SECTION 1000
STRUCTURES

SECTION 1001—CEMENT CONCRETE STRUCTURES

1001.1 DESCRIPTION—This work is construction of bridges, arches, culverts, and other cement concrete work.

1001.2 MATERIAL—

(a) Cement Concrete. Section 704. Do not use High Early Strength (HES), as specified in Section 704, Table A in bridge decks.

1. Barrier.

1.a Fixed Form Bridge Barrier. Class AA Cement Concrete – Section 704, except use No. 8 coarse aggregate.

1.b. Slip-Formed Bridge Barrier. Class AA Cement Concrete – Section 704, except, use No. 8, No. 67, or No. 57 coarse aggregate. Mixes using No. 8 coarse aggregate must contain No. 57 or No. 67 or both coarse aggregate.

(b) Concrete Curing Material and Admixtures.

- Curing and Protecting Covers—Section 711.1
- Curing Compounds—Section 711.2(a) (white only) and 711.2(c)
- Concrete Admixtures—Section 711.3. Do not use admixtures containing chloride salts in bridge-deck concrete.

(c) Structure Foundation Drains. Section 610.2 and Section 615.2

(d) Nonstaining, Nonshrinking Grout. Use for minor patching of concrete surfaces. Mix one part cement, two parts fine aggregate, and enough water to provide a consistency stiff enough to place by either manual or mechanical tamping. Do not use more than 4 1/2 gallons of water per bag of cement. Mix for 60 seconds, cover to prevent loss of moisture, and allow to stand for 45 minutes. Remix for 60 seconds without further addition of water, then place within 30 minutes after completion of mixing. Use material as follows:

- Cement, Type IP, IS, IL or II—Section 701
- Fine Aggregate, Type A or C—Section 703.1
- Water—Section 720.1

The Contractor may use premixed grout. Obtain from a manufacturer listed in Bulletin 15. Mix according to the manufacturer's instructions. Certify as specified in Section 106.03(b)3.

(e) Nonshrink Grout for Studs, Dowels, and Anchor Bolts. Section 1080.2(c), except use Type C fine aggregate.
The Contractor may use premixed nonshrink grout. Obtain a grout, which passes a No. 8 sieve, from a manufacturer listed in Bulletin 15. Mix according to the manufacturer's instructions. Certify as specified in Section 106.03(b)3.

(f) Asphalt Tack Coat (for Bridge Decks). Section 460.2

(g) Lighting Pole Anchorage. Provide as shown on the Standard Drawings and as follows:

- Anchor Bolts, Nuts, and Washers—Section 1105.02(c)2 (metallic coated)
- Steel Angle—Section 1105.02(a)2
- Conduit—Section 1101.09(b)
- Junction Box—Section 1101.10

(h) Forms.

1. Temporary. Use plywood at least 5/8 inch thick or other accepted material made for form work. For final exposed concrete surfaces, use smooth material, free of knots, holes, bulges, and depressions.

2. Metal Bridge Deck Forms. Use permanent forms, fabricated from steel conforming to ASTM A924/A924M and ASTM A653/A653M (Structural Quality (SQ) excluding Grade 50 Class 3), with a coating designation of G165, and a minimum thickness of 22 gage. Coat fasteners, if used, either by galvanizing according to ASTM A153 or ASTM B633, Thickness Class Fe/Zn 12; or cadmium plating, according to ASTM B766, Class 12.

An alternate form system may be used, if indicated or if accepted in writing by the Chief Bridge Engineer. Submit material details and erection methods of the alternate form system for review and acceptance.

Certify as specified in Section 106.03(b)3.

(i) Other Material.

- Premolded Expansion Joint Filler—Section 705.1
- Closed Cell Neoprene Sponge—Section 1107.02(p)1
- Joint Sealing Material—Section 705.4(b), (c), or (d)
- Waterstops—Section 705.5
- Caulking Compound—Section 705.8
- Reinforcement—Section 1002.2
- Steel Welded Wire Fabric (WWF)—Section 709.3
- Deformed WWF—Section 704.4
- Deformed and Plain Bar Dowels—Section 709.1
- Structural Steel—Section 1105
- Waterproofing—Section 680.2
- Coarse Aggregate, No. 57—Section 703.2
- Conduits and Conduit Protective Coating—Sections 1101.09(b) and (d)
- Selected Borrow Excavation—Structure Backfill, Section 205 and as shown on the Standard Drawings.
- Anchor Bolts—Section 1105.02(c)2

- Asphalt Material, Class RC-250—Section 702
- Geotextiles, Class 1—Section 735
- Polyethylene Sheeting—Section 505.2
- Asphalt Impregnated Paper—Section 727
- Asphalt Cement, PG 64S-22—Section 702
- Epoxy Binder Resin—Bulletin 15 approved epoxy based surface treatment for bridge decks, epoxy binder resin component only.
- Epoxy Bonding Compound—Section 706.1.

(j) Tremie Cement Concrete. Use Class A cement concrete as specified in Section 704, modified as follows:

- Cement Factor (Min.) — 7.0 bags per cubic yard
- Slump—7 inches ± 1 inch
- Compressive Strength at 7 Days—2,000 pounds per square inch

Provide admixtures that retard concrete set 5 feet above and below the tremie pipe outlet, are compatible with the air entrainment agents, and do not allow excessive segregation of the aggregate.

(k) Concrete Bonding Compound. Section 706

(l) Anti-washout Admixture. Section 711.3(f) from a manufacturer listed in Bulletin 15. Certify as specified in Section 106.03(b)3.

1001.3 CONSTRUCTION—Construct as shown on the Standard Drawings and as follows:

(a) Forms and Centering.

1. General. Support forms so that deflection does not exceed 1/2 inch under plastic concrete. Before using forms, clean them and obtain approval for use. Use forms that are strong and firm; securely braced; tied together, if required, by means of form ties, tight enough to prevent the leakage of mortar; and strong enough to withstand the action of mechanical vibrators, if used.

Remove dirt, chips, sawdust, and other foreign materials before placing concrete. Except for stay-in-place forms, before placing reinforcing steel, thoroughly coat forms with a release agent. Coat forms for exposed surfaces with a nonstaining release agent.

Adequately brace forms. If forms are insufficiently braced or unsatisfactorily built, the work will be halted, either before or during concrete placement, until such defects have been satisfactorily corrected. Chamfer the edges as indicated. Do not leave wood separators in the completed work.

Do not use form support systems that will cause unacceptable overstress or deformation to permanent bridge members.

Use ties that are adjustable in length, to allow tightening of forms. Use ties that leave no metal in the concrete within 1 1/2 inches of the exposed surface. Do not fit ties with lugs, cones, washers, or other devices to act as spreaders within the form, or devices that leave depressions in back of the exposed surface of the concrete. Flat bands may be used, if the bands conform to the following:

- Not less than 3/4 inch wide.
- Not less than 14 gage thick.

- Placed on edge.
- Protected by adequate spreaders to prevent twisting during construction.

Do not use wire ties or thin, narrow, flat bands, except in the construction of endwalls, inlets, and manholes. Where necessary, coat the form ties with a release agent to facilitate removal. Do not damage the concrete on the exposed surface when removing forms and ties. Do not cut ties back from the concrete face.

Before starting construction, obtain acceptance of working drawings required for centering and falsework, as specified in Section 105.02(c). Before placing concrete, obtain acceptance of in-place forms. Camber the centering to compensate for dead-load deflection and settlement of centering. Provide for gradual and uniform lowering.

Where required, drench the inside of forms with water immediately before placing concrete.

2. Metal Bridge Deck Forms (Permanent). When portions of a bridge deck are constructed adjacent to each other and divided by an open or a preformed joint, do not use metal forms in the cantilever area on either side of the joint, except with prior written permission of the Chief Bridge Engineer.

Submit shop drawings of the forms as specified in Section 105.02(d) for review and acceptance. Include the following on the shop drawings:

- Grade of steel.
- Physical and section properties for permanent metal bridge deck form sheets.
- Methods of attachment.
- Locations where the forms are supported by steel beam flanges, subject to tensile stresses.

Prepare the drawings, conforming to the details and design shown on the Standard Drawings.

Before installing forms, submit for acceptance top of beam elevations in tenth points with tables showing beam haunches and deck elevations. For bridge deck replacements, before removing the existing deck, survey existing deck above beams at tenth points to determine deflection. If an asphalt overlay is present, remove before surveying. Tenth point surveys are incidental to the deck placement.

Before welding in a tension zone, make a test installation on a sample of a simulated flange, using the same welding procedure, materials, and fit-up that are to be used in the tension zone. Allow no burn-through of the parts being welded or fusion to the flange. Do not weld to flanges in tension zones. When this welding procedure has been satisfactorily demonstrated, do not deviate from that used in the test during welding in the tension zone.

Perform field cutting of forms, supports, and closures using saws, shears, or other acceptable methods. Do not cut by burning or melting. Make the attachments concrete tight. A fastening system, using a low-velocity, powder-actuated piston tool to attach forms to support angles, may be used. Thoroughly clean and wire brush form metal where galvanized coating has been damaged. Paint with two coats, no color added, according to ASTM A780. Areas of welds and of weld burns need not be touched up. Uncoated edges, resulting from shearing or punching, are acceptable.

(b) Reinforcement.

1. Reinforcement Bars. Section 1002.3. For bridge decks, also comply with the following:

Place bars as indicated. Use reinforcement chairs, spaced not greater than 3 feet apart, to maintain the position of bottom and top bars. Tie down the top bar mat as specified in Section 1002.3(d). Tie the top bar mat to the lower bar mat, forms or form straps, or studs or chairs tied to the lower mat, at sufficient locations to hold the reinforcement in the proper position. Provide beam haunch reinforcement as indicated and as shown on the Standard Drawings.

Use galvanized chairs with ASTM A641, Class 3 coating, or use stainless steel, plastic-coated or epoxy-coated steel chairs. Use chairs with exposed cut-ends coated or turned up.

Place reinforcement so the indicated cover clearance does not deviate from position by more than ±1/4 inch.

Do not place concrete until the reinforcing placement is accepted.

2. Steel WWF and Deformed WWF. Place as indicated. Lap ends and sides 12 inches. Fasten with annealed iron wire or metal clips.

(c) Weep Holes. Construct holes as indicated or directed. Place geotextiles, Class 1, as specified in Section 212.3. Then place approximately 1/2 cubic yard of No. 57 coarse aggregate within the geotextiles at the inlet end.

(d) Structure Foundation Drains. Construct as indicated. Place within geotextiles, Class 1, as specified in Section 212.3.

(e) Pipes and Conduits. Place pipes and conduits in the structure concrete as indicated, including pipes and conduits supplied by others. Maintain existing pipes and conduits, where indicated. If indicated, wrap pipes with asphalt impregnated paper.

(f) Placing Anchor Bolts and Expansion Plates. Place expansion plates, anchor bolts, pier nosing angles, and other material as indicated. Place anchor bolts as indicated or directed. Inspect and repair galvanizing on the projecting portions of anchor bolts as specified in Section 1105.02(s)2 as soon as practical after the anchor bolts have been set, but not until the surrounding concrete or grout has cured. Coat threads with grease.

If the bridge substructure and superstructure are built under separate contracts, proceed as specified in Section 1050.3(c)4.g.

(g) Placing Lighting Pole Anchorage. Construct the lighting pole anchorages as an integral part of the structure. Where indicated, install anchor bolts, nuts, and washers, as specified in Section 1105.02(c)2, 1 1/4-inch conduit, junction box, drain pipe, steel angles, and the required fittings. Cap the conduit with a cap or plug to prevent entry of foreign material and moisture.

For future lighting, protect the anchor bolts using a painted hardwood block.

(h) Consistency of Concrete at the Time of Placement. Do not add water to concrete in the field, unless authorized in writing by the District Executive. If written authorization is obtained, the quantity of water may be increased by a maximum of 1 gallon per cubic yard not to exceed maximum water cement ratio. Immediately remove free water, soft concrete, or mortar that appears on the surface of the concrete, and correct the cause of this condition.

For bridge decks, do not add water to concrete in the field. Adjustment of slump may be allowed by adding water reducer at the job site if a comprehensive procedure detailed in the QC plan has been submitted and accepted by the DME/DMM for this purpose.

(i) Mixing Conditions. Section 704.1(f)

(j) Proportioning and Mixing Concrete. Section 704

(k) Placing and Finishing Concrete.

1. General Requirements. At least 15 days before the element of work is started, submit, for review and acceptance, a QC Plan showing the methods, sequence, and schedule for placing concrete. Maintain material on hand and in place, if necessary, for curing and protecting the concrete. Before placing foundation concrete, ensure that the bearing area is firm, reasonably dry, and free of water. The Representative will inspect the foundation area for bearing capacity before placement. If directed, drill or drive a bar into the material below the foundation or footing bottom to a depth sufficient to determine the suitability of the material. Place concrete without segregation. Remove and discard any concrete that is segregated, too wet for use, or not of uniform consistency. Do not drop the concrete mixture a distance greater than 5 feet. Do not allow concrete to come in contact with aluminum, unless the aluminum is coated with an accepted coating.

Do not place consecutive batches adjacent to each other at concrete temperatures differing by more than 20F. Do not place concrete upon frozen foundation material, in forms containing frost, around frosted reinforcement, or in pile shells surrounded by ice or frozen earth.

For succeeding batches, place concrete in the forms within 30 minutes. Place concrete in horizontal layers no more than 15 inches in depth. Fill each part of the form by depositing the concrete as close to its final position as possible. Do not work or flow concrete along the forms from the point of deposit. Work the concrete without displacing the reinforcement. Place concrete so that the upper surface of the concrete is at the indicated elevation after it has been struck off and after initial shrinkage has taken place.

Finish exposed concrete surfaces accurately and evenly, free from open and rough areas, and free from depressions and projections. In bridge seats and walls, place concrete to the required elevation. Strike off with a

straightedge and float to the correct elevation. Do not add water or curing agent to the concrete surface to assist in finishing.

Finish bearing areas of substructures, as specified in Section 1001.3(k)9.

In areas where reinforcement extends through a construction joint, do not place concrete adjacent to previously placed concrete until at least 24 hours has elapsed.

2. Use of Vibrating Equipment. Keep sufficient vibration equipment in reserve to guard against a work shutdown, caused by the failure of the equipment in operation.

Use an acceptable mechanical vibrator. Do not attach it to the forms or reinforcement. Use a vibrator capable of transmitting vibration to the concrete with a frequency of not less than 100 impulses per second. Determine the vibrator size by the reinforcement spacing.

When sufficient concrete has been deposited, spade and manipulate it to fill the form. Apply the vibrator to the concrete, at intervals not exceeding 3 feet, immediately after the concrete has been deposited. Move the vibrator throughout the mass, completely working the concrete around the reinforcement and other embedded fixtures, and into the corners and angles of the forms. Correct any reinforcement displacement caused by the vibrator before continuing vibration. Move the vibrator slowly to prevent segregation. Do not use vibrators to spread concrete.

Remove and discard concrete segregated by the vibrating operation. Ensure that the vibrator does not penetrate or disturb partially hardened layers. Reinforcement in freshly placed concrete may be vibrated for short durations to ensure proper reinforcement embedment.

3. Placing Concrete in Water.

3.a General. When the depth of water in the foundation area is less than 1 inch, no adjustments to the specified class of concrete are required. When there is greater than 1 inch of water in the foundation, utilize an anti-washout admixture (AWA) as specified below unless otherwise approved by the DME/DMM based on a case specific justification. If use of the AWA is waived by the Representative, provide concrete with a 2.5 inch maximum slump and add 25% more cement than the quantity specified for the concrete class being used, as specified in Section 704.1(h).

Drilled shafts and caissons are exempt from this requirement. Do not deposit concrete in water having a temperature below 40F.

Utilize a mix design using an AWA to achieve a loss no more than 8.0% as determined by PTM No. 641.

If concrete with an AWA is placed below the frost line no air entrainment is required in the concrete mix design.

When concrete is placed above the frost line, design concrete to have an air content of 6.0%. Accept concrete at point of placement with an air content between 4.5% and 7.5%.

Limit the slump at point of placement to no more than 8.0 inches.

Hold a concrete placement meeting and present details of the placement to the Representative. Do not begin concrete placement until the placement procedures, concrete mix design, inspection procedures, and concrete sampling procedures have been accepted by the Representative.

If the tremie method is selected for placing concrete, submit a concrete placement procedure plan for approval at least 21 calendar days before performing the work, and include the following:

- Concrete mix design.
- Available concrete production capability.
- Availability and capacity of equipment to be used to transfer concrete to the tremie.
- The total volume of concrete to be placed.
- The various placement schemes available.
- Tremie locations.
- Maximum flow distance of concrete.

- Any restrictions to flow, such as reinforcing steel, piles, and internal form bracing.
- The method of sealing the tremies and the emergency restart procedure if the seal is broken.
- An inspection plan detailing sounding locations and the frequency of soundings. Take soundings over the entire placement area on, at least, an hourly basis.
- A concrete sampling and testing plan.

3.b Water Under 2 feet Deep. If placing concrete in water 2 feet deep or less, build the concrete above the water level in one end of the form, then place the concrete on top of the concrete above water, and gradually work ahead so that the smallest possible area of fresh concrete is exposed to the water.

3.c Water Over 2 feet Deep. If concrete is placed in water deeper than 2 feet, place in approximately horizontal layers, in a consolidated mass in its final position, using the tremie method or other acceptable method, and do not disturb after placing. Do not place concrete with bottom-dump buckets.

Use tight forms, constructed to retain concrete under water, and maintain still water within the forms. Regulate the consistency of the concrete to prevent segregation of the material.

Before placing tremie concrete, ensure the foundation area is level, and forms and surfaces are free of mud and silt.

Use a tremie with a smooth interior face; and watertight discharge tube at least 10 inches in diameter, long enough to reach the bottom of the placement, and marked in 1-foot increments. Provide a valve or similar device, including various types of plugs, at the lower end of the discharge tube that closes tightly while the tremie is being charged and lowered into position, and that can be fully opened in the lowered position. Attach tremie tube to a funnel or hopper of at least 1/2-cubic yard capacity to facilitate transfer of concrete to the tremie. Do not use tremie tubes fabricated from aluminum. Furnish at least two tremie tubes to ensure continuous concrete placement. Do not place tremie concrete by pumping directly to the bottom of placement. Place tremie concrete only in the presence of the Representative.

Maneuver the tremie tube by using an accurately controlled crane or hoist that allows free vertical movement of the discharge end of the tube. Keep the concrete level in the tremie tube stable. Maintain the equilibrium level. Keep the discharge end of the tremie tube fully submerged in the freshly deposited concrete. Keep the tremie tube relatively motionless. Do not move the tremie laterally during concrete placement.

Place tremie concrete in one continuous operation. Place concrete at a rate that prevents aggregate segregation and allows flow over the entire placement area. Keep the top surface of concrete as level as possible. Maintain balanced hydrostatic pressures to prevent form failure and movement of water through the plastic concrete.

When the tremie concrete has reached a minimum compressive strength of 2,000 pounds per square inch, proceed with dewatering of forms. Upon completion of dewatering, and in the presence of the Representative, thoroughly inspect the hardened tremie concrete. Remove laitance and other undesirable material by chipping, scraping, or other means that are not detrimental to the sound concrete. Visually inspect tremie slabs 3 feet or less in thickness, and if any areas of the concrete are suspect, drill cores as directed. For slabs greater than 3 feet in thickness, verify concrete integrity by drilling four 2-inch diameter cores, or one 2-inch core for every 100 square feet of slab area, whichever is greater. Drill additional cores as directed. Use a double tube core barrel with a diamond bit to obtain the cores. Do not exceed 5 feet for individual core runs. Drill cores from the top of the tremie slab to within 12 inches of the bottom. Operate drilling equipment at speeds and pressures that ensure satisfactory core recovery. Pull the core at the end of each run. Identify and store to preserve the integrity of the cores. Record the existence of any void areas or other concrete deficiencies. If defective concrete areas or voids are found, fill with pressure grout or Class A cement concrete as directed. Completely fill core holes as specified in Section 1001.3(k)11. Upon completion of the project, dispose of cores in a satisfactory manner.

4. Pumping Concrete.

4.a Concrete Pump and Reduction Device. Provide a concrete pump with a flexible end section at least 10 feet long equipped with a reduction device or combination of devices to provide a steady and continous discharge. Devices that may be used include, but are not limited to, a combination of 90 degree angles, a tapered reduction hose, a slide gate, a 6-foot diameter loop in rubber hose, or a finger reducer. Pump and waste enough material through the pump to insure that the grout used to prime the pump has been discharged from the system.

4.b Determining QC and Acceptance Testing Location. The location of the QC sampling and acceptance sampling will be determined daily on the first load of concrete and for every 200 cubic yard therafter, by the following procedure:

- Provide a concrete mixture in conformance with specification requirements in Section 704 for slump, air content, and temperature before placement into the pump.
- Obtain a sample of concrete before placement in the pump and perform slump and air content tests.
- Position the pump into the most severe vertical drop boom configuration, or, when pumping from the same elevation as the placement, at the longest horizontal section configuration that will occur during placement.
- Obtain a sample of conrete at the discharge end of the pump and perform slump and air content tests.
- The air content must conform to the requirements as specified in Section 704.1(c)3.

If the test results for slump and air content taken at the discharge end of the pump are within ± 1.0 inch of the slump and ± 1.0% of the air content taken before placement into the pump, QC and acceptance testing may be performed before placement into the pump. If the test results are not within these tolerances, acceptance testing will be performed at the discharge end of the pump.

The Representative may require acceptance testing and QC testing to be performed at the point of placement at any time the quality of the material comes into question.

If more than one pump is utilized during a placement, each pump must comply with the above procedure.

5. Superstructures. When constructing superstructures, place the concrete in one continuous operation, unless otherwise indicated, specified, or directed.

Before constructing spandrel walls, barriers, or other concrete construction placed on concrete slab, T-beam, rigid frame superstructures, or open or closed spandrel arches, relieve the supporting centering of falsework to allow the superstructures to take part of the permanent deflection.

Do not place barriers for concrete rigid frame structures until after completing the backfilling and the embankment adjacent to the structures.

6. Bridge Decks. Follow the procedure as specified below:

6.a Pre-Placement Meeting. At least 2 weeks before concrete deck placement, schedule a deck pre-placement meeting to review the specification, method and sequence of placing deck concrete, quality control testing, and method of protective measures, to control the concrete evaporation rate.

6.b Ambient Conditions During Placement. Place concrete at a concrete temperature between 50F and 80F. Do not proceed with mixing and placement operations if the forecasted ambient temperature is expected to reach 80F within the scheduled placement time or if the evaporation rate will exceed 0.06 pounds per square foot per hour. Unless otherwise authorized in writing by the District Executive, do not start the placement operation unless the ambient air temperature is a minimum of 40F and rising and is predicted to stay above 40F throughout the placement operation. Do not proceed with placement operations if the temperature of the concrete and surfaces to be in contact with concrete differ by more than 22F.

Provide the necessary equipment and determine the evaporation rate before starting deck placement and every hour during the placement. Do not exceed an evaporation rate of 0.06 pounds per square foot per hour.

6.c Finishing Equipment. Have readily available at the bridge deck placement site, remediation equipment and procedures as submitted, accepted, and demonstrated during the dry run before starting the placement. If the evaporation rate in Section 1001.3(k)6.b is exceeded, stop concrete placement until protective measures are taken to reduce the values to an acceptable level.

Fog cure misting is an acceptable method to mitigate an excessive evaporation rate. Use high or low pressure equipment equipped with nozzles that atomize droplets and can keep a large surface damp without causing water deposits.

Apply the fog over the entire placement area behind the finishing operation, not covered by wet burlap when the evaporation rate in Section 1001.3(k)6.b is exceeded. Do not leave concrete exposed for an extended duration.

Place concrete no greater than 5 feet ahead of finishing machine to prevent any premature drying, unless concrete will be finished within 15 minutes.

Use self-propelled, motorized, mechanical finishing equipment capable of applying vibration to the plastic deck surface through the use of a separate attachment from the machine manufacturer or by other approved means. Use a finishing machine capable of forward and reverse movement under positive control. Make provision for raising screeds to clear the surface when traveling in reverse. Submit a sketch to the Inspector-in-Charge, describing the equipment and showing complete details of supports for the equipment. Vibrating screeds may be used, with the written permission of the District Executive. Vibrating screeds are to be power-vibrated and moved by means of a positive, power-operated apparatus, but are not to be a substitute for high-frequency vibrators. Hand-finishing methods will be allowed outside mechanically screeded areas and to a placed bulkhead in cases of power equipment failures. Use strike-off finishing machines or screeds large enough to finish the full width of deck between curbs or between longitudinal construction joints, or between both.

When strike-off finishing machines are used, support the wheels above the pavement surface on temporary rails, supported on non-deflecting forms or other horizontal structural devices. When vibrating air screeds are allowed, provide a temporary rail system that is supported above the concrete deck surface.Support vibrating screeds on temporary pipe guides or on-grade angles. Use adjustable finishing machine supports or vertical supports for screed guides. Fix supports during finishing, at intervals to limit deflection to not more than 1/8 inch in 10 feet. Do not place supports where concrete is to be placed unless allowed in writing by the District Executive. If allowed, use supports that are removable to at least 2 inches below the surface with a minimum disturbance of concrete. Fill voids left upon removal of screed guides and supports with nonstaining, nonshrinking mortar, after the deck concrete has reached its initial set.

6.d Concrete Placement and Finishing. For rigid frame decks, place the concrete from the center of the span toward each leg or abutment simultaneously. Continuously check falsework or supporting beams so the concrete, as placed, meets the lines and grades indicated. Keep wedges and blocking tight during placement of the concrete.

Use a placing sequence as indicated in the contract drawings or as accepted by the Structure Control Engineer.

Unless allowed in writing by the District Executive, do not allow truck mixers, truck agitators, or other heavy motorized equipment on the deck spans in which concrete is being placed.

Provide sufficient materials at the work site, during concrete deck placement, to protect the bridge deck concrete against rain before initial set. If rain begins, stop placement operations and immediately cover the concrete with protective materials.

If it is necessary to stop operations, due to weather or operational conditions, provide full depth bulkheads at the work site, and place them as directed. Remove bulkheads before resuming concrete placement operations.

Obtain acceptance of changes or additions to indicated construction joints, before incorporating into the work.

Adjust the deck openings at expansion joints and at expansion dams at the time concrete is placed to provide the openings indicated at 68F under full dead load.

Do not allow screed or runway supports to bear on the forms, unless direct undersupport is provided to prevent form damage or deflection. Do not discharge concrete near side laps or at midspan of the corrugated sheets, to a depth greater than 10 inches above the top of the forms. Do not discharge concrete in a manner that causes excessive concentrated construction loads.

Place concrete, at a minimum rate of 20 linear feet of deck per hour, in a longitudinal direction, except for reinforced concrete slabs and rigid frames.

Vibrate the concrete to prevent honeycombing and voids, especially at construction joints, expansion joints, valleys, and ends of form sheets. Obtain acceptance of placing sequences, procedures, and mixes before placing concrete.

Repair or replace damaged material.

Conduct final finishing operations immediately behind the finishing machines or screeds from work bridges of rigid construction, not in contact with the surface of the concrete, set on rails, and easily moved. Finish with a 10-foot, long-handled straightedge to achieve a smooth surface. Make one pass of the float if the concrete surface remains open after the finishing machine operations. Do not overfinish concrete. Use of steel trowels and fresno floats are prohibited.

Perform straightedge testing and surface correction as specified in Section 501.3(k)3 while the concrete is workable. After completing the straightedge testing and surface corrections, before the concrete becomes nonplastic, manually texture/tine the surface transversely as specified in Section 501.3(k)4.b. Immediately after texturing/tining operations are completed, perform intermediate curing as specified in Section 1001.3(p)3.c.

When mechanical texturing is indicated, immediately after straightedge testing and surface correction, provide initial texturing with a burlap drag or broom device to produce striations parallel with centerline. Provide a drag that

produces a uniform surface of gritty texture without blemishes, marks, tears and scratches deeper than 1/16 inch. Replace the drag as necessary to produce the desired finish. Water cure as specified in Section 1001.3(p)3.b.2 after the initial texturing operation.

6.e Concrete Curing and Testing. Cure the deck as specified in Section 1001.3(p)3.b.2. Maintain wet burlap application within 15 feet behind the finishing equipment. Minimal marking of the concrete is allowed. Following cure, test the surface again, as specified in Section 501.3(o). If directed to facilitate inspection, remove at least one section of permanent forms, at a location directed, for each span of every bridge in the project. After the deck concrete has been in place for a minimum period of 2 days, test the concrete by sounding with a hammer, where directed. If unsound or unconsolidated areas are found, or full depth cracking is visible, remove the forms as directed for inspection after the concrete has attained adequate strength. The forms need not be replaced. Repair the adjacent metal forms and supports in order to present a neat appearance. Remove or repair unsatisfactory concrete. Provide facilities for the safe and convenient conduct of the inspection.

6.f Mechanical Texturing. Provide mechanical texturing for bridge decks and approach slabs when indicated.

Do not begin grooving operations until directed and live loads can be applied as specified in Section 1001.3(q)2.2c.

Do not begin grooving operations until the surface tolerance has been checked and any high points are removed as specified in Section 501.3(o).

Terminate grooves 12 inches from gutter lines and scuppers.

Terminate grooves within 5 inches, but no closer than 3 inches of bridge joints. Use smaller grooving machine or hand held circular saw with diamond blade and guide to control depth of grooves at skewed joints or low spots missed with larger equipment to provide a uniformly grooved bridge deck where grooves terminate within 5 inches, but no closer than 3 inches of skewed joints.

Do not overlap sawed grooves or leave more than 1 inch of the surface without sawed grooves between passes or where a single pass of the grooving machine cannot be made.

Remove and collect debris and slurry resulting from the grooving operations concurrently with the grooving operations. Surfaces are to be immediately left in a washed and clean condition, free from slurry and debris.

Do not open to traffic until mechanical texturing is complete.

6.f.1 Test Area. Do not begin production grooving operations until the test area is accepted.

- **Transverse Sawed Grooves.** Perform a test pass of the grooving equipment. The test area is the width of a single pass of production grooving equipment by a length of one lane width. Check groove widths, depths and spacing to ensure conformance to requirements specified in Section 1001.3(k)6.f.2.

- **Longitudinal Sawed Grooves.** Perform a test pass of the grooving equipment. The test area is the width of a single pass of production grooving equipment by a length of ten feet longitudinally in one lane. Check groove widths, depths and spacing to ensure conformance to requirements specified in Section 1001.3(k)6.f.3.

6.f.2 Mechanical Texturing with Transverse Sawed Grooves. Texture the deck surface with transverse sawed grooves with the following characteristics:

- Perpendicular with centerline
- Rectangular in shape
- 1/8 inch (± 1/32 inch) in width
- 1/8 inch to 3/16 inch in depth
- Random groove pattern of 1.5 inches, 1.75 inches and 2 inches nominal center-to-center sawed groove spacing

6.f.3 Mechanical Texturing with Longitudinal Sawed Grooves. Texture the deck surface with longitudinal sawed grooves with the following characteristics:

- Parallel with centerline

- Rectangular in shape for straight bridge decks, sawed along the curve for curved bridge decks
- 1/8 inch (± 1/32 inch) in width
- 1/8 inch to 3/16 inch in depth
- 3/4 inch nominal center-to-center sawed groove spacing

7. Reinforced Concrete Arches. Place the concrete symmetrically on each side of the span and progress uniformly from the spring line to the crown.

8. Reinforced Concrete Box Culverts. Place concrete in the base slab with horizontal construction joints formed in the sidewalls as indicated. Form horizontal construction joints to provide keys, as shown on the Standard Drawings.

When the concrete has reached the top of the sidewall, stop the concrete operation for 2 hours to allow for settlement of the wall concrete before placing the top slab.

9. Bearing Areas of Substructures. As indicated, construct concrete bearing areas of substructures upon which neoprene pads, masonry plates, shoes, pedestals, column bases, or other metallic bearing devices are to be placed. Slope areas between and surrounding bearings to drain so no water accumulates or stands at any point. After curing, grind the defined bearing area to the indicated elevations, as necessary, according to the following tolerances:

- Deviation from specified elevations:
  - For steel beam superstructures, ±0.01 feet, except do not exceed a 0.01 feet difference between specified elevations of bearing areas of adjacent beams measured at the centerline of beams and centerline of bearings.
  - For prestressed concrete beam superstructures, ±0.02 feet
- Having no projecting irregularities exceeding 1/16 inch
- Variations in flatness:
  - For neoprene pads, ±1/16 inch
  - For metal bearings and high load multi-rotational bearings:
    - Bearing seats up to 30 inches long, ±1/16 inch
    - Bearing seats over 30 inches but less than 45 inches long, ±3/32 inch
    - Bearing seats over 45 inches long, ±1/8 inch
- Variation in slope between specified elevations for each beam seat:
  - For neoprene pads, 300:1
  - For metal bearing and high load multi-rotational bearings, 200:1

Submit as-built beam seat elevations for review and acceptance. Provide drawings and/or spreadsheets stamped by a professional land surveyor or professional engineer registered in the State. Do not set beams until accepted. For beam seat elevations that do not meet the tolerances above, submit a corrective action plan for review and acceptance. Do not set beams until the corrective action plan is accepted.

When using neoprene pads, provide a bearing surface with a rough texture.

For metal and high-load multi-rotational bearings, fill minor depressions caused by finishing, bush hammering, or grinding with a low-viscosity epoxy applied with a squeegee.

10. Final Finishes.

10.a Conventional Finish. Do not brush or bag finish, or paint with grout or neat cement. After the forms are removed, correct irregularities in the exposed concrete surfaces. Exposed surfaces are surfaces above normal ground level or water level, when applicable, and surfaces that will not be concealed by other construction. Irregularities include fins, protrusions, individual holes larger than 1 inch in any dimension, and clusters of smaller holes.

10.b Tooled Finish. Tool finish surfaces as indicated by cutting into the body of the concrete with a pointed tool or bush hammer until the concrete surface shows a grouping of broken aggregate particles in a matrix of mortar.

10.c Other Finishes. Finish surfaces by other methods as indicated.

11. Patching. Saturate holes with water and, immediately, completely fill the holes with nonstaining, nonshrinking mortar. For holes passing entirely through walls, use a plunger-type caulking gun or other device to force the mortar through the wall starting at the back face. Hold a piece of burlap or canvas over the hole on the front face. Then, when the hole is completely filled, strike off the excess mortar until the mortar is flush with the surface. Completely fill holes not passing entirely through the wall by ramming the mortar in place with a suitable tool. Strike off the excess material until the material is flush with the wall surface.

For minor patching, treat concrete surfaces to be patched with a paint coat mixture of neat cement and water. Tamp mortar into place manually, preferably to at least 1/2 inch depth. When possible, overfill spaces being repaired. Allow the excess to stand for 5 minutes, then strike off and finish without excess troweling. Where the space cannot be overfilled, finish immediately. Cure for at least 3 days using an acceptable method that ensures against loss of moisture by evaporation. When required for all or part of the curing period, hold the mortar in place or support by using an acceptable method that ensures retention of the mortar without its drying out.

12. Concrete Bridge Barriers. Construct barrier as indicated and as shown on the Standard Drawings using either a slip form or conventional fixed forms. Conform to the following finished tolerances for both slip-form and conventional fixed-form methods of bridge barrier construction:

• Bar Reinforcement Cover	±1/4 inch
• Width (Top)	±1/4 inch
• Width (Bottom)	±1/4 inch
• Surface Straightness (Deviation from centerline of individual section of unit)	1/4 inch in 10 feet
• Vertical Profile Alignment (Deviation from a line parallel to the grade line)	1/4 inch in 10 feet
• Alignment with Edge of Bridge Deck	1/4 inch in 10 feet

Test surface straightness and vertical alignment along the front face, top, and rear face of the barrier using a 10-foot straightedge. Hold the straightedge in successive positions for the entire length of the barrier and advance in stages of not more than 5 feet.

Cure barrier as specified in Section 1001.3(p).

12.a Fixed Formed Bridge Barriers. For the fixed form method, provide and install formwork as specified in Section 1001.3(a). Drilling or nailing into the bridge deck for the attachment of formwork is not allowed. Place barrier concrete in three lifts with the first lift being 8 inches in height. Ensure vibration and consolidation at gutterlines. Place remaining two lifts equal in height. Extend vibration equipment from second lift into the first and third lift into the second to ensure consolidation within the entire barrier placement.

12.b Slip-Formed Bridge Barriers. If the slip-form method is used, submit a QC Plan at least 15 calendar days before beginning slip-forming. Obtain acceptance of the QC Plan before placing barrier concrete. As a minimum, include in the QC Plan the type of equipment, materials, slump target and range, coarse aggregate source and procedures required for the test section and to construct the barrier. Furnish concrete conforming to the QC Plan.

If the finished tolerances, specified in Section 1001.3(k)12., cannot be maintained during production, stop slip-forming operations, remove the unacceptable work, and modify the operation. If the modifications do not produce acceptable results, as specified in Section 1001.3(k)12., use the fixed-form method of construction, as specified in Section 1001.3(a). The Department will not grant additional compensation or additional time as a result of required removals, modifications, or changes resulting from the method of forming concrete bridge barriers.

12.b.1 Test Section. Construct one 50-foot test section per project to demonstrate that an acceptable product can be produced. Construct this test section at a location near the project site using the same equipment, material, personnel, and procedures as described in the QC Plan. Construct an additional test section if any changes in equipment, material, procedures, or personnel are made. Place the test section on a concrete slab with reinforcing steel to simulate actual conditions. With the District Executive's written approval, the test section may be constructed

in-place, on the bridge structure. The test section will consist of the first 50 feet of the bridge barrier placed. Include in the submission to the District Executive, documentation of past experience constructing slip-form bridge barriers, with contract references

Test concrete as specified in Section 704. In addition, obtain three test cores from the test section, according to PTM No. 1. Submit cores to LTS to be tested for information. Repair tears as directed. Honeycombing, sags, tears, or other evidence of poor quality concrete that cannot be satisfactorily repaired without the use of water or extra concrete or grout, will be cause for rejection of the test section. Test reinforcement cover, in the presence of the Representative, using a Pachometer, or other non-destructive test method.

The Representative will evaluate the procedure, material, equipment, and appearance of the test section. If the test section is rejected by the Representative, place an additional test section, with the approval of the Representative, or use the fixed-form method of construction. Remove and dispose of rejected test sections. Leave the accepted test section in place until the slip-formed bridge barriers are complete. The slip-formed bridge barriers will be compared to the accepted test section to ensure that similar, acceptable quality is being achieved. If the test section was not constructed in place on the bridge structure, remove and dispose of the test section following completion and final acceptance of slip-formed bridge barriers.

12.b.2 Construction of Slip Formed Bridge Barriers. After set up, make a dry run of the equipment to ensure it will clear obstacles to be embedded or flush with surfaces, such as pull boxes, expansion joint plates, and light standard foundations. Ensure that clearances for concrete cover are maintained on reinforcement bars. If modifications are necessary, correct any deficiencies and perform another dry run, in the presence of the Representative, before starting the slip-form operation. At no additional cost to the Department, place additional epoxy-coated reinforcing steel to provide bracing for the barrier against displacement due to the pressure developed by the slip-form extruding process. If applicable, apply a uniform coat of concrete bonding compound as specified in Section 706 and according to the manufacturer's recommendations, to the interface between the hardened concrete bridge deck surface and the slip-formed bridge barrier, before the slip-forming operation. Coordinate operations for mixing, delivering and placing of concrete with minimal stopping and restarting of the slip-form machine and according to the QC Plan. Do not allow vehicular traffic on the bridge while slip-forming operations are in progress, except for slip-form machine and supply trucks. Meet temperature and humidity requirements as specified in Section 1001.3(k)3.

Ensure that the barrier maintains its shape, without support, after extrusion. If honeycombing, sagging, or tearing of the bridge barrier occurs during the slip forming operation, repair according to the approved QC Plan. Ensure that the completed surface is free of honeycombing, sags and tears, and finish with a light vertical brushing.

Mark the bridge deck in advance of the concreting operation to ensure that saw cuts are made at the indicated locations and do not conflict with the reinforcing steel pattern. Space joints as indicated. Accurately locate saw cut joints to ensure the reinforcement steel will have the specified cover. Saw cut as soon as possible after concrete has set sufficiently to preclude raveling during the sawing, and before any shrinkage cracking occurs in the concrete. Saw cut joints, 1/8 inch wide and 3/4 inch deep, in the top, outside, and inside faces. Complete saw cuts 3 inches above the top of the deck slab or pavement surface.

(l) Not used.

(m) Connections of Existing and New Concrete.

1. Terms. The terms “new concrete construction,” “fresh concrete,” and “hardened concrete” refer to work performed under the current contract. “Hardened concrete” has cured for a minimum of 28 days.

The terms “existing concrete structures” and “existing concrete” refer to work performed under a previous contract.

2. General. To connect fresh concrete with hardened or existing concrete, thoroughly clean the connecting surface of laitance and loose and foreign material before applying the Type II (in a non-load bearing joint) or Type V (in a load bearing joint) epoxy bonding compound as specified in Section 706.

Coat contact surfaces with concrete bonding compound at construction joints between fresh concrete and existing concrete. Coat contact surfaces with concrete bonding compounds to connect fresh concrete with hardened concrete at deck construction joints, deck expansion joints, expansion dam block out areas, and where indicated, as specified in Section 1040.3(e). Coat contact surfaces with concrete bonding compound to connect fresh concrete with hardened or existing deck concrete for Slip-Formed Bridge Barriers as specified in Section 1040.3(e) and Section 1001.3(k)12.b.2. Coat surfaces according to the manufacturer’s recommendations. Use of other bonding compound

coatings extends the period after coating between placement pours, but in no case longer than 24 hours (typical), or according to the manufacturer's recommended viability of the coating, whichever is less.

3. Tied Connections. Where indicated, to connect new concrete construction to existing concrete structures, use drill holes of the required depth and diameter in the existing structure to allow placing dowel bars, expansion bolts, or extensions of reinforcement. Furnish and place in the holes, dowel bars, expansion bolts, and reinforcement of the size and type indicated. Grout studs, dowels, and anchor bolts with nonshrink grout or anchor as indicated.

(n) Joints. Rivet or fold-seam the splices of metal waterstops before soldering. Make splices for rubber, plastic and similar waterstops according to the manufacturer's recommendations.

If the construction plane is to be horizontal and concrete placement is stopped for more than 30 minutes, provide acceptable keyways and sufficient dowel bars.

When directed, place vertical construction joints, then place acceptable dowel bars as required.

(o) Not used.

(p) Curing and Protection of Concrete. Begin curing as soon as the concrete has been placed and is sufficiently hardened. Cure concrete as specified in Section 1001.3(p)3.

1. Definitions of Temperatures.

1.a Air Temperature. Section 101.03

1.b Curing Temperature. Curing temperature is the temperature of the air immediately adjacent to concrete. Where concrete is not covered by forms or other protective coverings, or where protective coverings are considered inadequate, the curing temperature will be the air temperature. During cool and cold weather, the curing temperature is the temperature inside the forms, protective coverings, or housings specified in Section 1001.3(p)4 and Section 1001.3(p)5. The curing temperature for the first 24-hour period after placing concrete will be considered as not more than the temperature of the concrete at the time of its placement in the forms.

2. Curing Days, Curing Temperatures, and Records of Temperature. Do not count as a curing day, a day on which the curing temperature drops below 50F at any time during that day, except for flood curing of footings. For bridge decks, during day 1 through day 7, do not count as a curing day, a day on which the curing temperature drops below 50F. During day 8 through day 14, do not count as a curing day, a day on which the curing temperature drops below 40F. If at any time during the curing period, the curing temperature falls below 35F, the Department will consider the work unsatisfactory and will reject it.

Provide high-low thermometers to maintain an accurate daily record of air and curing temperatures during cool and cold weather. In the presence of an Inspector, take curing temperatures on the surface of the concrete, at representative locations on a structure. Submit these temperature records daily to the Inspector-in-Charge.

3. Normal Curing and Protection.

3.a Liquid Membrane-Forming Curing Compound. Utilize a white liquid membrane-forming curing compound. Apply curing compound according to the manufacturer's recommendations and as follows:

For surfaces cured by the liquid membrane-forming curing compound method, finish before application of the curing compound. Apply curing compound in two coats, by spraying, to provide a continuous, uniform membrane. For each coat, apply at least 1 gallon of curing compound per 300 square feet of concrete. After the first application has set, apply the second coat at a direction perpendicular to the first application. Do not apply curing compound to construction joint surfaces. Protect exposed steel during application of curing compound. Water cure these areas, as specified in Section 1001.3(p)3.b. If curing compound is damaged or peels from concrete surfaces, repair immediately.

Protect the curing compound against damage for a minimum of 7 days. Re-apply an additional coat of curing compound to any damaged areas at no additional cost to the Department. Should the curing compound be subjected to continuous damage, the Representative may limit work until the 7-day period is complete. Reduction of the 7-day period will not be allowed under any circumstance.

3.a.1 Formed Surfaces. For formed surfaces, perform water curing during the finishing period and until forms are removed. Apply the first coat of curing compound immediately after stripping forms, and after acceptance

of the concrete finish. If the surface is dry, soak the concrete with water, and apply the curing compound just as the surface film of water disappears. During spray-curing operations, keep unsprayed surfaces wet with water.

3.a.2 Unformed Surfaces. Apply curing compound to unformed surfaces immediately after finishing operations have been completed and after the surface film of water has disappeared. When applying curing compound after water curing to unformed surfaces, apply curing compound onto the surface within 30 minutes of removing the curing covers. Apply curing compound when no free water remains on the surface, but while the surface is still saturated. If the surface is dry or becomes dry, thoroughly wet the surface using a fogger or mister.

3.b Water Curing.

3.b.1 General. Use curing covers of either a double thickness of burlap, white polyethylene sheeting placed on top of a single layer of burlap, or burlap-backed white polyethylene sheeting. Use one type of cover for the duration of curing, unless a change in type is accepted or a combination of covers are accepted. Place curing covers in a manner that minimizes marring of the finished surface. Secure curing covers to prevent lifting or displacement due to adjacent construction operations or wind. Provide a minimum of 2 feet overlap at white polyethelyne sheeting edges. Replace any torn or damaged curing covers as directed. If curing covers are temporarily removed for any reason during the curing period, use watering devices to keep the entire exposed area continuously wet. Replace saturated curing covers as soon as possible.

Saturate curing covers before use and keep in a saturated condition for the curing period. Soak burlap for a minimum of 48 hours before placement. Re-wet burlap as needed before placement. During times of delay expected to exceed 10 minutes, cover concrete that has been placed, but not finished, with wet burlap.

As soon as the concrete can support curing covers, place curing covers on the exposed concrete. Minimal marking of the concrete from curing covers is allowed. If the double thickness of burlap method is used, place second layer of burlap so each strip overlaps one-half the width of the preceding layer. Maintain curing covers in a fully wet condition using misting hoses, fogging machines, or other accepted devices until the concrete has sufficiently hardened to support watering devices.

As soon as forms or sections of forms are loosened or removed, cover the exposed concrete surfaces with pre-saturated curing covers, then keep saturated for the remainder of the curing period.

Use a fog-spray, perforated pipe, sprinkler, soaker hose, or other accepted watering devices to keep forms and curing covers saturated during the curing period. For curing and protecting covers on endwalls, inlets, manholes, copings, bridge seats, and similar miscellaneous concrete, keep saturated using an acceptable method. Flood curing of concrete footings will be allowed if the water temperature is 40F or above.

Cure for a minimum of 7 days and until minimum compressive strengths are attained, as specified in Section 704.1(d)4.b, as determined from molded cylinder specimens tested according to PTM No. 604.

3.b.2 Bridge Decks, Bridge Deck Patches, Expansion Dam Blockouts, Cast in Place (CIP) Box Culverts at Grade, and Box Culvert Distribution Slabs at Grade. Provide water curing as specified in Section 1001.3(p)3.b.1 and as follows:

Provide curing water that is a minimum of 50F for the entire water curing period. Use only a double thickness of burlap for curing covers. Apply two layers of wet burlap within 15 feet of strike-off from the finishing machine. Do not allow burlap stacked on a work bridge to drip onto the finished surface. Keep work bridge with stacked burlap over covered surfaces or reverse work bridge over covered surfaces when not placing burlap. Do not allow the surface to dry after strike-off, or at any time during the curing period. Maintain burlap in a fully wet condition using misting hoses, fogging machines, or other accepted devices that span the entire burlap covered surface until the concrete has sufficiently hardened to support foot traffic. At that time, place soaker hoses, sprinklers, or other accepted watering devices to maintain continuous saturation of burlap over the entire surface. At a minimum, place watering devices at grade breaks and high sides of superelevations to ensure continuous saturation.

Water cure for a minimum of 14 days. After 14 curing days, if the 14-day QC compressive strength result is greater than or equal to 3,500 pounds per square inch, water cure may discontinue for the lot of concrete represented by the QC cylinders. If the 14-day QC cylinders are less than 3,500 pounds per square inch, continue water curing until the 28 day minimum mix design strength is obtained, or for a maximum of 28 curing days. At the end of the water curing period, remove the wet burlap. While the surface is still saturated, place white polyethylene sheeting. If dry spots are present, ensure entire surface is saturated before placing white polyethylene sheeting. Keep white polyethylene sheeting in place for 7 days. When cool or cold weather curing and protection is required, leaving the insulation in place for 7 days after water curing instead of placing white polyethylene sheeting is allowed. For bridge deck patches and expansion dam blockouts, 7 day polyethylene sheeting is not required.

3.b.3 Approach Slabs. Section 1001.3(p)3.b.1 except use only a double thickness of burlap for curing covers.

3.c Bridge Deck Intermediate Curing. For manually textured decks in the plastic state or as directed by the Representative, apply an intermediate monomolecular film curing agent after the finishing operation. If directed, apply additional applications to prevent surface drying before placement of curing covers.

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 monomolecular film in a continuous film, immediately after the final finishing operation is completed on any area. Do not perform finishing after application of the curing agent.

After application of the monomolecular film, complete curing using water.

3.d Accelerated Structural Concrete (ASC) Curing. When ASC is indicated, cure using white liquid membrane-forming curing compound as specified in Section 1001.3(p)3.a except apply as many uniform continuous coats of curing compound until the surface is equal in appearance to that of a sheet of white copy paper. The 7 day protection is not required. After application of curing compound, place insulation mats or heated curing blankets until a compressive strength of 3,000 pounds per square inch is attained.

3.e High Early Strength Concrete (HES) Curing. When HES is indicated, water cure as specified in Section 1001.3(p)3.b.1 except use only a double thickness of burlap for curing covers and cure for a minimum of 3 days. If the 3-day QC compressive strength result is greater than or equal to 3,000 pounds per square inch, water cure may discontinue for the lot of concrete represented by the QC cylinders. If the 3-day QC cylinders are less than 3,000 pounds per square inch, continue water curing until the 28 day minimum mix design strength is obtained, or for a maximum of 28 curing days. At the end of the water curing period, remove the wet burlap and apply liquid membrane-forming curing compound as specified in Section 1001.3(p)3.a except the 7 day protection is not required.

4. Cool Weather Curing and Protection. If the forecasted air temperature during concrete curing is expected to drop to 50F but not below 35F, or if concrete is placed at an air temperature below 50F but above 35F, follow the requirements specified for normal curing and protection. In addition, cover burlap with polyethylene sheeting and insulation mats as specified in Section 1001.3(p)7. Keep insulation mats in place during curing as required to maintain curing temperatures. Use heating as required during curing to maintain curing temperatures.

5. Cold Weather Curing and Protection. If the forecasted air temperature is expected to drop to 35F or lower, during concrete curing, or if concrete is to be placed at air temperatures below 35F, follow the requirements specified for normal curing and protection. In addition, cover burlap with polyethylene sheeting and insulation mats as specified in Section 1001.3(p)7. Keep insulation mats in place during curing as required to maintain curing temperatures. Use heating as required during curing to maintain curing temperatures.

If forms are removed before the end of the curing period, provide additional heating or insulation, as required, to maintain the curing temperatures for the remainder of the curing period.

After the concrete has cured for the required length of time, gradually lower its temperature to that of the surrounding air. Do not allow the temperature of the concrete to drop more than 20F in any 24-hour period for the first 3 days after the curing period. Continue to record the air temperature and curing temperature during this 3-day period.

6. Heating During Cool and Cold Weather Placement and Curing. Furnish and place sufficient canvas and frames, or another type of housing to enclose and protect fresh concrete, forms, and to protect concrete during curing. Before placing concrete, furnish necessary fuel and sufficient acceptable heating apparatus; preferably steam-heating equipment.

Keep air surrounding fresh concrete during placement at a temperature above 50F but not more than 80F. Maintain temperature of air surrounding concrete during curing as specified in Section 1001.3(p)2. Keep the concrete covers wet during the curing period. Do not allow the temperature difference between the concrete and surfaces in contact with concrete to exceed 22F during concrete placement and curing.

7. Insulating Mats or Foam Insulation. Insulating mats or foam insulation, as specified in Section 711.1(e) and Section 711.1(f), respectively, may be used to maintain curing temperature.

Apply the mat insulation tightly against the forms. Seal the ends of the mat to exclude air and moisture. Overlap the insulation on previously placed concrete by 1 foot.

When using steel forms, place the insulation tightly against the forms. In addition, insulate the framework of the steel forms, either by the use of the insulating mat material or foam insulation, or by draping polyethylene sheets or tarpaulins over the exposed members, to effectively reduce the heat loss.

Immediately repair tears in the mat liner. Where tie rods extend through the insulated form, place close-fitting washers on the rod against the mat and secure, to provide adequate protection.

Cover the tops of piers, abutments, and similar concrete surfaces with the insulation mat, tightly secured to prevent loss of heat.

For the areas around protruding reinforcement that cannot be protected with the insulation mat, cover with a double thickness of burlap. Cover with enough straw or hay to prevent loss of heat from the concrete during the curing period. In addition, cover insulated areas with tarpaulins.

Do not insulate bridge decks unless the underside is enclosed and preheated before the concrete is placed and the heat is maintained at the specified temperature during the entire curing period.

When foam insulation is used, use a minimum thickness of 1 1/2 inches. The Contractor may use cracked molded foam boards only after repairs are made with an adhesive.

Keep the insulation protection in place for the full curing period, but do not allow the concrete temperature to rise above 160F.

Do not expose fresh concrete to subfreezing temperatures. Provide standby heat, if directed. Failure to properly place the insulation material or failure to maintain the necessary concrete temperature will be cause for the Representative to deny continued use of the material on the project, for curing in cool or cold weather, and require the use of heating, as specified in Section 1001.3(p)6.

(q) Removal of Falsework and Forms and Application of External Loads to Concrete. Except for flood curing of concrete footings, do not count a day during which the curing temperature falls below 50F in the total elapsed days required for removal of falsework or forms or for the application of external loads on concrete.

1. Removal of Falsework and Forms. Keep falsework and forms under arches, box culverts, pier caps, slabs, beams, girders, and brackets in place for 5 days after placing the final portion of the section involved, after which they may be removed provided the concrete has attained a minimum compressive strength as specified in Table A. Determine the minimum compressive strength according to PTM No. 604 or determine the minimum compressive strength by the maturity method according to PTM No. 640. Cure test cylinders according to PTM No. 611.

During normal and cool-weather curing, keep forms for walls, columns, outside faces of pier caps, arches, sides of beams, and other vertical faces not sustaining loads, in place for a minimum of 12 hours after completing placement of concrete. Then, remove forms, provided the concrete has hardened enough to preclude damage resulting from form removal. Barrier forms may be removed in less than 12 hours, provided the concrete has hardened enough to preclude damage from form removal. During cold-weather curing, keep forms in place for a minimum of 5 days. Do not remove deck forms before the end of the water curing period (removal of burlap), unless approved by the Representative.

At construction joints, keep bulkheads in place for a minimum of 12 hours after placing concrete. Then, remove bulkheads provided the concrete has hardened enough to preclude damage resulting from removal of the bulkheads. During cold weather curing, keep bulkheads in place for 48 hours, and keep the concrete moist at all times.

Table A
Minimum Compressive Strength

	Minimum psi
Class AAAP	3,000
Class AAA	3,300
Class AA	2,750
Class A	2,500

2. Application of External Loads to Concrete. Strength determination for all values as specified in Section 1001.3(q)2 will be determined by compressive strength according to PTM No. 604 or maturity method according to PTM No. 640.

2.a Dead Loads. Do not begin work on wall, column, or pier shaft construction until 12 hours after placing footings. For footings on piles, do not begin work until 48 hours after placing footings.

Where falsework for the cap on pier bents is supported on the footings or from the ground, do not begin work on the cap construction until 24 hours after placing the columns.

Where forms are supported on collars attached to the columns, do not begin work on cap construction until 5 days after placing the columns, and the concrete has attained a minimum compressive strength, as specified in Table A.

Construct column- and pier-shaft lifts according to one of the following methods:

> **Method 1.** Where the forms for previous lifts, not including the footing, are left in place and adequately braced, do not place the next higher lift until 24 hours after placing the lift immediately below.
>
> **Method 2.** Where forms are supported by the concrete in the previous lift, not including the footing, and where other forms and bracing have been removed from the lower lifts, do not place the next higher lift until 5 days after placing the previous lift, and the concrete has attained a minimum compressive strength, as specified in Table A.

Do not place superstructure beams on abutment walls, or solid shaft piers without cantilevers until 3 days after placing the wall or shaft, and the concrete has attained a minimum compressive strength, as specified in Table A.

For all other substructure units, do not place superstructure beams until 5 days after placing the substructure units, and the concrete has attained a minimum compressive strength, as specified in Table A.

2.b Backfilling. Backfill as specified in Section 205 and as shown on the Standard Drawings. Do not backfill or place material adjoining CIP abutment walls, backwalls, retaining walls, box culverts, arches and precast box culvert end sections with closure placements until 7 days after placing last concrete, and then only if concrete has attained the 7-day Minimum Mix Design Compressive Strength as specified in Section 704, Table A.

Maintain symmetrical loading on each side of the span, and progress uniformly in placing embankment and structure backfill adjacent to, and over, arch rings, box culverts, or rigid frame structures, unless otherwise indicated.

2.c Live Loads. Do not allow live loads onto bridge decks or approach slabs until directed and the following minimum criteria are met:

TABLE B
Live Loads - Class AAAP Cement Concrete

Live Load	Min. Duration After Deck Placement	Min. Duration After Barrier Placement	Min. Concrete Compressive Strength (psi)	Additional Requirements
Conveyor Belt Systems	72 Hours	-	-	weight of system is uniformly distributed; operation of system does not damage deck
Truck Mixers, Slip Form Pavers, Truck Agitators, Heavy Equipment, Construction Traffic	7 Days	-	3,250 in Deck	do not exceed 5 mph; no more than one truck on deck at a time in a span or continuous unit for each truck placement occurrence
	-	7 Days	3,000 in Barrier	do not travel within 12 feet of barrier
Barrier or Sidewalk Placement	7 Days	-	3,250 in Deck	-
Power Operated Concrete Buggies	7 Days	-	3,250 in Deck	-
Diamond Grinding and Mechanical Texturing	21 Days	-	3,600 in Deck	-
Opened to Traffic	21 Days	-	3,600 in Deck	min. duration after last deck placement
	-	7 Days	3,000 in Barrier	min. duration after last barrier placement

TABLE C
Live Loads - Bridge Preservation

Live Load	Construction Operation	Min. Duration After Placement			Min. Concrete Compressive Strength (psi)
		AAAP or AA Concrete as noted	ASC	HES Concrete	
Opened to Traffic	Bridge Deck Patching	AAAP, 14 Days	Equal to time to attain min. concrete compressive strength plus time for liquid membrane-forming curing compound to set according to manufacturer's recommendations	*	3,000
	Expansion Dam Blockouts			*	
	Barrier Patching	AA, 7 Days		Equal to 3 days plus time for liquid membrane-forming curing compound to set according to manufacturer's recommendations*	
	Approach Slabs	AAAP, 7 Days			
		AA, 7 Days			

*Do not use HES in bridge decks

(r) Waterproofing. Apply waterproofing as indicated or where directed, as specified in Section 680.3 and as follows:

1. Cracks in Culverts. Where directed, cover minor cracks in culverts by waterproofing them with an accepted sealer. Apply the sealer as recommended by the sealant manufacturer. Seal cracks on backfill sides only.

2. Form Tie Holes. If directed, satisfactorily waterproof form tie holes on the backfill side of the box or arch culverts.

(s) Tack Coat for Bridge Decks. If an asphalt concrete surface is to be placed on the bridge deck, apply an asphalt tack coat on the deck, before placing the asphalt material as specified in Section 460.3.

(t) Bridge Deck, Barrier, and Approach Slab Sealing. For new bridge decks, at a minimum of 28 days after last barrier placement, apply 2 inch by 2 inch strip of epoxy binder resin along base of barrier reveal and deck to seal the gutterlines. Apply 2 inch by 2 inch strip of epoxy resin binder to seal curb gutterlines and barrier sidewalk gutterlines. After gutterlines have been sealed, apply boiled linseed oil as specified in Section 1019.3(a) or penetrating sealer as specified in Section 1019.3(c).2 as indicated to bridge deck and barrier. For new approach slabs, apply boiled linseed oil as specified in Section 1019.3(a) or penetrating sealer as specified in Section 1019.3(c).2 as indicated. If liquid membrane-forming curing compound was used to cure concrete to receive gutterline sealing, boiled linseed or penetrating sealer, remove curing compound from the surface by water blasting before sealing. Water blasting equipment must have a minimum rated capacity of 5,000 pounds per square inch.

(u) Defective Work. At no additional cost to the Department, remove and replace concrete that is bulged, uneven, or showing surface defects resulting from the effects of rain, improper finish, improper cure, scaling or honeycombing, which, in the Structure Control Engineer's opinion, cannot be repaired. If directed, remove and replace concrete that has not attained the minimum compressive strength. Repair or replace concrete that exhibits cracks or surface tears, as directed by the Structure Control Engineer. Use a high molecular weight methacrylate penetrating crack sealer, a low viscosity epoxy resin, or other suitable material to repair the surface cracks and tears.

Submit for review, a detailed Quality Control and Action Plan that includes, at a minimum, the proposed crack sealing material data sheet from the manufacture and conditions for use, including ambient and substrate temperature and moisture conditions. Do not perform any crack sealing before the Quality Control and Action Plan has been reviewed by the Representative.

(v) Bridge Approach Slabs. Construct as shown on the Contract Drawings and as specified in Section 505.3.

1001.4 MEASUREMENT AND PAYMENT—

(a) Cement Concrete. Cubic Yard or Lump Sum

As indicated, for the class specified, for the item indicated.

The Department will not make a deduction in measurement for anchor bolts, expansion plates, drainage openings, weep holes, pipes, or conduits if the volume displaced by an installation of opening does not exceed 1/2 cubic yard.

The Department will not deduct the volume of reinforcement bars from the measured volume of concrete.

Where it is impractical to measure concrete in cavities or sink holes, the Department will measure by the volume shown on the certified slips of the delivered batch weights, as recorded by Department representatives assigned to the work.

The cost of concrete cores, taken to examine tremie-placed concrete, is incidental to the other concrete work.

(b) Reinforcement.

1. Reinforcement Bars. Section 1002.4

Dowel bars required for unplanned joints are incidental to other reinforcement.

2. Steel-WWF. Pound

Annealed iron wire, chairs, and ties are incidental to the weight of the steel wire fabric.

3. Deformed WWF. Pound

Annealed iron wire, chairs, and ties are incidental to the weight of the deformed wire fabric.

(c) Structure Foundation Drain. Linear Foot

For the size indicated. Includes outlet protection.
Measurement includes all pipe connections.

(d) Selected Borrow Excavation, Coarse Aggregate, No. 57. Section 205.4

(e) Excavation. Section 204.4
For the class indicated.

(f) Backfill for Excavation Below Indicated Elevation. Cubic Yard
Paid as specified in Section 110.03.

(g) Selected Borrow Excavation, Structure Backfill. Section 205.4

(h) Lighting Pole Anchorage. Each
The price includes anchor bolts, nuts, washers, 1 1/4-inch conduit, junction box, drain pipe, steel angle, and required fittings.

(i) Anti-washout Admixture. Cubic Yard
The price includes only the additional cost associated with the incorporation of AWA into a cubic yard of cement concrete. This associated cost may include material, mix designs, and handling. The actual cement concrete is paid under the lump sum item for the structure or the item for the class of concrete specified.
Section 110.02(d) will not apply to this item.

(j) Mechanical Texturing with Transverse or Longitudinal Sawed Grooves. Square Yard
Measured as the finished grooved area.

(k) Epoxy Binder Resin for Gutterline Sealing. Sealing gutterlines with epoxy binder resin is incidental to the bridge deck and barrier placement.

(l) Boiled Linseed Oil or Penetrating Sealer. Section 1019.4