

**SECTION 32 05 23  
CEMENT AND CONCRETE FOR EXTERIOR IMPROVEMENTS**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. This section shall cover site work concrete constructed upon the prepared subgrade and in conformance with the lines, grades, thickness, and cross sections shown. Construction shall include the following:
- B. Pedestrian Pavement: Walks, steps.
- C. Vehicular Pavement: Maintenance yards, driveways.

**1.2 RELATED WORK**

- A. Laboratory and Field Testing Requirements: Section 01 45 29, TESTING LABORATORY SERVICES.

**1.3 DESIGN REQUIREMENTS**

Design all elements with the latest published version of applicable codes.

**1.4 WEATHER LIMITATIONS**

Placement of concrete shall be as specified under Article 3.4 E., for Cold Weather Placement and Article 3.4 D., for Cold Weather Placement of Section 03 30 53, SHORT FORM CAST-IN-PLACE CONCRETE.

**1.5 SUBMITTALS**

- A. Furnish the following:
- B. Manufacturers' Certificates and Data certifying that the following materials conform to the requirements specified.
  - 1. Expansion joint filler
  - 2. Hot poured sealing compound
  - 3. Reinforcement
  - 4. Curing materials
- C. Data and Test Reports:
  - 1. Job-mix formula.
  - 2. Source, gradation, liquid limit, plasticity index, percentage of wear, and other tests as specified and in referenced publications.

**1.6 APPLICABLE PUBLICATIONS**

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only. Refer to the latest edition of all referenced Standards and codes.
- B. American Association of State Highway and Transportation Officials (AASHTO):

- M31-07.....Deformed and Plain Billet Steel Bars for  
Concrete Reinforcement (ASTM A615/A615M-96A)
  - M55M/55M-09.....Welded Steel Wire Fabric for Concrete  
Reinforcement (ASTM A185)
  - M147-04.....Materials for Aggregate and Soil-Aggregate  
Subbase, Base and Surface Courses (R 1996)
  - M148-05.....Liquid Membrane-Forming Compounds for Curing  
Concrete (ASTM C309A)
  - M171-05.....Sheet Materials for Curing Concrete (ASTM C171)
  - M182-05.....Burlap Cloth Made from Jute or Kenaf
  - M213-05.....Preformed Expansion Joint Fillers for Concrete  
Paving and Structural Construction  
(Non-extruding and Resilient Bituminous Type)  
(ASTM D1751)
  - T99-09.....Moisture-Density Relations of Soils Using a 2.5  
kg. (5.5 lb) Rammer and a 305 mm (12 in.) Drop
  - T180-09.....Moisture-Density Relations of Soils Using a 4.54  
kg (10 lb.) Rammer and a 457 mm (18 in.) Drop
- C. American Society for Testing and Materials (ASTM):
- C94/C94M-09.....Ready-Mixed Concrete
  - C143/C143M-08.....Slump of Hydraulic Cement Concrete
  - C1116/C1116M-08.....Fiber Reinforced Concrete
  - //C979-05.....Pigments for Integrally Colored Concrete//

**PART 2 - PRODUCTS**

**2.1 GENERAL**

Concrete shall be Type C, air-entrained as specified in Section 03 30 53, SHORT FORM CAST-IN-PLACE CONCRETE, with the following exceptions:

TYPE	MAXIMUM SLUMP*
Curb & Gutter	75 mm (3")
Pedestrian Pavement	75 mm (3")
Vehicular Pavement	50 mm (2") (Machine Finished) 100 mm (4") (Hand Finished)
* For concrete to be vibrated: Slump as determined by ASTM C143. Tolerances as established by ASTM C94.	

**2.2 REINFORCEMENT**

- A. The type, amount, and locations of steel reinforcement shall be as shown on the drawings and in the specifications.
- B. Welded wire-fabric shall conform to AASHTO M55.

- C. Dowels shall be plain steel bars conforming to AASHTO M31 or M42. Tie bars shall be deformed steel bars conforming to AASHTO M31 or M42.

### **2.3 FORMS**

- A. Use metal or wood forms that are straight and suitable in cross-section, depth, and strength to resist springing during depositing and consolidating the concrete, for the work involved.
- B. Do not use forms if they vary from a straight line more than 3 mm (1/8 inch) in any 3000 mm (ten foot) long section, in either a horizontal or vertical direction.
- C. Wood forms should be at least 50 mm (2 inches) thick (nominal). Wood forms shall also be free from warp, twist, loose knots, splits, or other defects. Use approved flexible or curved forms for forming radii.

### **2.4 CONCRETE CURING MATERIALS**

- A. Concrete curing materials shall conform to one of the following:
  - 1. Burlap conforming to AASHTO M182 having a weight of 233 grams (seven ounces) or more per square meter (yard) when dry.
  - 2. Impervious Sheeting conforming to AASHTO M171.
  - 3. Liquid Membrane Curing Compound conforming to AASHTO M148 (ASTM C309), Type 1 and shall be free of paraffin or petroleum.

### **2.5 EXPANSION JOINT FILLERS**

Material shall conform to AASHTO M213.

## **PART 3 - EXECUTION**

### **3.1 SUBGRADE PENETRATION**

- A. Prepare, construct, and finish the subgrade as required.
- B. Maintain the subgrade in a smooth, compacted condition, in conformance with the required section and established grade until the succeeding operation has been accomplished.

### **3.2 SETTING FORMS**

- A. Base Support:
  - 1. Compact the base material under the forms true to grade so that, when set, they will be uniformly supported for their entire length at the grade as shown.
  - 2. Correct imperfections or variations in the base material grade by cutting or filling and compacting.
- B. Form Setting:
  - 1. Set forms sufficiently in advance of the placing of the concrete to permit the performance and approval of all operations required with and adjacent to the form lines.

2. Set forms to true line and grade and use stakes, clamps, spreaders, and braces to hold them rigidly in place so that the forms and joints are free from play or movement in any direction.
3. Forms shall conform to line and grade with an allowable tolerance of 3 mm (1/8 inch) when checked with a straightedge and shall not deviate from true line by more than 6 mm (1/4 inch) at any point.
4. Do not remove forms until removal will not result in damaged concrete or at such time to facilitate finishing.
5. Clean and oil forms each time they are used.

### **3.3 EQUIPMENT**

- A. The COR shall approve equipment and tools necessary for handling materials and performing all parts of the work prior to commencement of work.
- B. Maintain equipment and tools in satisfactory working condition at all times.

### **3.4 PLACING REINFORCEMENT**

- A. Reinforcement shall be free from dirt, oil, rust, scale or other substances that prevent the bonding of the concrete to the reinforcement.
- B. Before the concrete is placed, the COR shall approve the reinforcement, which shall be accurately and securely fastened in place with suitable supports and ties. The type, amount, and position of the reinforcement shall be as shown.

### **3.5 PLACING CONCRETE - GENERAL**

- A. Obtain approval of the COR before placing concrete.
- B. Remove debris and other foreign material from between the forms before placing concrete. Obtain approval of the COR before placing concrete.
- C. Before the concrete is placed, uniformly moisten the subgrade, base, or subbase appropriately, avoiding puddles of water.
- D. Convey concrete from mixer to final place of deposit by a method which will prevent segregation or loss of ingredients. Deposit concrete so that it requires as little handling as possible.
- E. While being placed, spade or vibrate and compact the concrete with suitable tools to prevent the formation of voids or honeycomb pockets. Vibrate concrete well against forms and along joints. Over-vibration or manipulation causing segregation will not be permitted. Place concrete continuously between joints without bulkheads.
- F. Install a construction joint whenever the placing of concrete is suspended for more than 30 minutes and at the end of each day's work.

- G. Workmen or construction equipment coated with foreign material shall not be permitted to walk or operate in the concrete during placement and finishing operations.

**3.6 PLACING CONCRETE FOR CURB AND GUTTER, PEDESTRIAN PAVEMENTS, AND EQUIPMENT PADS**

- A. Place concrete in the forms in one layer of such thickness that, when compacted and finished, it will conform to the cross section as shown.
- B. Deposit concrete as near to joints as possible without disturbing them but do not dump onto a joint assembly.
- C. After the concrete has been placed in the forms, use a strike-off guided by the side forms to bring the surface to the proper section to be compacted.
- D. Consolidate the concrete thoroughly by tamping and spading, or with approved mechanical finishing equipment.
- E. Finish the surface to grade with a wood or metal float.
- F. All Concrete pads and pavements shall be constructed with sufficient slope to drain properly.

**3.7 PLACING CONCRETE FOR VEHICULAR PAVEMENT**

- A. Deposit concrete into the forms as close as possible to its final position.
- B. Place concrete rapidly and continuously between construction joints.
- C. Strike off concrete and thoroughly consolidate by a finishing machine, vibrating screed, or by hand-finishing.
- D. Deposit concrete as near the joints as possible without disturbing them but do not dump onto a joint assembly. Do not place adjacent lanes/areas without approval by the COR.

**3.8 CONCRETE FINISHING - GENERAL**

- A. The sequence of operations, unless otherwise indicated, shall be as follows:
  - 1. Consolidating, floating, straight-edging, troweling, texturing, and edging of joints.
  - 2. Maintain finishing equipment and tools in a clean and approved condition.

**3.9 CONCRETE FINISHING PEDESTRIAN PAVEMENT**

- A. Walks, steps:
  - 1. Finish the surfaces to grade and cross section with a metal float, trowled smooth and finished with a broom moistened with clear water.
  - 2. Brooming shall be transverse to the line of traffic.
  - 3. Finish all slab edges, including those at formed joints, carefully with an edger having a radius as shown on the Drawings.

4. Unless otherwise indicated, edge the transverse joints before brooming. The brooming shall eliminate the flat surface left by the surface face of the edger. Execute the brooming so that the corrugation, thus produced, will be uniform in appearance and not more than 2 mm (1/16 inch) in depth.
  5. The completed surface shall be uniform in color and free of surface blemishes, form marks, and tool marks. The finished surface of the pavement shall not vary more than 5 mm (3/16 inch) when tested with a 3000 mm (10 foot) straightedge.
  6. The thickness of the pavement shall not vary more than 6 mm (1/4 inch).
  7. Remove and reconstruct irregularities exceeding the above for the full length between regularly scheduled joints.
- B. Steps: The method of finishing the steps and the sidewalls is similar to above except as herein noted.
1. Remove the riser forms one at a time, starting with the top riser.
  2. After removing the riser form, rub the face of the riser with a wood or concrete rubbing block and water until blemishes, form marks, and tool marks have been removed. Use an outside edger to round the corner of the tread; use an inside edger to finish the corner at the bottom of the riser.
  3. Give the risers and sidewall a final brush finish. The treads shall have a final finish with a stiff brush to provide a non-slip surface.
  4. The texture of the completed steps shall present a neat and uniform appearance and shall not deviate from a straightedge test more than 5 mm (3/16 inch).

### **3.10 CONCRETE FINISHING FOR VEHICULAR PAVEMENT**

- A. Accomplish longitudinal floating with a longitudinal float not less than 3000 mm (10 feet) long and 150 mm (6 inches) wide, properly stiffened to prevent flexing and warping. Operate the float from foot bridges in a sawing motion parallel to the direction in which the pavement is being laid from one side of the pavement to the other, and advancing not more than half the length of the float.
- B. After the longitudinal floating is completed, but while the concrete is still plastic, eliminate minor irregularities in the pavement surfaces by means of metal floats, 1500 mm (5 feet) in length, and straightedges, 3000 mm (10 feet) in length. Make the final finish with the straightedges, which shall be used to float the entire pavement surface.
- C. Test the surface for trueness with a 3000 mm (10 foot) straightedge held in successive positions parallel and at right angles to the direction in which the pavement is being laid and the entire area covered as

necessary to detect variations. Advance the straightedge along the pavement in successive stages of not more than one half the length of the straightedge. Correct all irregularities and refinish the surface.

- D. The finished surface of the pavement shall not vary more than 6 mm (1/4 inch) in both longitudinal and transverse directions when tested with a 3000 mm (10 foot) straightedge.
- E. The thickness of the pavement shall not vary more than 6 mm (1/4 inch).
- F. When most of the water glaze or sheen has disappeared and before the concrete becomes nonplastic, give the surface of the pavement a broomed finish with an approved fiber broom not less than 450 mm (18 inches) wide. Pull the broom gently over the surface of the pavement from edge to edge. Brooming shall be transverse to the line of traffic and so executed that the corrugations thus produced will be uniform in character and width, and not more than 3 mm (1/8 inch) in depth. Carefully finish the edge of the pavement along forms and at the joints with an edging tool. The brooming shall eliminate the flat surface left by the surface face of the edger.
- G. The finish surfaces of new and existing abutting pavements shall coincide at their juncture.

**3.11 JOINTS - GENERAL**

- A. Place joints, where shown, conforming to the details as shown, and perpendicular to the finished grade of the concrete surface.
- B. Joints shall be straight and continuous from edge to edge of the pavement.

**3.12 CONTRACTION JOINTS**

- A. Cut joints to depth as shown with a grooving tool or jointer of a radius as shown or by sawing with a blade producing the required width and depth.
- B. Finish edges of all joints with an edging tool having the 3/8" radius.
- E. Score pedestrian pavement with a standard grooving tool or jointer.

**3.13 EXPANSION JOINTS**

- A. Use a preformed expansion joint filler material of the thickness as shown to form expansion joints.
- B. Material shall extend the full depth of concrete, cut and shaped to the cross section as shown, except that top edges of joint filler shall be below the finished concrete surface where shown to allow for sealing.
- C. Anchor with approved devices to prevent displacing during placing and finishing operations.
- D. Round the edges of joints with an edging tool.
- E. Form expansion joints as follows:

1. Without dowels, about structures and features that project through, into, or against any site work concrete construction.
2. Using joint filler of the type, thickness, and width as shown.
3. Installed in such a manner as to form a complete, uniform separation between the structure and the site work concrete item.

**3.14 CONSTRUCTION JOINTS**

- A. Locate longitudinal construction joints between slabs of vehicular pavement.
- B. Place transverse construction joints of the type shown, whenever the placing of concrete is suspended for more than 30 minutes.

**3.15 FORM REMOVAL**

- A. Forms shall remain in place at least 12 hours after the concrete has been placed. Remove forms without injuring the concrete.
- B. Do not use bars or heavy tools against the concrete in removing the forms. Promptly repair any concrete found defective after form removal.

**3.16 CURING OF CONCRETE**

- A. Cure concrete by one of the following methods appropriate to the weather conditions and local construction practices, against loss of moisture, and rapid temperature changes for at least seven days from the beginning of the curing operation. Protect unhardened concrete from rain and flowing water. All equipment needed for adequate curing and protection of the concrete shall be on hand and ready to install before actual concrete placement begins. Provide protection as necessary to prevent cracking of the pavement due to temperature changes during the curing period. If any selected method of curing does not afford the proper curing and protection against concrete cracking, remove and replace the damaged pavement and employ another method of curing as directed by the COR.
- B. Burlap Mat: Provide a minimum of two layers kept saturated with water for the curing period. Mats shall overlap each other at least 150 mm (6 inches).
- C. Impervious Sheeting: Use waterproof paper, polyethylene-coated burlap, or polyethylene sheeting. Polyethylene shall be at least 0.1 mm (4 mils) in thickness. Wet the entire exposed concrete surface with a fine spray of water and then cover with the sheeting material. Sheets shall overlap each other at least 300 mm (12 inches). Securely anchor sheeting.
- D. Liquid Membrane Curing:
  1. Apply pigmented membrane-forming curing compound in two coats at right angles to each other at a rate of 5 m<sup>2</sup>/L (200 square feet per gallon) for both coats.



2. Do not allow the concrete to dry before the application of the membrane.
3. Cure joints designated to be sealed by inserting moistened paper or fiber rope or covering with waterproof paper prior to application of the curing compound, in a manner to prevent the curing compound entering the joint.
4. Immediately re-spray any area covered with curing compound and damaged during the curing period.

**3.17 CLEANING**

- A. After completion of the curing period:
1. Remove the curing material (other than liquid membrane).
  2. Sweep the concrete clean.
  3. After removal of all foreign matter from the joints, seal joints as herein specified.
  4. Clean the entire concrete of all debris and construction equipment as soon as curing and sealing of joints has been completed.

**3.18 PROTECTION**

The contractor shall protect the concrete against all damage prior to final acceptance by the Government. Remove concrete containing excessive cracking, fractures, spalling, or other defects and reconstruct the entire section between regularly scheduled joints, when directed by the Resident Engineer, and at no additional cost to the Government. Exclude traffic from vehicular pavement until the concrete is at least seven days old, or for a longer period of time if so directed by the COR.

**3.19 FINAL CLEAN-UP**

Remove all debris, rubbish and excess material from the Station.

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TECHNICAL NOTES

A. These Technical Notes are intended as a guide in preparing this specification section and the detail drawings. Delete these notes before typing the Contract Specifications. Modify this specification section and appropriate details and finishes included on the drawings for site work concrete, such as, other methods of construction (when aesthetics is of prime importance). If any of the following items are used, include the referenced publication and paragraphs in the appropriate portion of the contract specification.

1. When the project is located in an area where winter damage from deicing chemicals and freeze-thaw cycles pose a serious problem, the Spec Writer shall check the need for a special protective coating of linseed oil mixture. The coating protects only against the action of urea, sodium chloride, and calcium chloride used for deicing purposes. Protection against these chemicals is not required for concrete that will be in place for a cumulative time of six weeks at a continuous minimum temperature of 5 °C (40 °F), excluding the curing time. Otherwise, give concrete protective coating. Referenced paragraphs:

APPLICABLE PUBLICATION: AASHTO M233. Boiled Linseed Oil Mixture for Treatment of Portland Cement Concrete.

MATERIALS: Concrete Protection Material-Linseed Oil mixture shall conform to AASHTO M233.

CURING AND PROTECTION: Protective Coating - apply protective coating of linseed oil mixture to exposed-to-view concrete surfaces, drainage structures, and features that project through, into, or against the items constructed under this section to protect the concrete against the action of deicing materials.

- a. Application: Complete backfilling and curing operation prior to applying protective coating. Concrete shall be surface dry and thoroughly clean before each application. Give the concrete surface at least two applications. Coverage shall not be more than 11 m<sup>2</sup>/L (50 square yards per gallon) for first application, and not more than 16 m<sup>2</sup>/L (70 square yards per gallon) for the second application, except when the number of applications and coverage for each application for commercially prepared mixture shall be in accordance with the manufacturer's instructions. Protect coated surfaces from vehicular and pedestrian traffic until dry.
- b. Precautions: Do not heat protective coating, and do not expose the protective coating to open flame, sparks, or fire adjacent to open

containers or applicators. Do not apply material at temperatures lower than 10 degrees C (50 degrees F).

SUBMITTALS: Certificates-Concrete Protective Coating.

2. In some case it may be practical and economical to build concrete vehicular pavement with an integral curb section. The integral curb being constructed simultaneously with the pavement slab in a one-step operation avoids a longitudinal joint between the curb and gutter, and pavement. The curb is easily formed with a template and straightedge. The only joints generally required in the integral curbs are continuations of the transverse joints in the pavement slab. Another option for concrete curb or curb and gutter not required to be constructed integral with or tied to a concrete pavement, is the use of a self-propelled machine (slipforming machine) to place the concrete. This type of construction is most advantageous when the drawing details indicate a "mountable" (rolled) type curb and gutter. However, use of these machines on small jobs is generally not cost justifiable. Include the following paragraph and additional requirements for the integral curb template, extrusion equipment, and self-propelled machine in the appropriate portions of the Contract Specification, when an integral curb is indicated on the drawings or the use of a curb-forming machine is justified.  
CURB-FORMING MACHINES: Curb-forming machines for constructing // integral curbs // curbs // and gutter // will be approved based on trail use on the job. If the equipment produces unsatisfactory results, discontinue use of the equipment at any time during construction and accomplish the work by hand method construction as specified. Remove unsatisfactory work and reconstruct the full length between regularly scheduled joints. Dispose of removed portions off the Station.
3. When aesthetics is of prime importance and certain areas are shown to have a special finish and texture, such as an exposed aggregate surface or to have colored concrete, the Spec Writer shall consider the use of the following data:
  - a. Contact the Portland Cement Association district office in the area of the project for advice in specifying and detailing the finish and texture desired.
  - b. Exposed Aggregate Concrete: For use by the physically handicapped, the texture of an exposed aggregate surface shall be smooth and the aggregate size shall not produce a rough finish. There are a number of ways to obtain exposed aggregate finishes, so base the

method selected on local materials and construction practices. The following is a suggested paragraph:

EXPOSED AGGREGATE CONCRETE: When concrete is shown to have an exposed aggregate surface, the finish shall be as follows: Apply mix and mark off surface as indicated with surface joints at least 10 mm (3/8 inch) deep. Level off finish to a true surface and compact with a wood float, working as little as possible so that coarse material will remain at the top. Before finish has set, treat top surface with cement retarding material. When body of concrete finish has set, remove retarded surface film by wire brushes and fine water spray to remove the mortar from the top of the colored aggregate. Continue washing and brushing until flush water runs clear and there is no noticeable cement film left on the aggregate. Specify color of aggregate in Section 09 06 00, SCHEDULE FOR FINISHES. Prior to starting work, submit a sample of exposed aggregate concrete panel to the Resident Engineer for approval.

Edit the above paragraph to describe the "seeding method" of preparing a concrete base 10 to 13 mm (3/8 to 1/2-inch) lower than the finish grade to accommodate the aggregate to be scattered over the concrete base surface and embedded therein by use of a hand float, straight edge, or darby. After the aggregate is embedded, the usual procedures are followed to expose the aggregate.

B. Colored Concrete - Two method of producing colored concrete finishes are: By integral color or by the dry-shake method. For durability, uniformity of color and lower cost, the Department of Veterans Affairs preference is the integral color method. The amount of pigment used to achieve integral colored concrete should be the minimum amount necessary to produce the desired color, but never more than 10 percent by weight of the cement. The use of white Portland cement produces cleaner, brighter colors and is the preference to normal gray Portland cement, except for black or dark gray colors. The following is a suggested paragraph:

COLORED CONCRETE: Pedestrian pavement designed to be colored shall have the coloring introduced into the concrete mix at the batch plant. Introduce sufficient quantities of // carbon black // mineral oxide pigment // to produce the color specified in Section 09 06 00, SCHEDULE FOR FINISHES. Prior to starting work, submit a sample of the colored concrete with type of coloring additive and the amount of additive per m3 (cubic yard) of concrete mix to the Resident Engineer for approval.

Some coloring materials affect air entrainment while others do not, the Spec Writer will make certain that the color and mixtures used do not produce a concrete having less than the desired air content specified in Section 03 30 53, SHORT FORM CAST-IN-PLACE CONCRETE. Edit the above paragraph and drawing details as required to cover mixing, placing, preparation, equipment, finish, and any special construction.

C. Include under the SUBMITTALS portion of Contract Specifications the following paragraphs(s) as applicable:

Samples:

1. Exposed aggregate concrete panel, 0.4 m2 by 50 mm (4 square feet by 2 inches) thick, 2 required, each color and finish.
2. Color concrete panel, as specified in Section 09 06 00, SCHEDULE FOR FINISHES, with mix data.
3. Snow Melting Systems - Specify snow melting systems as required by the HVAC design manual in a separate section and that section title referenced in this section. The site plan drawings shall indicate the areas to be provided with the snow melting systems.

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