

CITY OF MEMPHIS - STANDARD CONSTRUCTION SPECIFICATIONS
SECTION 03310 CONCRETE STRUCTURES

PART 1 – SCOPE

1.01 This work shall consist of the construction of all structures, or parts of structures, composed of Portland cement concrete whether plain, reinforced, or a combination of both. Concrete structures shall be constructed of Class A Concrete, unless otherwise specified. They shall be constructed on prepared foundations, at the locations indicated or directed in conformity with the dimensions, lines and grades shown on the Plans or as directed by the Owner and in accordance with these Specifications.

1.02 The concrete used in this construction shall be composed of a mixture or mixtures of Portland cement, aggregates, air-entraining agents, water, and chemical additives when approved, combined by the methods and in the proportions defined for the particular class of concrete designated as shown in Specification Section 03050.

1.03 Parts of a structure, or structures, indicated to be constructed with materials other than Portland cement concrete and concrete reinforcement steel shall be constructed in accordance with the provisions set out in the Specification Section covering the particular type of construction.

PART 2 – MATERIALS AND EQUIPMENT

2.01 MATERIAL

A. Materials used in this construction shall meet the requirements of the applicable Sections or Paragraphs of Specification Section 03050, "Portland Cement Concrete" and the following:

B. Waterstops.

1. Waterstops shall be of the type, shape, and dimensions shown on the Plans.

2. Metallic.

Metallic waterstops shall be sheet copper conforming to the requirements as specified in the current Specifications for Copper Sheet, Strip, Plate, and Rolled Bar, Type ETP, ASTM Designation B 152. The weight per square foot shall be as specified on the Plans.

3. Nonmetallic

a. Nonmetallic waterstops shall be manufactured from either natural rubber, synthetic rubber, or polyvinylchloride (PVC) at the option of the Contractor. Waterstops shall be produced by such a process that, as supplied for use, they will be dense, homogeneous, and free from holes and other imperfections. The cross-section of the waterstop shall be uniform along its length and transversely symmetrical so that the thickness at any given distance from either edge of the waterstop will be uniform.

b. Rubber Waterstop.

(1) The waterstop shall be fabricated from a high grade thread-type compound. The basic polymer shall be natural rubber or a copolymer of butadiene and styrene, or a blend of both. The compound shall contain no less than 70 percent by volume of the basic polymer, and remainder shall consist of reinforcing carbon black, zinc oxide, accelerators, antioxidants, vulcanizing agents and plasticizers, but shall contain no factice.

(2) Samples taken from the finished waterstop shall meet the following requirements when tested in accordance with the current specified ASTM method of test.

ASTM

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<u>Title</u>	<u>Requirement</u>	<u>Method of Test</u>
Tensile Strength (Die "C")	2500 psi. min.	D 412
Ultimate Elongation (Die "C")	450 percent, min.	D 412
Shore Durometer Hardness	60-70	D 2240
Specific Gravity	1.15 + 0.03	D 297 (Sec. 17)
Water Absorption (% by Wt.)	5 percent, max.	D 570
Tensile Strength after accelerated Aging, oxygen-pressure method	80 percent, min.	D 572

c. Polyvinylchloride Waterstop.

(1) This waterstop shall be extruded from an elastomeric plastic material. The material shall be a plastic compound, the basic resin of which shall be polyvinylchloride. The compound shall contain any additional resins, plasticizers, stabilizers, or other materials needed to insure that when the material is compounded it will meet the performance requirements of this Specification. No reclaimed polyvinylchloride shall be used.

<u>Title</u>	<u>Requirement</u>	<u>ASTM Method of Test</u>
Tensile Strength (Die "C")		
Sheet Material	2,000 psi	D 412
Finished Waterstop	1,700 psi	D 412
Ultimate Elongation (Die "C")		
Sheet Material	350% Min.	D 412
Finished Waterstop	300% Min.	D 412
Stiffness in Flexure	750 psi Min.	D 747
Accelerated Extraction		CRD C 572
Tensile Strength (Die "C")	1,750 psi	D 412
Elongation (Die "C")	300%	D 412
Effect of Alkali (After 7 Days)		
Change in Weight	-0.1 to +0.25%	
Change in Hardness, Shore Durometer	+ or - 5%	
Low Temperature Brittleness	-35°	D 746
Specific Gravity	1.3	D 792

(2) For polyvinylchloride waterstops, the supplier shall submit a certificate stating that all of the performance requirements specified for the sheet material under Polyvinylchloride Waterstops have been complied with. Field splices for Polyvinylchloride waterstops shall be performed by heat sealing the adjacent surfaces in accordance with the manufacturer's recommendations. Waterstops shall be manufactured with an integral cross-section which shall be uniform within plus or minus 1/8 inch in width, and the web thickness or bulb diameter within plus 1/16 inch and minus 1/32 inch.

(3) The Contractor shall furnish the Owner at this request and at no cost to the City a certified test report from an approved laboratory covering each lot or unit of finished waterstops. These test reports shall contain the numerical laboratory test data of the required test.

B. Epoxy Resin Systems.

Two Component epoxy resin systems shall conform to the requirements of the appropriate class designation of AASHTO M 200, M 234, M 235, unless otherwise designated on the Plans or in the Contract. The appropriate class designation is determined by the proposed use of the material.

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1. Requirements for Specific Uses:

a. Bonding fresh concrete to cured concrete.

Requirements: The material shall meet the compositional specification fo AASHTO M 235, Class I and applicable requirements of the Class III performance specification.

b. Bonding cured concrete to cured concrete.

Requirements: The material shall meet the compositional specification of AASHTO M 235, Class II and the applicable requirements of the Class III performance specification.

c. Binder in epoxy resin concrete and mortar for repairing spalls and other defects in concrete.

Requirements: The material shall meet the compositional specification of AASHTO M 235, Class II and the applicable requirements of the Class III performance specification.

C. Bar Reinforcement.

Unless otherwise specified, all steel reinforcement for concrete shall be billet steel bars conforming to the requirements of ASTM A 615.

D. Dowel Bars.

Dowel bars shall be plain and shall conform to the requirements of ASTM A 306, Grade 55, 60, 65, or 70.

E. Welded Wire Fabric.

Fabric for reinforcement shall conform to ASTM A 185, or as indicated on the Plans, and shall be supplied in mats of the size, design and weight shown on the Plans.

2.02. EQUIPMENT.

A. Equipment and tools necessary for handling materials and performing all parts of the Work shall be subject to approval by the Owner as to design, capacity, and mechanical condition. Equipment shall be on hand sufficiently ahead of the start of construction operations to be examined and approved. The equipment and organization shall be of sufficient capacity to accomplish the maximum continuous concrete placement, as governed by the construction joints shown on the Plans or as directed by the Owner.

B. The requirements for batching plant and mixers shall be as prescribed in Specification Section 03050.

C. Ample and satisfactory equipment for conveying concrete from the mixer to final position in the forms shall be provided. Closed chutes or pipes shall be used when concrete is to be dumped or dropped for a distance greater than 5 feet. Where steep slopes are required, the chutes shall be equipped with baffle boards or shall be in short lengths that will enable the direction of movement to be reversed.

D. Vibrators shall be of an approved type and design and shall operate under load at a rate as recommended by the manufacturer and approved by the Owner.

PART 3 – CONSTRUCTION REQUIREMENTS

3.01 FORMS.

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A. Construction.

1. Forms shall be mortar-tight and sufficiently rigid to prevent distortion due to the pressure of the concrete and other stresses incidental to the construction operations, including vibration. Forms shall be so constructed and maintained as to prevent the opening of joints due to shrinkage of the lumber.
2. The forms shall be built true to line and grade and shall be held in place by means of studs or uprights, and waling, which shall be sufficiently and substantially braced and tied.
3. All forms and studding shall be cut off and capped with not less than a 2 inch by 4 inch piece so that the top of the cap will be at the elevation of the finished exposed surface of the concrete.
4. All edges shall be chamfered with $\frac{3}{4}$ inch material, unless otherwise specified. All chamfer strips shall be straight, of uniform width, and dressed.
5. Wood devices of any kind used to separate forms shall be removed before placing concrete within 4 inches of such devices.

B. Form Lumber.

1. Form lumber for all exposed concrete surfaces shall be dressed at least on one side and two edges and shall be so constructed as to produce mortar-tight joints and smooth, even concrete surfaces.
2. Plywood forms, or forms face-lined with plywood, masonite, or other approved similar material may be used, provided the plywood forms and form linings are substantial, of uniform thickness, and are mortar-tight when in position.

C. Metal Ties.

Metal ties or anchorages within the forms shall be so constructed as to permit their removal to a depth of at least one inch from the face without injury to the concrete. In case wire ties are permitted, the wires shall be cut back at least $\frac{1}{4}$ inch from the surface of the concrete, and the surface left sound, smooth, even, and uniform in color.

D. Walls.

Sufficient openings shall be provided at intervals along the bottom of wall forms to permit thorough cleaning prior to concrete placement. Such openings shall be closed before placing concrete in the forms.

E. Surface Treatment.

Prior to placing reinforcement, all forms shall be treated to prevent the adherence of concrete. Forms not provided with a special treatment shall be treated with an approved oil. Any material that will adhere to or discolor the concrete shall not be used.

F. Metal Forms.

1. The specifications for forms, as regards design, mortar tightness, filleted corner, beveled projections, bracing, alignment, removal, and reuse and oiling apply to metal forms. The metal used for forms shall be of such thickness that the forms will remain true to shape. All bolt and nut heads shall be countersunk on the face forming the concrete surface. Clamps, pins, or other connecting devices shall be designed to hold the forms rigidly together and to allow removal without injury to the concrete. Metal forms which do not present a smooth surface or do not line up properly shall not be used. Care shall be exercised to keep metal forms free from rust, grease, or other foreign matter.

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2. When the Contractor wishes to utilize a special forming system not specifically authorized in this Specification, he shall submit his design and calculation to the Owner for review and approval.

3.02 FALSEWORK.

A. The falsework used to support the forms and concrete for concrete structures shall be supported on sills resting on rigid foundations composed of piles driven until the bearing capacity of each pile is sufficient to support the load to which it will be subjected, or earth-borne footings as hereinafter provided.

B. Earth-borne footings will be permitted only when, in the opinion of the Owner, the soil can adequately support the superimposed loads and the following conditions are met:

1. Spread footings will only be permitted on stable ground, capable of supporting the superimposed load.

2. The site is graded and so maintained to prohibit ponding of water or erosion of soil in the proximity of the spread footings.

3. The falsework system shall be designed and constructed to preclude exceeding the bearing capacity of the soil but in no case shall exceed 3,000 pounds per square foot.

4. The footings shall be designed and constructed to carry the superimposed loads.

5. All footings shall be constructed on a level plane.

C. The falsework shall be designed and constructed to support the required loading without distortion or settlement of the forms.

D. The Contractor shall place "tell-tales" for observation of the amount of falsework settlement at locations designated by the Owner.

E. The Owner may require the Contractor to submit detailed falsework plans, together with a soils report, design calculations or any other information necessary for a thorough review. The Contractor is totally responsible for the design and construction of the falsework system and shall repair, or remove and replace, as directed and at his expense, any concrete, other material or portions of the structure which are damaged or destroyed due to failure of the falsework.

3.03 REINFORCEMENT

A. All reinforcement shall consist of deformed steel bars, unless otherwise indicated or directed. Deformed steel bars shall have a net area at all sections equivalent to that of plain round or square bars of the corresponding nominal size.

B. Structural steel shapes shall conform strictly to the shapes indicated or required.

C. Steel wire fabric may be furnished in rolls or sheets.

D. Reinforcing steel shall be stored above the ground surface upon platforms, skids or other supports located without the scope of the active construction operations and shall be protected at all times from injury and damage. All brush and weeds shall be removed from the area immediately prior to storing reinforcing steel thereon.

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E. Reinforcing steel, where indicated, shall be accurately bent, without heating, to the forms and dimensions indicated on the Plans. Minimum bend diameters shall be in accordance with the requirements of the American Concrete Institute. Unless otherwise indicated, all bends shall be in one plane. Bars of ¾ inch or less which have only hooks or a single bend may be bent in the field, provided satisfactory equipment for proper and accurate work is used and provided the bending is accomplished true to form and dimensions without damage to the bars. All other bending shall be done in the shop before shipment.

F. Substitution of bars of different sizes from those indicated on the Plans may only be made with the written permission of the Owner. If substitution is permitted, the following shall apply:

1. The total area of steel in any one linear foot in each direction shall not be reduced.
2. For cast-in-place concrete the clear distance between parallel bars in a layer shall not be less than 1.5 bar diameters, 1.5 times the maximum size of the coarse aggregate, nor 1-1/2 inches.
3. Where positive or negative reinforcement is placed in two or more layers, bars in the upper layers shall be placed directly above those in the bottom layer with the clear distance between layers not less than 1 inch.
4. Clear distance limitation between bars shall also apply to the clear distance between a contact lap splice and adjacent splices or bars.
5. Groups of parallel reinforcing bars bundled in contact to act as a unit shall be limited to 4 in any one bundle. Bars larger than #11 shall be limited to two in any one bundle in beams. Bundled bars shall be located within stirrups or ties. Individual bars in a bundle cut off within the span of a member shall terminate at different points with at least 40 bar diameters stagger. Where spacing limitations are based on bar diameter, a unit of bundled bars shall be treated as a single bar of a diameter derived from the equivalent total area.
6. In walls and slabs, the primary flexural reinforcement shall be spaced not farther apart than 1.5 times the wall or slab thickness, nor 18 inches.

G. All reinforcement shall be furnished in the full lengths shown on the Plans, unless otherwise approved in writing by the Owner. No splices shall be made unless indicated on the Plans or authorized by the Owner. Splices shall be so arranged and manipulated as to provide a minimum of 2 inches net clearance between the splices and the surface of the complete concrete work, unless otherwise indicated or directed. Splices of tension reinforcement at points of maximum stress shall be avoided. The members at all splices shall be rigidly clamped by means of at least two approved metal clips located approximately 3 inches from the ends of the bars and bolted around them or securely wired in a manner satisfactory to the Owner.

H. Steel shapes shall be spliced only as indicated on the Plans.

I. Steel fabric shall be spliced by overlapping of the sheets by not less than 12 inches; by matching at least three transverse member; and by securely wiring the overlapped sections in a manner satisfactory to the Owner.

J. All reinforcing steel before being placed shall be thoroughly cleaned of mill scale, rust, dirt, paint, oil, or other foreign substances or coating of any character that will reduce the bond. If reinforcement which has been placed becomes dirty, rusty, or spattered with mortar which dries before concrete is placed around it, such reinforcement, or part affected, shall be thoroughly cleaned before being covered with concrete.

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K. Reinforcement shall be accurately placed and firmly held in position as indicated on the Plans. Steel bars shall be securely fastened together with metal clips or wire at each intersection, except where spacing is less than on 1 foot in each direction then alternate intersections shall be fastened. All reinforcing steel shall be securely spaced from the forms and between adjacent reinforcement by means of precast mortar blocks, metal spacers or other approved devices or methods, and where possible, all spacer devices shall be so arranged that their use cannot be detected in the completed structure. Spacer blocks shall be cast of mortar mixed in the same proportions as that in the concrete mixture and shall not have a length or width greater than the depth required for proper spacing from the forms or between adjacent reinforcement. The use of gravel, concrete, brick, or wooden blocks is prohibited.

L. All the reinforcing steel necessary for a section of a concrete structure shall be accurately and securely placed and the placement approved by the Owner before any concrete is deposited in the section, and care shall be observed not to disturb it during the placing of the concrete.

M. All dimensions relating to reinforcing bars are to the centers of the bars, unless otherwise indicated.

N. Tolerances for bending and cutting during fabrication shall be in accordance with the "Manual of Standard Practice" published by the Concrete Reinforcing Steel Institute.

3.04 DRAINAGE AND WEEP HOLES

Drainage openings and weep holes shall be constructed using materials in the manner and at the locations shown on the Plans or established by the Owner. Ports or vents for equalizing hydrostatic pressure, when required, shall be placed as directed.

3.05 PLACING PIPES, CONDUITS, ANCHORS, CASTING, AND OTHER APPURTENANCES

A. Pipes, conduits, anchors, castings, bolts, plates, grillage, and other appurtenances which are necessary or desirable to be placed in the concrete of a structure, whether indicated on the Plans or not, shall be placed by the Contractor during construction, as directed. Unless otherwise stipulated, pipes and conduits will be delivered to the Contractor at the site of the structure by the City of by other parties for whose use the pipes and conduits are intended.

B. No compensation will be allowed for placing such pipes, conduits, and other appurtenances, except that no deductions will be made for the volume of concrete displaced by those items.

3.06 EXPANSION JOINTS

A. Expansion devices shall be as indicated on the Plans. The devices shall be securely anchored in correct position. All sliding surfaces shall be true and smooth and shall form complete contact throughout. Movement shall not be impeded by the concrete in which they are embedded.

B. Unless otherwise provided, where portions of concrete bridge superstructure rest on the substructure, the contact area shall be separated by at least two layers of three-ply bituminous-saturated paper.

C. Open joints shall be constructed using forms which will permit removal without injury to the concrete. After removal of the forms, the joints shall be cleaned thoroughly. Filled joints shall be constructed with premolded filler, unless otherwise indicated. Joints requiring a sealant shall be thoroughly cleaned and sealed with one of the specified joint sealing materials before the structure is opened to traffic. Edges of open and filled joints shall be chamfered or edged, as directed. Mortised joints shall be constructed as shown on the Plans or as directed.

3.07 PLACING CONCRETE

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A. General

1. Concrete shall not be placed until forms and reinforcing steel have been checked and approved. The forms shall be clean of all debris and kept wet immediately before concrete is placed. The method and sequence of placing concrete shall be approved by the Owner. Unless otherwise permitted, all concrete shall be placed in daylight, and the placing of concrete in any portion of the structure shall not be started unless it can be entirely completed in daylight. When the placing of concrete is permitted during other than daylight hours, an adequate and approved artificial lighting system shall be provided and operated.
2. All concrete shall be thoroughly worked during the placing by means of tools of approved type. The working shall be such as to force all coarse aggregate from the surface and to bring mortar against the forms to produce a smooth finish, substantially free from water and air pockets or honeycomb.
3. If the forms show bulging or settlement while concrete is being placed, the placing shall be stopped until correction has been made.
4. T-beam girders, slabs, arch rings, and all horizontal sections of bridges except curbs and sidewalks shall be constructed monolithically and continuously, unless otherwise permitted. Curbs and sidewalks shall be constructed after the bridge deck is completed, unless otherwise indicated on the Plans.
5. After initial set and prior to final set of the concrete, the forms shall not be jarred, and no strain shall be placed on the ends of the projecting reinforcement. Piles shall not be driven closer than 20 feet to footings less than 7 days old nor to foundations supporting concrete less than 7 days old.

B. Railings and Curbing.

1. When constructing curb, careful attention shall be given to the installation of railing steel or anchoring devices.
2. Concrete railings shall not be constructed on any structure until the falsework has been struck.

C. Chutes and Troughs

1. Concrete shall be placed so as to avoid segregation of the materials and the displacement of the reinforcement.
2. All chutes, troughs, and pipes shall be kept clean and free from coatings of hardened concrete by thoroughly flushing with water after each run. The water used for flushing shall be discharged clear of the concrete already in place.
3. Care shall be taken to fill each part of the form by depositing the concrete as near final position as possible. The coarse aggregate shall be worked back from the forms and around the reinforcement without displacing the bars. After initial set of the concrete, the forms shall not be jarred and no strain shall be placed on the ends of projecting reinforcement.

D. Vibrating

1. Unless otherwise directed, the concrete shall be compacted with suitable mechanical vibrators operating within the concrete. When required, vibrating shall be supplemented by hand spading with suitable tools to assure proper and adequate compaction.

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2. Vibrators shall be so manipulated as to work the concrete thoroughly around the reinforcement and embedded fixtures and into corners and angles of the forms. Vibrators shall not be used as a means to cause concrete to flow or run into position in lieu of placing. The vibration at any point shall be of sufficient duration to accomplish compaction but shall not be prolonged to the point where segregation occurs.

3. At least one additional standby vibrating unit shall be available for all individual pours in excess of 10 cubic yards.

E. Joints

1. Feather-edge construction joints will not be permitted. Transverse or longitudinal joints through spans will not be permitted, except where specified.

2. In no case shall the concreting of any section or layer be stopped or temporarily discontinued within 18 inches of any finished surface, unless the details of the structure provide for a coping having a thickness of less than 18 inches, in which case, at the option of the Owner, the construction joint may be made at the underside of the coping.

3. Layers completing a day's work or placed just prior to temporarily discontinuing operations shall be cleaned of all laitance or other objectionable material as soon as the surface has become sufficiently firm to retain its form.

3.08. BONDING CONSTRUCTION JOINTS

A. Where dowels, reinforcing bars, or other adequate ties are not indicated on the Plans, keys of a directed size shall be made by constructing projections above the concrete and monolithically with the concrete.

B. In resuming work, the forms shall be drawn tightly against the face of the concrete. The entire surface of the concrete to be bonded shall be cleaned thoroughly and roughened with a steel tool. In addition, if directed, the surface to be bonded shall be cleaned and roughened by sandblasting. The surface shall then be soaked with clean water, after which concreting may proceed.

3.09. REMOVAL OF FORMS AND FALSEWORK.

A. Forms for ornamental work, railings, parapets, columns, and vertical surfaces that do not carry loads shall be removed in from 12 to 48 hours, unless otherwise directed by the Owner. In cold, damp, or freezing weather, all vertical forms shall remain in place until the concrete has set sufficiently to withstand damage when the forms are removed. In removing forms, care shall be exercised not to mar the surface of the concrete nor to subject it to any undue pressure.

B. Projecting wires or other metal devices used for holding forms in place and which pass through the body of the concrete shall be removed or cut as specified in Specification Section 03310 Paragraph 3.01.A, and the holes or depressions thus made and all other holes, depressions, and small voids which show upon the removal of the forms shall be filled with cement mortar mixed in the same proportions as that which was used in the body of the concrete which is being repaired.

C. Falsework and supports under slab or girder spans, any length, may be released and removed when representative specimens of the concrete in the spans, cured by the methods and in the manner the concrete which the test specimens represent is cured, attain a compressive strength of 3,000 pounds per square inch. In addition to the above requirement, the concrete

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shall have been placed a minimum of 10 days, not counting the days of 24 hours each in which the temperature falls below 40° F., or 21 calendar days, whichever occurs first.

D. For continuous concrete girder or slab units, any length, the falsework and supports shall not be released or removed from any span in the continuous unit until the concrete in all spans in the unit has been placed a sufficient length of time to meet all requirements for the removal of falsework and supports as set forth above.

E. Forms supporting bridge decks between girders and outside curb overhangs may be removed after seven days.

3.10. DEFECTIVE CONCRETE

A. Any defective concrete discovered after the forms have been removed shall be removed immediately and replaced. If the surface of the concrete is bulged, uneven, or shows honeycombing which cannot be repaired satisfactorily, the entire section shall be removed and replaced.

B. Concrete having a 28 day strength of less than the minimum specified shall be removed and disposed of by the Contractor, at his expense, unless specifically authorized by the Owner, in writing, to remain in place. The removal shall be in such a manner as will not cause damage to the remaining concrete or to other structural units or other facilities and property.

3.11. FINISHING CONCRETE SURFACES

A. Unless otherwise authorized, the surface of the concrete shall be finished immediately after form removal.

B. All concrete surfaces shall be given a Class 1 finish. The following surfaces of all structures shall be given a Class 2 Finish: roadway face and top of curb, vertical outside face of curb overhang or sidewalk slab, bottom surface of slab overhang, bridge railings, barrier railings, all vertical surfaces of the superstructure of dual bridges exposed to view from either structure, and all surfaces of retaining walls, wingwalls, and end walls which are visible from passing vehicles.

1. Class 1, Ordinary Surface Finish.

a. Immediately following the removal of the forms, all fins and irregular projections shall be removed from all surfaces which are to be exposed or waterproofed. On all surfaces, the cavities produced by form ties and all other holes, honeycomb spots, broken corners or edges, and other defects, shall be thoroughly cleaned, saturated with water, and carefully pointed and trued with a mortar of cement and fine aggregate mixed in the proportions used in the Class of the concrete being finished. Mortar used in pointing shall not be more than 30 minutes old. All construction and expansion joints in the completed work shall be left carefully tooled and free of all mortar and concrete. The joint filler shall be left exposed for its full length with clean and true edges.

b. All surfaces which cannot be repaired to the satisfaction of the Owner shall be "rubbed" as specified for a Class 2 finish.

2. Class 2, Rubbed Finish.

a. After removal of forms, the rubbing of concrete shall be started as soon as its condition will permit. Immediately before starting this work, the concrete shall be kept thoroughly saturated with water. Sufficient time shall have elapsed before the wetting down to allow the mortar used in the pointing to thoroughly set. Surfaces to be finished shall be rubbed with a wetted wooden block or a medium coarse carborundum stone.

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The carborundum stone shall not be used until the concrete has hardened to the state where the sand will grind, rather than ravel or roll. Rubbing shall be continued until all form marks, projections, and irregularities have been removed; all voids filled; and a uniform surface has been obtained. The paste produced by this rubbing shall be left in place. A brush finish or painting with grout will not be permitted.

b. After all concrete above the surface being finished has been cast, the final finish shall be obtained by rubbing with a fine carborundum stone and water. This rubbing shall be continued until the entire surface is of a smooth texture and uniform color.

c. After the final rubbing is completed and the surface has dried, it shall be rubbed with burlap to remove loose powder and shall be left free from all unsound patches, paste, powder, and objectionable marks.

3. Class 3, Float Finish

a. This finish, for unformed surfaces, except slab surfaces for pavements or bases, shall be achieved by placing an excess of material in the form and removing or striking off the excess with a template, forcing the coarse aggregate below the mortar surface. Creation of concave surfaces shall be avoided after the concrete has been struck off, the surface shall be thoroughly worked and floated with a suitable floating tool of wood, canvas, or cork. Before the finish has set, the surface cement film shall be removed with a fine brush in order to have a fine-grained, smooth but sanded texture.

3.12. FINISHING SLAB SURFACES FOR PAVEMENTS OR BASES.

A. Bridge floors or top slabs of structures serving as finished pavements or bases shall be finished either by hand methods or approved mechanical finishing machines.

B. When the hand method is used, the bridge floors or slabs shall be struck off with a screed which is parallel to the centerline of the roadway, resting on bulkheads or screed strips cut or set to the required cross-section of the roadway. This screed shall be so constructed as to have sufficient strength to retain its shape and that the cutting edge may be adjusted to conform to the profile of the roadway. Screeds shall be of sufficient length to finish the full length of spans 40 feet or less in length. Spans over 40 feet in length shall be finished in two or more sections, but no section shall be less than 20 feet in length. Screed strips or headers shall be accurately set to the specified grades, checked, and adjusted as necessary prior to the final screeding operation. The screed shall be worked back and forth over the surface until the proper profile and cross-section is obtained.

C. When mechanical finishing machines are used, they shall be approved power driven machines, traveling on rails adjusted to conform to the profile of the roadway. The machines shall be equipped with oscillating or vibrating transverse or longitudinal screeds that may be adjusted to conform to the profile or the required cross-section of the roadway. The screeds shall have sufficient strength to retain their shape after adjustment. The finishing machine shall go over each area of the bridge floor as many times as is required to obtain the required profile and cross-section.

D. Regardless of the method of finishing, the Contractor shall maintain a minimum rate of placement of 20 linear feet of bridge deck per hour when concrete is placed in a longitudinal section.

E. After finishing as described above, the surface shall be checked with a 12 foot straightedge and shall show no deviation in excess of 1/8 inch from the testing edge of the straightedge when placed parallel to the centerline. Deviations in excess of this requirement shall be corrected before the concrete sets.

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F. The surface shall be finished by dragging a seamless strip of damp burlap over the full width of the surface. The burlap drag shall consist of sufficient layers of burlap to slightly groove the surface and shall be moved forward with minimum bow of the lead edge. The drag shall be kept damp, clean, and free of particles of hardened concrete. A light broom or brush herring bone finish that leaves a texture similar to that obtained by the burlap drag may be used when permitted by the Owner. For bases, the surface shall be finished by grooving lightly with a wire broom at an angle of 60° with the centerline. All strokes shall begin at the center and end at the edge. After the slab has been finished by the burlap drag, surfaces which will become traffic lanes shall be textured by the formation of transverse grooves. The grooves shall be formed in the surface at an appropriate time during the stiffening of the concrete, so that in the hardened concrete the grooves will be between 0.09 inch and 0.13 inch in width; between 0.12 inch to 0.19 inch in depth; and spaced at random intervals between 0.3 inch and 1.0 inch. The grooves shall terminate approximately 18 inches from curbs, parapets, barrier walls, and other vertical walls. The grooves shall be relatively smooth and uniform; shall be formed without tearing the surface and without bringing pieces of coarse aggregate to the top of the surface; and shall be formed to drain transversely. All areas which do not conform to these requirements shall be corrected at the Contractor's expense by approved methods.

G. As soon as the surface has set sufficiently to withstand damage when walking on it and not later than the morning following the placing of the concrete, it shall be straightedged with the 12 foot straightedge and all variations exceeding 1/8 inch shall be plainly marked. The Contractor shall correct an seal such variations in the same manner as specified for Portland Cement Concrete Pavement.

3.13. CURING CONCRETE

A. All concrete surfaces, except those surfaces protected by forms that remain in place seven days or longer as required under the provisions of Specification Section 03310 Paragraph 3.09, "Removal of Forms and Falsework", shall be cured as specified below. Curing shall begin as soon as the concrete has hardened sufficiently to withstand surface damage to unformed surfaces and immediately after the forms have been removed from formed surfaces.

B. When the temperature is expected to fall below 35° F., the concrete shall be protected in accordance with the provisions of Specification Section 03310 Paragraph 3.14.

C. The initial curing period for concrete surfaces shall be by the "Water Method" for a period of not less than 24 hours, or until the concrete surfaces have been prepared for the application of curing compound, in accordance with the provisions under B below. During the initial curing period, the concrete shall be protected from the sun by burlap mats or other approved materials and kept completely and continuously moist.

D. The "Water Method" and membrane-forming compound method of curing will be required for all bridge decks, and on all concrete slabs when the temperature exceeds 90° F. during placement.

1. Water Method

a. All concrete slabs shall be covered immediately with material suitable for use with the water cure and kept thoroughly wet for at least 120 hours from the beginning of the initial curing period. All surfaces other than slabs shall be protected from the sun and shall be kept wet for a period of at least 72 hours from the beginning of the initial curing period. Curbs, walls, handrails, and other surfaces requiring a Class 2 finish may have the covering temporarily removed for finishing, but the covering shall be restored as soon as possible.

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2. Membrane-Forming Compound Method

a. All surfaces shall be given the required surface finish prior to application of the curing compound. Prior to the application of curing compound, the surface shall be kept moist.

b. The rate of application of curing compound shall be as recommended by the manufacturer but shall not be less than one gallon for 150 square feet of concrete surface. The curing compound shall be applied, under pressure, immediately after completion of the initial curing period or acceptance of the concrete finish. If the surface is dry, the concrete shall be thoroughly wet with water and the curing compound applied just as the surface film of water disappears. At the time of use, the compound shall be in a thoroughly mixed condition with the pigment uniformly dispersed throughout the vehicle. If the application of the compound results in a streaked or blotchy appearance, the method shall be stopped and water curing, as set out above, applied until the cause of the defective appearance is corrected. The coating shall be protected against marring for a period of seven days from date of application. Any coating marred or otherwise disturbed within the seven day period shall be replaced at once.

3.14 PROTECTION OF CONCRETE IN COLD WEATHER

Concrete shall be protected in cold weather as specified in Specification Section 03050.

3.15 WATERPROOFING AND WATERSTOPS

A. Waterproofing where indicated on the Plans or directed by the Owner shall be performed in accordance with the requirements of Specification Section 03052.

B. Metallic or nonmetallic waterstops, as specified, shall be installed in accordance with the details shown on the Plans and in conformity with the requirements of these Specifications.

C. Metallic waterstops shall be spliced, welded or soldered, as necessary, to form continuous, watertight joints.

D. Nonmetallic waterstops shall be installed in continuous strips without splices, except that splices will be permitted at changes in direction when necessary to avoid buckling or distortion of the web or flange. All splices of nonmetallic waterstops shall be performed in accordance with the manufacturer's recommendations and in the case of polyvinylchloride waterstops, the heat used shall be sufficient to melt but not char the plastic.

E. Adequate provisions shall be made to support the waterstops during the progress of work and to insure their proper embedment in the concrete. The concrete shall be thoroughly worked in the vicinity of the joints to insure maximum density and imperviousness. Forms shall be so designed that they can be removed without damaging the waterstops. Suitable guards shall be provided to protect exposed projecting edges and ends of partially embedded waterstops from mechanical damage.

PART 4 – MEASUREMENT

4.01 MEASUREMENT

A. All concrete will be measured for payment as stipulated under the Specification Section specifying each individual type of construction.

B. No allowance will be made for furnishing the material and the construction of drainage openings and weep holes as indicated or as directed, provided such openings are 6 inches in diameter or less, except that no deduction will be made for such openings in the computation of concrete quantities. Allowance will be made for other openings as indicated.

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C. No allowance will be made for additional cement used in depositing concrete underwater; for use of calcium chloride or chemical additives; for fillers, sealer, and tar paper used in expansion joints; for dowels or other materials used in bonding construction joints; for waterstops; and for painting metals.

D. No allowance will be made for concrete placed below the foundation elevation shown on the Plans or as directed by the Owner.

E. No additional compensation will be made for high-early-strength concrete substituted by the Contractor.

PART 5 – PAYMENT

5.01 PAYMENT

All concrete will be paid for as stipulated under the Specification Section specifying each individual type of construction.

END OF SECTION 03310