopping, or with a gloved hand, to produce a thorough coating approximately 2 mm (1/16 inch) thick. Do not use brushes for lubricant application. Apply the lubricant, as specified, at least 1 hour before placing the concrete around the dowel assembly. Type A coated dowel bars do not need lubricant.

Where existing concrete pavements are widened, align transverse construction or contraction joints, if possible, with existing construction or contraction joints or cracks; otherwise, do not place within 3 m (10 feet) of a joint.

When constructing pavement one lane at a time or placing concrete shoulders after pavement construction, fill the ends of transverse joints with joint backing material, or cover with duct tape, to prevent intrusion of cement mortar into the joint. In these cases, when saw cutting transverse joints in the newly constructed lane or shoulders, saw cut the existing transverse joint in the previously placed lane to ensure the removal of any mortar that might have intruded into the joint.

1. Construction Joints. If more than a 30-minute interruption occurs in concreting operations, construct a transverse joint using a bulkhead. Place dowels in bulkheads by drilling or inserting into fiberglass dowel sleeves. Do not construct a transverse joint within 3 m (10 feet) of another transverse joint. If not enough concrete has been placed or mixed at the time of interruption to form a slab at least 3 m (10 feet) long, remove concrete to the preceding joint and dispose of excess mix.

2. Contraction Joints. Accurately mark using tacks or other approved methods the location for the center of the sawed transverse contraction joints. The sawed transverse joint must be located directly ±13 mm (±1/2 inch) over the centerline of the dowel basket assemblies or the centerline of the mechanically implanted dowels. Saw joints with equipment having guides, a blade guard, watercooling system, and cut-depth control. Provide adequate and extra equipment and parts at the site, before placing concrete and during sawing operations.

Other than white membrane curing compound, remove curing materials from pavement, at the location where a joint is to be cut. Only remove sufficient covering to provide space necessary for sawing joints. Immediately after sawing the initial saw cut, thoroughly flush the joint as necessary to remove slurry. Place oversized (width plus 50%) backer rod in the top of the sawed joint to maintain cure. Monitor the movement of the joint throughout the cure period and up to placement of permanent seal. If at any time the joint opens remove and replace backer rod with appropriate oversized backer rod. The maximum time period permitted for curing covers to be removed for sawing is 1/2 hour. If white membrane curing compound is used, reapply curing compound as specified in Section 501.3(l)1.c.

The Representative will not allow displacing coarse aggregate from the joint location by use of a vibrating T-bar, or by use of a filler strip at the joint.

In single-lane construction, mark the joints that have cracked and opened on the first lane placed. Align the location of the first joints sawed in the second lane with the marked joints on the first lane. In lanes adjacent to previously constructed lanes, saw joints before uncontrolled cracking occurs. Make the full required depth cut from edge to edge of the pavement. In formed paving, do this by loosening or removing the side forms or by other acceptable methods.

Saw all initial saw cuts to prevent random cracking, without damaging the pavement surface. If damage to the pavement surface occurs, repair in an approved method at no additional cost to the Department. Slight raveling along the joint edge is permissible. If necessary, conduct sawing operations continuously, both day and night, regardless of weather conditions.

If a crack or spall occurs at any location and any time before final inspection and resolution of all issues regarding the condition of the pavement, repair the pavement in accordance with Table A, at no additional cost to the Department. Field coat the dowels with the graphite lubricant, as specified in Section 501.3(i), where necessary as determined by the Representative. Join original pavement to replacement pavement and test as specified in Section 507; if Ride Quality and Incentive are not applicable, test as specified in Section 501.3(p).

For joints requiring a second stage of sawing, saw the sealant reservoir 72 hours or more after placing the concrete.

Clean joints with pressurized water or water and air pressure immediately after sawing. Patch voids or spalls, in excess of the specified width, as specified in Section 525. Continue curing and protect joint until sealed.

3. Expansion Joints. Place transverse expansion joints, where indicated. If existing concrete pavements are widened, align transverse expansion joints, if possible, with existing expansion joints. Place transverse expansion joints, without load transfer units, in the plain cement concrete pavement in paved divisor areas. Conform to the dimensions and locations in adjacent concrete curb. Place expansion joint filler, as indicated or as directed.

Table A
Repair Procedures for Deficiency in New Concrete Pavement

Item	Deficiency	Location	Description	Contractor Repair Options
1	Partial Depth Crack	Anywhere	≤ 0.175 mm (0.007 inches) wide	Do nothing
			>0.175 mm (0.007 inches) wide AND ≤ D/3 deep	Epoxy inject crack as specified in Section 1091
			> 0.175 mm (0.007 inches) wide AND > D/3 deep	Repair as specified in Section 516 Partial Panel Full Depth Patch[a, b, c]
2	Spall	Mainline or shoulder panel	Minimal spalling[d] ≤ 50 mm (2 inches) wide AND ≤ D/3 deep	Do nothing
			Significant spalling[e] > 50 mm (2 inches) wide (measured perpendicular to joint) AND ≤ D/3 deep or > 300 mm (12 inches) wide (not at a joint) AND ≤ D/3 deep	Spall Repair as specified in Section 525 (Repair must perform satisfactorily for 1 year or replace with Partial Panel Full Depth Patch as specified in Section 516)[a, b, c]
			Significant spalling[e] > 50 mm (2 inches) wide (measured perpendicular to joint) AND > D/3 deep or > 300 mm (12 inches) wide (not at a joint) AND ≤ D/3 deep	Repair as specified in Section 516, Partial Panel Full Depth Patch[a, b, c]

3	Single Full Depth Crack (any orientation)	Shoulder	Non-working crack with minimal spalling[d]	Epoxy inject crack as specified in Section 1091
			Working crack with minimal spalling[d]	Seal crack as specified in Section 590
			Crack with significant spalling[e]	Repair as specified in Section 516 Partial Panel Full Depth Patch[a, b, c] OR Full Panel Replacement[c]
		Mainline or Shoulder panel is affected by irregular geometry (construction joints do not line up)	Crack with minimal spalling[d]	Seal crack as specified in Section 590
		Mainline	Entire length of crack ≤ 230 mm (9 inches) from longitudinal joint AND crack is parallel to longitudinal joint ± 25 mm (1 inch)	Seal crack as specified in Section 590
		Mainline crack is in center one-third of dowelled panel.	Crack ≤ 13 mm (1/8 inch) wide AND spalling ≤ 6.5 mm (1/4 inch) from edge of crack.	Dowel Retrofit as specified in Section 527: three dowels per wheel path (panels ≤ 250 mm (10 inches) thick); four dowels per wheel path (panels > 250 mm (10 inches) thick) OR Partial Panel Full Depth Patch[a, b, c] repaired as specified in Section 516 OR Full Panel Replacement[c]
		Mainline	All other conditions	Partial Panel Full Depth Patch[a, b, c] OR Full Panel Replacement[c]
4	Multiple Cracks > D/3 deep (any orientation)	Mainline or Shoulder	Panel has more than 1 crack > D/3 deep	Partial Panel Full Depth Patch[a, b, c] OR Full Panel Replacement[c]

Notes:

a Minimum patch length is 1 800mm (6 foot) for Plain Cement Concrete (PCC) or 3 000 mm (10 foot) for Reinforced Concrete Pavement (RCP).

b Minimum amount of panel left in place is 1 800 mm (6 foot).

c All patches (partial panel and full panel replacements) must be full width and depth.

d Minimal spalling is defined as ≤ 50 mm (2 inches) total width AND ≤ 300 mm (12 inches) (combined length) along crack.

e Significant spalling is defined as > 50 mm (2 inches) total width OR > 300 mm (12 inches) (combined length) along crack.

D Design pavement depth.

Payment for new pavement where the crack has been removed is at the Contract Unit Price (CUP) with NO additional compensation for the repair.
Payment for new pavement where the crack has not been removed but sealed as specified in Section 590 is at five percent CUP for the slab with NO additional compensation for the repair. Payment for slabs with Partial depth Crack or Spall is at the CUP with NO additional compensation for the repair

Crack depth is to be determined by coring at no cost to the Department

(j) Longitudinal Joints. Place tie bars as indicated or directed. The Representative will select 15 tie bars from the first day's concrete placement according to PTM No. 1. Test each selected tie bar for pull-out resistance after the concrete has attained a compressive strength of 24 MPa (3,500 pounds per square inch), or epoxy anchoring material has met manufacturer's requirements. Use a center-pull hydraulic jack with a load measuring gage and bearing ring capable of testing each tie bar to 53 400 N (12,000 pounds) or to a 0.8 mm (1/32-inch) slippage. Do not use jack and gage having a calibration date older than 6 months. Record the gage reading at point of slippage or 53 400 N (12,000 pounds), whichever occurs first. Determine the average of pull-out test results. Divide pull-out test average by the tie bar spacing to determine pull-out resistance of tie bars, in newtons per meter (pounds per cubic foot), for compliance with Table B. If the newtons per meter (pounds per cubic foot) is not in compliance with Table B, replace failed tie bars or install additional tie bars until compliance with Table B is attained, at no additional cost to the Department. Install additional tie bars from the center of slab out in an approved pattern. Do not install additional tie bars within 750 mm (30 inches) of a transverse joint. Do not construct adjacent lanes until the tie bars comply with Table B. Perform additional testing as directed.

Saw tied, longitudinal contraction joints to prevent random cracking, as specified in Section 501.3(i)2. Clean joints with pressurized water or water and air pressure immediately after sawing. Continue curing and protect the joint until it is sealed, as specified in Section 501.3(n).

TABLE B
Pull-Out Resistance of Tie Bars

Tied Width of Pavement (Distance from Joint Being Constructed to Nearest Free Edge)	Minimum Average Pull-Out Resistance of Tie Bars
	N/m (lb/ft) of Joint
3.6 m (12 feet) or less	32 000 (2,200)
Over 3.6 m (12 feet) to 5.2 m (17 feet)	46 500 (3,200)
Over 5.2 m (17 feet)	65 500 (4,500)

If a longitudinal crack occurs within a lane, remove and replace slabs containing the crack at no additional cost to the Department. If damage to the pavement surface occurs, repair in an approved method at no additional cost to the Department. Join original and replacement pavements. Field coat dowels with graphite lubricant, as specified in Section 501.3(i), where necessary.

(k) Final Strike-Off, Consolidation, and Finishing. Complete these operations during hours of natural light, unless using an acceptable lighting system.

1. Strike-Off and Consolidation.

1.a Machine Method. Immediately after placing, strike off and screed the concrete, with a finishing machine, as necessary, to properly consolidate the concrete and to leave a uniform textured surface.

Keep the top of forms free from accumulation of concrete or of foreign material. Maintain true machine travel on the forms without lift, wobble, or other variations that affect accurate finishing. Use equipment that does not groove the concrete pavement edges for a width greater than can be eliminated by edging tools. Use a rubber-tired wheel to support the spreader and a transverse finishing machine on the adjoining concrete pavement surface, keeping the wheel approximately 300 mm (12 inches) from the pavement edge.

Maintain a uniform roll of concrete ahead of the finishing machine front screed for its entire length. Overlap the previously screeded concrete on the last pass.

Place and vibrate concrete adjacent to joints and other areas, as specified in Section 501.3(f), then bring the finishing machine forward. Operate the machine carefully to avoid damage, misalignment of joints, or concrete segregation.

Do not add water to the concrete surface to assist in finishing.

1.b Manual Method. Unless otherwise directed, do not use manual strike-off methods, except to strike off concrete already deposited on the subbase if a breakdown of mechanical equipment occurs or on small turnout areas and patches up to 3 m (10 feet) in length.

If finishing manually, use screeds contoured to the pavement cross section. Provide screeds sufficiently rigid to retain their shape and at least 600 mm (2 feet) longer than the maximum slab width to be struck off. Operate the equipment in a manner to obtain consolidation and a uniform textured surface free of porous areas. Consolidate as specified in Section 501.3(f).

2. Floating. After the concrete has been struck off and consolidated, smooth and fill in open-textured pavement areas with a float, as necessary. Do not add water to the surface. Mechanical floats or long handled floats may be used.

3. Straightedge Testing and Surface Correction. While concrete is still plastic, test the surface using a 3 m (10-foot) straightedge, swung from handles 1 m (3 feet) longer than one-half the slab width, as required. Hold the straightedge in contact with the surface in successive positions. Advance in successive stages of not more than 1.5 m (5 feet) a stage. Immediately correct low areas, then strike off, consolidate, and refinish. Cut down high areas and refinish. Make sure the surface across joints meets requirements for smoothness as specified in Section 501.3(p). Continue straightedge testing and surface corrections until the entire surface is free from observable departures from the straightedge and until the slab conforms to the required grade and cross-section.

4. Final Finish. After straightedge testing and surface corrections have been completed and before concrete becomes non-plastic, texture the surface transversely for the full pavement width. Produce a textured finish with grooves that have the following characteristics: rectangular in shape; from 2.5 mm to 5 mm (3/32 inch to 3/16 inch) in width; and from 3 mm to 5 mm (1/8 inch to 3/16 inch) in depth.

For a 3 m (10-foot) rake use center-to-center tine spacing as follows:

TABLE C (Metric)
Center-to-Center Tine Spacing

34	36	47	54	48	43	32	31	27	36	29	46	21	43	23
42	52	24	18	28	40	34	27	26	25	27	20	37	38	52
51	45	37	43	53	14	27	37	42	41	29	43	14	45	44
30	37	33	40	28	31	50	34	45	15	20	45	50	16	53
51	29	25	18	16	53	18	38	51	40	17	15	49	50	39
51	36	36	38	46	29	38	50	24	33	mm				

TABLE C (English)
Center-to-Center Tine Spacing

1 3/8	1 3/8	1 7/8	2 1/8	1 7/8	1 3/4	1 1/4	1 1/4	1 1/8	1 3/8	1 1/8	1 3/4	7/8	1 3/4	7/8
1 5/8	2	1	3/4	1 1/8	1 5/8	1 3/8	1 1/8	1	1	1 1/8	3/4	1 1/2	1 1/2	2
2	1 3/4	1 1/2	1 3/4	2 1/8	1/2	1 1/8	1 1/2	1 5/8	1 5/8	1 1/8	1 3/4	1/2	1 3/4	1 3/4
1 1/8	1 1/2	1 1/4	1 5/8	1 1/8	1 1/4	2	1 3/8	1 3/4	5/8	3/4	1 3/4	2	5/8	2 1/8
2	1 1/8	1	3/4	5/8	2 1/8	3/4	1 1/2	2	1 5/8	5/8	5/8	1 7/8	2	1 1/2
2	1 3/8	1 3/8	1 1/2	1 3/4	1 1/8	1 1/2	2	1	1 1/4	(in)				

When using this chart begin in the upper left corner and read across the entire row then start again on the left side in the next row.

Produce the texture in one pass, without overlapping the previous pass, to provide a uniform finish. Keep the texturing device free of hardened concrete particles.

(l) Curing Concrete. Cure the entire surface immediately after finishing operations have been completed. Do not mar the concrete surface. After removing forms and correcting honeycombed areas, cure the sides with the same method as the surface. When using covers, secure over the entire surface and sides. The Representative will suspend concrete operations immediately if sufficient curing is not provided. Cure by the same method throughout the work unless directed to change by the Inspector. Have material available for emergency curing.

If normal curing is delayed, apply an intermediate monomolecular film curing agent to all cement concrete patches before normal curing.

Apply the monomolecular film in a light-fog application, using a pressure spray tank with an adjustable nozzle. Use a water-to-curing-agent ratio and rate of application both according to the manufacturer's recommendations. Agitate the solution before each application.

Apply the curing agent in a continuous film, immediately after finishing and texturing operations are completed on any area. Do not provide any additional finishing after application of the monomolecular film. Apply additional applications as required, if surface drying is taking place and curing covers have not been placed.

After application of the monomolecular film, provide normal curing as specified.

1. Normal Curing. Apply curing materials and maintain them as specified below, for a period of 96 hours for normal strength concrete or 72 hours for high early strength concrete. The Contractor may use methods other than those described below to protect and cure joints, if the procedure and materials are acceptable. The Representative may require a change in method if unsatisfactory results are obtained.

1.a White Polyethylene Curing. Use sheeting wide enough to cover the pavement surface and sides. Provide lengths consistent with pavement joint spacing. Overlap sheets a minimum of 300 mm (12 inches) and secure sides and seams to form a tight seal. After form removal, fold sheeting down over the sides for the full pavement depth, then secure with suitable material.

1.b White Polyethylene Burlap-Backed Curing. Use sheeting wide enough to cover the pavement surface and sides. Provide lengths consistent with pavement joint spacing. Overlap sheets a minimum of 300 mm (12 inches), then secure sides and seams to form a tight seal. Saturate the burlap side with water, then place and secure with the burlap side down. After form removal, fold sheeting down over the sides for the full pavement depth, then secure with suitable material.

1.c White Membrane Forming Curing Compound. The Representative will allow this method of curing if the air temperature is above 4 °C (40F) at the time of application and the air temperature is forecasted to remain above 4 °C (40F) a period of 4 hours after application.

Following the final finishing, immediately after free water has left the pavement surface and while the surface is still damp, seal exposed concrete areas with an application of curing compound. Apply at a rate of 1 L/4 m^2 (1 gallon per 150 square feet) ± 10% of surface area, or as directed. Using a self-propelled mechanical spreader, apply in a fine mist, without marring the concrete surface. Use atomizing type spraying equipment, equipped with a tank agitator providing continual compound agitation during application. Provide proper calibration to allow accurate control of the amount of material being placed. Use a hood to protect the spray device against the wind and control so the spray overlaps transversely 50%, to produce two coverages of a continuous, uniform membrane. Do not drip curing compound on the pavement. If rain falls on newly coated pavement before the film has dried sufficiently to resist damage or if film is damaged in any way before the pavement is cured, apply a new coat immediately, in an amount equal to the original specified application.

After form removal, apply a uniform coat to the sides, at the rate specified for the surface. Manual spraying equipment may be used for spraying the sides and for any small or irregular areas not reached by surface spraying equipment.

The Contractor may cure joints and protect them by use of tape, a strip of white polyethylene, or white polyethylene backed with burlap. During the curing period, to prevent moisture loss from concrete, in and adjacent to joints, use strips 75 mm to 150 mm (3 inches to 6 inches) wide, securely held in place on the pavement surface by an acceptable method, or place saturated rope strands in the joints. Just before the curing compound application or reapplication, carefully place rope without damaging or distorting the joints.

Keep workmen, materials, and equipment off the membrane film during curing, unless adequate precautions are taken to protect the film.

1.d Burlap Curing. Place burlap in double-thickness by overlapping each strip one-half its width on the pavement surface. Keep this covering saturated with water for the full curing period. After sides are exposed, fold burlap down over the sides and secure with suitable material.

1.e White Polypropylene Fiber-Backed Curing. Use sheeting wide enough to cover the pavement surface and sides. Provide lengths consistent with pavement joint spacing. Overlap sheets a minimum of 300 mm (12 inches), then secure sides and seams to form a tight seal. Saturate the burlap side with water, then place and secure with the burlap side down. After form removal, fold sheeting down over the sides for the full pavement depth, then secure with suitable material.

1.f Black Membrane-Forming Curing Compound. Liquid Membrane-Forming Curing Compound, Black, may be used, provided the cement concrete pavement will be overlayed and is not accessible to traffic before the surface course is placed. Apply at a rate not to exceed 0.07 L/m^2 (0.015 gallon per square yard) to produce a uniform continuous film. Discontinue use of the compound if it becomes unsatisfactory as a curing agent; and resume curing by other methods, as specified.

2. Cold Weather Curing. If the forecasted air temperature during concrete curing is expected to fall blow 4 C (40 F), place high-low thermometers on the concrete surface and monitor concrete curing temperatures. Protect the pavement surface and sides to effectively maintain a temperature of not less than 4 °C (40F) for at least 4 days and until the concrete achieves a strength of 21 MPa (3,000 pounds per square inch). If at any time during this period the high-low thermometer falls between 4 °C and 2 °C (40F and 35F), extend the cure period by and additional day. If at any time during the curing period the high-low thermometer temperature falls below 2 °C (35F), the concrete will be considered defective. Remove and replace defective pavement as specified in Section 501.3(t) at no cost to the Department.

(m) Removal of Forms. Do not remove forms from freshly placed concrete until it has set. Remove the forms carefully to avoid pavement damage.

(n) Sealing Joints and Cracks. Seal joints before opening any pavement section to traffic including construction equipment, and before discontinuing work for the winter season. When permitted, the Contractor may open pavement to construction equipment provided an approved temporary sealing material is in place, and initial concrete strength and curing requirements are met. Provide construction equipment within vehicle code limits. Seal cracks as indicated or directed.

Do not place joint sealing material on the same day as the sawing or if joint is wet or damp due to weather conditions. Clean joints of all scale, dirt, curing compound, temporary joint sealing material, and other foreign material with a wire brush. Upon completion of the cleaning, thoroughly sand-blast or water-blast the joint sidewalls with sufficient pressure to clean but not damage joint. Immediately before placing bond breaker or joint sealing material, blow the joint clean with a compressed air stream of at least 700 kPa (100 pounds per square inch) measured at the source. Use compressed air free of oil, moisture, and other contaminants.

1. Poured In Place Seal. Do not place poured joint-sealing material if the air temperature is less than 4 °C (40F), unless permitted.

For hot-poured seals use heating equipment of an indirect heating type, constructed as a double boiler. Provide positive temperature control and mechanical agitation. Determine the safe heating temperature range and recommended pouring temperature from the manufacturer's shipping container. Heat and maintain the material temperature within these recommended safe temperatures. Place the material as close as possible to the recommended pouring temperature. Do not maintain any single batch of material at the pouring temperature for more than 6 hours. Reheat according to the manufacturer’s recommendations.

Fill the joint reservoir with sealing material to the level shown on the Standard Drawings. Do not let sealing material to spread over the pavement surface.

When required, place the tape bond breaker and/or backer rods on the bottom surface of the joint reservoir before sealing. Do not extend tape up the reservoir face more than 3 mm (1/8 inch). If necessary for support, install an acceptable joint backing material below the tape.

2. Neoprene Seals. Install preformed neoprene seals as specified, using installation equipment capable of placement without cutting, nicking, twisting, or damaging the seal. Install seals with lubricant adhesive applied, according to manufacturer's recommendations, to the contact surfaces of the joint faces or sides of the seal. Install seal in one piece to the depth indicated unless approved. Do not elongate the seal more than 3% or compress longitudinally more than 2%.

Prepare and submit a QC Plan to the Representative at the start of the project, as specified in Section 106.03(a)2. As a minimum include the following in the QC Plan: Contractor's and manufacturer's representatives; list of equipment and construction sequence; list of material, along with sampling and testing procedures; test section schedule; and procedure to replace unacceptable seals.

Before sealing joints, seal a minimum of three full-width pavement joints, according to the test section schedule specified in the QC Plan. Have the manufacturer's representative witness the test section(s) unless otherwise permitted in writing. The Representative will inspect the test section(s). Do not seal the remaining pavement joints until the Representative accepts an installation procedure. Conduct test(s) according to QC Plan when material is changed or seal installations are unacceptable.

Replace seals exceeding 3% elongation or 2% compression, or otherwise not conforming to the specifications at no expense to the Department. Patch pavement damaged by removing unacceptable seals and adhesive as specified in Section 525.

3. Silicone Seals. Prepare the joint and place silicone sealant material according to the manufacturers recommendations.

(o) Surface Tolerance. After the concrete has hardened, test the surface of pavement again, using straightedges, as specified in Section 501.3(k)3. Remove high points in excess of 6.5 mm (1/4 inch) by means of grinding or cutting tools, as directed. The Representative will consider pavement containing depressions of more than 6.5 mm (1/4 inch) to be defective.

1. Longitudinal Joints. Test the surface of pavement at all longitudinal joints, including the joint between the pavement and shoulder, again for the following tolerance requirements:

- Where there is no change in the design cross slope across a joint, the tolerance will not be greater than 6 mm (1/4 inch) as measured by holding a 3 m (10-foot) straightedge centered across and perpendicular to the joint.

- Where there is a change in the design cross slope across a joint, the tolerance will not be greater than 6 mm (1/4 inch) as measured by holding a 1.2 m (4-foot) straightedge perpendicular to and on each side of the joint.

- Remove high points in excess of 6 mm (1/4 inch) by means of grinding or with cutting tools, as directed. Pavement containing depressions of more than 3 mm (1/8 inch) between adjacent lanes will be considered defective.

(p) Protection of Pavement. Protect pavement, as specified in Section 901, and exclude traffic, including construction equipment. When required to complete adjacent pavement, the spreading, finishing, and subgrade machines may operate on the pavement surface after 96 hours if 21 MPa (3,000 pounds per square inch) is achieved.

(q) Opening to Traffic. The Representative will determine when pavement may be opened to traffic. However, do not open to traffic in less than 96 hours for normal strength concrete or 72 hours for HES concrete and until pavement develops the required 21 MPa (3,000 pounds per square inch) minimum compressive strength, determined by compressive tests made on cylinder specimens, according to PTM No. 604.

(r) Protection Against Rain. Provide sufficient materials on site, at all times, to properly protect the pavement edges and surface against rain, before initial set of concrete. If rain appears imminent, stop paving operations, immediately protect the pavement sides, and cover the concrete surface with protective material.

(s) Tests for Depth. Before final acceptance of the project, proceed as follows:

- The Department will divide the mainline pavement into lots representing not more than 2 500 m^2 (3,000 square yards) of pavement in each traffic lane. A traffic lane is defined as the pavement surface between longitudinal joints or between a longitudinal joint and the pavement edge. Include ramps in a separate lot or lots. The Inspector will select one coring location at random within each lot according to PTM No. 1. Drill cores according to AASHTO T 24 and in the presence of the Inspector. Thoroughly clean the vertical surface of the core hole of laitance and loose and foreign material. Fill the holes with the mixture used to construct the course and consolidate. As an alternative, use a premixed, nonshrink grout

- Provide a measuring apparatus conforming to PTM No. 614. The Inspector will determine the core depth according to PTM No. 614.

- If any core measurement is deficient by more than 6.5 mm (1/4 inch) in required depth, drill additional cores in the presence of and for measurement by the Inspector.

- Drill the additional cores at 30 m (100-foot) intervals in both directions longitudinally from each deficient core, in the same traffic lane, until the depth is no more than 6.5 mm (1/4 inch) deficient. Each core will represent the condition in the same traffic lane for a distance of 15 m (50 feet) in both directions longitudinally.

- If any core measurement is deficient by more than 12.5 mm (1/2 inch) in required depth, the Inspector will consider the pavement to be defective.

- Submit every tenth core to the MTD for 28 day compressive strength testing according to AASHTO T 24. For a partial lot, the Inspector will randomly select one core, according to PTM No. 1, for testing. If the core strength is less than 26 Mpa (3,750 pounds per square inch) immediately perform an investigation of the concrete operations to determine the cause of the low strength. Provide a written evaluation of the problem and the proposed solution to the Department.

(t) Defective Work. Unless otherwise directed in writing by the District Executive, remove and replace pavement that is: defective in construction or sawing of transverse joints as specified in Section 501.3(i); defective in curing requirements as specified in Section 501.3(l)2; defective in surface tolerance, as specified in Section 501.3(o); defective in depth, as specified in Section 501.3(s); defective in air content, as specified in Section 704.1(c)3; defective in compressive strength as specified in Section 704.1(d), or showing surface defects resulting from the effects of freezing and thawing, rain, improper final finish, or honeycombing which, in the Representative's opinion, cannot be repaired. Repair pavement that is cracked or spalled in accordance with Table A.

The minimum pavement removal and replacement length between transverse joints is 3 m (10 feet) if constructing reinforced cement concrete pavements or 2 m (6 feet) if constructing plain cement concrete pavements. After removal of defective pavement, construct required transverse joints according to the methods for joining pavements, as shown on the Standard Drawings. Where replacement extends to an existing transverse joint, satisfactorily salvage the joint or replace in kind, as directed.

If removing and replacing pavement defective in depth, start at the determined point of deficiency as determined by the Representative. Remove and replace defective work transversely for the full-lane width and longitudinally, until the pavement is not more than 6.5 mm (1/4 inch) deficient in depth, as specified in Section 501.3(s).

501.4 MEASUREMENT AND PAYMENT—Square Meter (Square Yard)

(a) Adjustment for Deficient Pavement. Where a deficiency exists, as determined by cores, the Department will pay as follows:

Deficiency in Depth Determined by Cores mm (inches)	Proportional Part of Contract Price Allowed
0.0 to 6.5 (0.0 to 0.25)	100%
6.6 to 7.7 (0.26 to 0.30)	95%
7.8 to 8.9 (0.31 to 0.35)	85%
9.0 to 10.1 (0.36 to 0.40)	75%
10.2 to 11.3 (0.41 to 0.45)	50%
11.4 to 12.5 (0.46 to 0.50)	25%

(b) Defective Pavement Left in Place. The Department will not pay for defective pavement left in place, unless otherwise directed in writing by the District Executive. When the District Executive directs that defective pavement be left in place, final payment for this pavement will be at 5% of the contract price.

(c) Concrete Pavement Cores. Each

The price includes the measuring apparatus, which remains the Contractor's property upon completion of the project. The Department will not pay for additional cores drilled if the depth is deficient by more than 6.5 mm (1/4 inch).