

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

**PART 1 - GENERAL**

**1.1 SUMMARY**

A. Section Includes:

1. Site work concrete.
2. Vehicular Pavement: Maintenance yards.
3. Equipment Pads: Above Ground Fuel Storage Tanks.

**1.2 RELATED REQUIREMENTS**

- A. Concrete Materials, Quality, Mixing, Design and Other Requirements:  
 Section 03 30 53, SHORT FORM CAST-IN-PLACE CONCRETE.

**1.3 APPLICABLE PUBLICATIONS**

- A. Comply with references to extent specified in this section.
- B. American Association of State Highway and Transportation Officials (AASHTO):
1. M31M/M31-15 - Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
  2. M55M/M55-09 - Steel Welded Wire Reinforcement, Plain, for Concrete, Single User.
  3. M147-65 (2004) - Materials for Aggregate and Soil-Aggregate Subbase, Base, and Surface Courses.
  4. M148-05 - Liquid Membrane-Forming Compounds for Curing Concrete.
  5. M171-05 - Sheet Materials for Curing Concrete.
  6. M182-05(2012) - Burlap Cloth Made from Jute or Kenaf and Cotton Mats.
  7. M213-01(2010) - Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types).
  8. M233-86 - Boiled Linseed Oil Mixture for Treatment of Portland Cement Concrete.
  9. T99-15 - Moisture-Density Relations of Soils Using a 2.5-kg. (5.5-lb) Rammer and a 305-mm (12-in.) Drop.
  10. T180-15 - Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop.
- C. American National Standards Institute (ANSI):

1. B101.3 - Wet DOCF of Common Hard Surface Floor Materials (Including Action and Limit Thresholds for the Suitable Assessment of the Measured Values).

D. ASTM International (ASTM):

1. A775/A775M-16 - Epoxy-Coated Steel Reinforcing Bars.
2. C94/C94M-16 - Ready-Mixed Concrete.
3. C143/C143M-15a - Slump of Hydraulic Cement Concrete.
4. // C979/C979M-16 - Pigments for Integrally Colored Concrete. //
5. C1116/C1116M-10a(2015) - Fiber-Reinforced Concrete.
6. D5893/D5893M-10 - Cold Applied, Single Component, Chemically Curing Silicone Joint Sealant for Portland Cement Concrete Pavements.
7. D6690-15 - Joint and Crack Sealants, Hot Applied, for Concrete and Asphalt Pavements.

#### 1.4 SUBMITTALS

- A. Submittal Procedures: Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Submittal Drawings:
  1. Show size, configuration, and fabrication and installation details.
  2. Show reinforcing.
  3. Include jointing plan for concrete pavements, curbs and gutters.
- C. Manufacturer's Literature and Data:
  1. Description of each product.
    - a. Expansion joint filler.
    - b. Reinforcement.
    - c. Curing materials.
  2. Installation instructions.
- D. Certificates: Certify products comply with specifications.
  1. Expansion joint filler.
  2. Reinforcement.
  3. Curing materials.
  4. Concrete protective coating.
- E. Qualifications: Substantiate qualifications comply with specifications.
  1. Installer with project experience list.
- F. Concrete mix design.

#### 1.5 QUALITY ASSURANCE

- A. Installer Qualifications:
  1. Regularly installs specified products.

2. Installed specified products with satisfactory service on five similar installations.

- a. Project Experience List: Provide contact names and addresses for completed projects.

#### **1.6 DELIVERY**

- A. Deliver products in manufacturer's original sealed packaging.
- B. Mark packaging, legibly. Indicate manufacturer's name or brand, type, and manufacture date.
- C. Deliver steel reinforcement to prevent damage.
- D. Before installation, return or dispose of products with damaged or opened packaging and distorted or damaged steel reinforcement.
- E. Bulk Products: Deliver bulk products away from buildings, utilities, pavement, and existing turf and planted areas. Maintain dry bulk product storage away from contaminants.

#### **1.7 STORAGE AND HANDLING**

- A. Store products indoors in dry, weathertight facility.
- B. Protect products from damage during handling and construction operations.

#### **1.8 FIELD CONDITIONS**

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

#### **1.9 WARRANTY**

- A. Construction Warranty: FAR clause 52.246-21, "Warranty of Construction."

### **PART 2 - PRODUCTS**

#### **2.1 CONCRETE**

- A. Concrete: Type C, air-entrained as specified in Section 03 30 53, SHORT FORM CAST-IN-PLACE CONCRETE, except as follows:

TYPE	MAXIMUM SLUMP*
Curb & Gutter	75 mm (3 inches)
Pedestrian Pavement	75 mm (3 inches)

TYPE	MAXIMUM SLUMP*
Vehicular Pavement	50 mm (2 inches) (Machine Finished) 100 mm (4 inches) (Hand Finished)
Equipment Pad	75 to 100 mm (3 to 4 inches)
* For concrete to be vibrated: Slump as determined by ASTM C143/C143M. Tolerances as established by ASTM C94/C94M.	

## 2.2 REINFORCEMENT

- A. Steel Reinforcement: Type, amount, and locations as shown on drawings and as specified.
- B. Welded Wire-Fabric: AASHTO M55M/M55.
- C. Dowels: Plain steel bars complying with AASHTO M31M/M31.
- D. Tie Bars: Deformed steel bars complying with AASHTO M31M/M31.
- E. Fiber Reinforcement: Polypropylene fibers designed for use in concrete pavement, complying with ASTM C1116/C116M, Type III, 13 to 38 mm (1/2 to 1 1/2 inches) long. Include 2.27 kg (5 lbs.) per .76 cu. m (1 cu. yd.) of concrete in batch.

## 2.3 FORMS

- A. Forms: Metal or wood, straight and suitable in cross-section, depth, and strength to resist springing during depositing and consolidating of concrete.
- B. Tolerance: 3 mm (1/8 inch) maximum variation from straight line in any 3000 mm (10 foot) long section, in either a horizontal or vertical direction.
- C. Wood Forms: Minimum 50 mm (2 inches) thick (nominal), free from warp, twist, loose knots, splits, or other defects. Provide approved flexible or curved forms for forming radii.

## 2.4 CONCRETE CURING MATERIALS

- A. Concrete Curing Materials: Comply with one of the following:
  - 1. Burlap: AASHTO M182, weighing 233 g/sq. m (7 oz./sq. yd.) dry.
  - 2. Impervious Sheeting: AASHTO M171.
    - a. Polyethylene: Minimum 0.1 mm (4 mils) thick.
  - 3. Liquid Membrane Curing Compound: AASHTO M148 Type 1, without paraffin or petroleum.

**2.5 EXPANSION JOINT FILLERS**

- A. Expansion Joint Filler: AASHTO M213.

**2.6 ACCESSORIES**

- A. Equipment and Tools: Obtain COR's approval of equipment and tools for handling materials and performing work before work begins. Maintain equipment and tools in satisfactory working condition at all times.
- B. Sealants:
  - 1. Concrete Paving Expansion Joints: ASTM D5893/D5893M, Type SL, single component, self-leveling, silicone joint sealant.
  - 2. Concrete Paving Joints: ASTM D6690, Type IV, hot-applied, single component joint sealant.
- C. Concrete Protective Coating: AASHTO M233 linseed oil mixture.

**PART 3 - EXECUTION****3.1 PREPARATION**

- A. Examine and verify substrate suitability for product installation.
- B. Protect existing construction and completed work from damage.
- C. Maintain subgrade in smooth, compacted condition, complying with required section and established grade until succeeding operation has been accomplished.

**3.2 SETTING FORMS**

- A. Form Substrate:
  - 1. Compact form substrate to uniformly support forms along entire length at grade as shown on drawings.
  - 2. Correct substrate imperfections or variations by cutting or filling and compacting.
- B. Form Setting:
  - 1. Set forms sufficiently in advance of concrete placement to permit performance and approval of operations required with and adjacent to form lines.
  - 2. Set forms to indicated line and grade and use stakes, clamps, spreaders, and braces to prevent movement in any direction.
  - 3. Tolerances: Conform to line and grade with 3 mm (1/8 inch) tolerance when checked with straightedge, with maximum 6 mm (1/4 inch) deviation from true line at any point.
  - 4. Remove forms when removal will not damage concrete and when required for finishing.

5. Clean and oil forms before each use.

### **3.3 PLACING REINFORCEMENT**

- A. Keep reinforcement free of dirt, oil, rust, scale or other substances preventing concrete bond.
- B. Install reinforcement as shown on drawings.
- C. Support and securely tie reinforcing steel to prevent displacement during concrete placement.
- D. Obtain COR's approval of reinforcement placement before placing concrete.
- E. Synthetic Fiber in Flatwork: Uniformly disperse in concrete mixture at 3 kg/cu. m (5 lbs./cu. yd.) minimum rate.

### **3.4 PLACING CONCRETE - GENERAL**

- A. Preparation:
  - 1. Obtain COR's approval.
  - 2. Remove debris and other foreign material from between forms.
  - 3. Uniformly moisten subgrade, base, or subbase without standing water.
- B. Convey concrete from mixer to final location without segregation or loss of ingredients. Deposit concrete to minimize handling.
- C. During placement, consolidate concrete by spading or vibrating to minimize voids, honeycomb, and rock pockets.
  - 1. Vibrate concrete against forms and along joints.
  - 2. Avoid excess vibration and handling causing segregation.
- D. Place concrete continuously between joints without bulkheads.
- E. Install construction joint whenever concrete placement is suspended for more than 30 minutes and at end of each day's work.
- F. Workmen or construction equipment coated with foreign material will not be permitted to walk or operate in concrete during placement and finishing operations.

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

- A. Place concrete in one layer conforming to cross section shown on drawings after consolidating and finishing.
- B. Deposit concrete near joints without disturbing joints. Do not place concrete directly onto joint assemblies.
- C. After concrete has been placed in forms, use a strike-off guided by side forms to bring surface to proper section to be compacted.

- D. Consolidate concrete thoroughly by tamping and spading, or with approved mechanical finishing equipment.
- E. Finish concrete surface to grade with wood or metal float.
- F. Construct concrete pads and pavements with sufficient slope to drain, preventing standing water.

### **3.6 PLACING CONCRETE FOR VEHICULAR PAVEMENT**

- A. Deposit concrete into 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 with finishing machine, vibrating screed, or by hand-finishing.
- D. Finish surface to elevation and crown as shown on drawings.
- E. Deposit concrete near joints without disturbing joints. Do not place directly onto joint assemblies. Do not place adjacent lanes/areas without COR's approval.

### **3.7 CONCRETE FINISHING - GENERAL**

- A. Follow operation sequence below, unless otherwise indicated on drawings:
  - 1. Consolidating, floating, straight-edging, troweling, texturing, and joint edging.
  - 2. Maintain finishing equipment and tools in clean and approved condition.

### **3.8 CONCRETE FINISHING - CURB AND GUTTER**

- A. Gutter and Curb Top:
  - 1. Round edges of gutter and curb top with edging tool to 6mm (1/4 inch) radius or as otherwise shown on drawings.
  - 2. Float surfaces and finish with smooth wood or metal float until true to grade and section and uniform texture.
  - 3. Finish surfaces longitudinally, while still wet, with bristle type brush.
- B. Curb Face:
  - 1. Remove curb form and immediately rub curb face with wood or concrete rubbing block and water until blemishes, form marks, and tool marks have been removed.
  - 2. Brush curb face, while still wet, to match gutter and curb top.
- C. Tolerances: Except at grade changes or curves, when tested with 3000 mm (10 foot) straightedge.
  - 1. Variation from Indicated Plane and Grade:

- a. Gutter: Maximum 3 mm (1/8 inch).
  - b. Curb Top and Face: Maximum 6 mm (1/4 inch).
- D. Replace curbs and gutters within joint boundary when curbs and gutters exceed specified tolerances.
- E. Correct depressions causing standing water.
- F. Visible surfaces and edges of finished curb, gutter, and combination curb and gutter to be free of blemishes, form marks, and tool marks, and uniform in color, shape, and appearance.

### 3.9 CONCRETE FINISHING - VEHICULAR PAVEMENT

- A. Longitudinally float pavement surface with float minimum 3000 mm (10 feet) long and 150 mm (6 inches) wide, properly stiffened to prevent flexing and warping. Operate float from foot bridges in sawing motion parallel to direction in which pavement is being laid from one side of pavement to the other, and advancing maximum half float length.
- B. After longitudinal floating, but while concrete is still plastic, eliminate minor irregularities in pavement surfaces by metal floats, 1500 mm (5 feet) long, and straightedges, 3000 mm (10 feet) long. Make the final finish and float entire pavement surface with straightedges.
- C. Test surface trueness with 3000 mm (10 foot) straightedge successively held parallel and at right angles to direction in which pavement is being laid and entire area, as required, to detect variations. Advance straightedge along pavement in successive stages of maximum one half straightedge length. Correct irregularities and refinish surface.
- D. Pavement Tolerances:
  - 1. Variation from Indicated Plane: Maximum 6 mm in 3000 mm (1/4 inch in 10 feet) tested parallel and perpendicular to traffic direction at maximum 1500 mm (5 feet) intervals.
  - 2. Variation from Indicted Thickness: Maximum 6 mm (1/4 inch).
- E. Finish pavement edges and joints with edging tool.
- F. Broom finish concrete surface after bleed water dissipates and before concrete hardens with approved fiber broom, minimum 450 mm (18 inches) wide.
  - 1. Gently broom surface transverse to traffic direction from edge to edge.
    - a. Use brooming to eliminate flat surface produced by edger.
    - b. Produce uniform corrugations, maximum 3 mm (1/8 inch) deep.
- G. Align finish surfaces where new and existing pavements abut.



**3.10 CONCRETE FINISHING - EQUIPMENT PADS**

- A. Strike pad surface to elevation shown on drawings.
- B. Provide smooth, dense float finish, free from depressions or irregularities.
- C. Carefully finish pad edges with edger having radius as shown on drawings.
- D. After removing forms, rub pad edge faces with wood or concrete rubbing block, removing blemishes, form marks, and tool marks and providing uniform color.
- E. Pad Tolerances:
  - 1. Variation from Indicated Plane: Maximum 3 mm in 3000 mm (1/8 inch in 10 feet).
- F. Correct irregularities when pads exceed specified tolerances.

**3.11 JOINTS - GENERAL**

- A. Place joints, where shown on drawings.
  - 1. Conform to details shown.
  - 2. Install joints perpendicular to finished concrete surface.
- B. Make joints straight and continuous from edge to edge of pavement.

**3.12 CONTRACTION JOINTS**

- A. Cut joints to depth as shown with grooving tool or jointer of radius as shown on drawings or by sawing with blade to produce required width and depth.
- B. Construct joints in curbs and gutters by inserting 3 mm (1/8 inch) steel plates conforming to curb and gutter cross sections.
  - 1. Keep plates in place until concrete can hold its shape.
- C. Finish joint edges with edging tool having radius as shown on drawings.
- D. Score pedestrian pavement with standard grooving tool or jointer.

**3.13 EXPANSION JOINTS**

- A. Form expansion joints with preformed expansion joint filler material of thickness shown on drawings.
  - 1. Without dowels, locate joints around perimeter of structures and features abutting site work concrete.
  - 2. Create complete, uniform separation between structure and site work concrete.
- B. Extend expansion joint material full depth of concrete with top edge of joint filler below finished concrete surface where sealant is indicated on drawings.

- C. Cut and shape material matching cross section.
- D. Anchor with approved devices to prevent displacing during placing and finishing operations.
- E. Round the edges of joints with an edging tool.

### **3.14 CONSTRUCTION JOINTS**

- A. Locate longitudinal and transverse construction joints between slabs of vehicular pavement as shown on drawings.
- B. Place transverse construction joints of type shown, where indicated, and whenever concrete placement is suspended for more than 30 minutes.

### **3.15 FORM REMOVAL**

- A. Keep forms in place minimum 12 hours after concrete placement. Remove forms without damaging concrete.
- B. Do not use bars or heavy tools against concrete to remove forms. Promptly repair damaged concrete found after form removal.

### **3.16 CONCRETE**

- A. Concrete Protection:
  - 1. Protect unhardened concrete from rain and flowing water.
  - 2. Ensure sufficient curing and protection materials are available and ready for use before concrete placement begins.
  - 3. Protect concrete to prevent pavement cracking from ambient temperature changes during curing period.
    - a. Replace pavement damaged by curing method allowing concrete cracking.
    - b. Employ another curing method as directed by COR.
- B. Cure concrete for minimum 7 days by one of the following methods appropriate to weather conditions preventing moisture loss and rapid temperature change:
  - 1. Burlap Mat: Provide minimum two layers kept saturated with water during curing period. Overlap mats minimum 150 mm (6 inches).
  - 2. Impervious Sheeting: Provide waterproof paper, polyethylene-coated burlap, or polyethylene sheeting.
    - a. Wet exposed concrete surface with fine water spray and cover with sheet materials.
    - b. Overlap sheets minimum 300 mm (12 inches).
    - c. Securely anchor sheet materials preventing displacement.
- C. Liquid Membrane Curing Compound:

1. Protect joints indicated to receive sealants preventing contamination from curing compound.
2. Insert moistened paper or fiber rope into joint or cover joint with waterproof paper.
3. Apply curing compound before concrete dries.
4. Apply curing compound in two coats at right angles to each other.
5. Application Rate: Maximum 5 sq. m/L (200 sq. ft./gal.), both coats.
6. Immediately reapply curing compound to surfaces damaged during curing period.

### **3.17 CONCRETE PROTECTIVE COATING**

- A. Apply protective coating of linseed oil mixture to exposed-to-view concrete surfaces, drainage structures, and features that project through, into, or against concrete exterior improvements to protect the concrete against deicing materials.
- B. Complete backfilling and curing operation before applying protective coating.
- C. Dry and thoroughly clean concrete before each application.
- D. Apply two coats, with maximum coverage of 11 sq. m/L (50 sq. yds./gal.) for first coat, and maximum 16 sq. m/L (70 sq. yds./gal.) for second coat, except apply commercially prepared mixture according to manufacturer's instructions.
- E. Protect coated surfaces from vehicular and pedestrian traffic until dry.
- F. 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).

### **3.18 CLEANING**

- A. After completing curing:
  1. Remove curing material, except liquid membrane.
  2. Sweep the concrete clean.
  3. Seal all joints after removing foreign matter from joint.
  4. Clean concrete of debris and construction equipment as soon as curing and joint sealing have been completed.
- B. Remove and legally dispose of debris, rubbish, and excess material from project site.

**3.19 PROTECTION**

- A. Protect exterior improvements from traffic and construction operations.
  - 1. Prohibit traffic on paving for minimum seven days after placement, or longer as directed by COR.
- B. Remove protective materials immediately before acceptance.
- C. Repair damage.
  - 1. When directed by COR, replace concrete containing cracking, fractures, spalling, and other defects within joint boundary, at no additional cost to Government.

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