

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: driveways.

1.2 RELATED REQUIREMENTS

- A. Laboratory and Field Testing Requirements: Section 01 45 29, TESTING LABORATORY SERVICES.
- B. Subgrade Preparation: Section 31 20 11, EARTH MOVING-SHORT FORM.
- C. 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):

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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. C1116/C1116M-10a(2015) - Fiber-Reinforced Concrete.
 5. D5893/D5893M-10 - Cold Applied, Single Component, Chemically Curing Silicone Joint Sealant for Portland Cement Concrete Pavements.
 6. 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. Hot poured sealing compound.
 - c. Reinforcement.
 - d. Curing materials.
 2. Installation instructions.
 - D. Test Reports: Certify products comply with specifications.
 1. Job-mix formula.
 2. Select subbase materials.
 - E. Certificates: Certify products comply with specifications.
 1. Expansion joint filler.
 2. Reinforcement.
 3. Curing materials.
 4. Concrete protective coating.
 - F. Qualifications: Substantiate qualifications comply with specifications.
 1. Installer with project experience list.
 - G. Concrete mix design.
 - H. Select subbase job-mix design: Report the following:

1. Material sources.
2. Gradation.
3. Plasticity index.
4. Liquid limit.
5. Laboratory compaction curves indicating maximum density at optimum moisture content.

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.

B. Preconstruction Testing:

1. Engage independent testing laboratory to perform tests and submit reports.
 - a. Deliver samples to laboratory in number and quantity required for testing.
2. Concrete mix design.

1.6 DELIVERY

- A. Deliver products in manufacturer's original sealed packaging.
- B. Mark packaging, legibly. Indicate manufacturer's name or brand, type, color, 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)
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 SELECT SUBBASE (WHERE REQUIRED)

- A. Subbase: Select granular material composed of sand, sand-gravel, crushed stone, crushed or granulated slag, with or without soil binder, or combinations of these materials conforming to AASHTO M147, Grading E or F.
 - 1. Materials meeting other gradations than that noted will be acceptable whenever gradations are within tolerance of three to five percent, plus or minus, of single gradation established by job-mix formula.

- B. Subbase Material: Compacted, dense-graded course, meeting specified density requirement.

2.4 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.

2.5 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.

2.6 EXPANSION JOINT FILLERS

- A. Expansion Joint Filler: AASHTO M213.

2.7 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.

2.8 CEMENT, SAND, AGGREGATES AND OTHER ADDITIVES

- A. Cement, Sand and Aggregate Color: As required to match paver colors.
- B. Provide silicon carbide or aluminum oxide grains as required to match paver colors.

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. Prepare, construct, and finish subgrade as specified in // Section 31 20 00, EARTH MOVING // Section 31 20 11, EARTH MOVING-SHORT FORM //.
- D. Maintain subgrade in smooth, compacted condition, complying with required section and established grade until succeeding operation has been accomplished.

3.2 SELECT SUBBASE (WHERE REQUIRED)

- A. Mixing: Proportion select subbase by weight or by volume in quantities so final approved job-mixed formula gradation, liquid limit, and plasticity index requirements will be met after subbase course has been placed and compacted. Add water in approved quantities, measured by weight or volume, to produce uniform blend.
- B. Placing:
 - 1. Place mixed material on prepared subgrade in uniform layer to required contour and grades, to maximum 200 mm (8 inches) loose depth that, when compacted, will produce layer of required thickness.
 - 2. When required compacted thickness exceeds 150 mm (6 inches), place subbase material in equal thickness layers. Remove unsatisfactory areas and replace with satisfactory mixture, or mix material in placement area.
 - 3. Adding thin layers of material to top layer in order to meet grade will not be permitted.
 - 4. When subbase elevation is 13 mm (1/2 inch) or more below grade, excavate top layer and replace with new material to minimum 75 mm (3 inches) compacted thickness.
- C. Compaction:
 - 1. Perform compaction with approved hand or mechanical equipment well suited to material being compacted.
 - 2. Moisten or aerate material as required to provide moisture content that will readily facilitate obtaining specified compaction with equipment used.

3. Compact each subbase layer to minimum 95 percent or 100 percent of maximum density as specified by AASHTO T180 or AASHTO T99, respectively.

D. Tolerances:

1. Test completed subbase for grade and cross section with straight edge.
2. Surface Variation: Maximum 10 mm (3/8 inch) each layer.
3. Variation from Indicated Thickness: Maximum 13 mm (1/2 inch).

E. Protection:

1. Maintain finished subbase in smooth and compacted condition until concrete is placed.
2. When subsequent construction operations or adverse weather disturb approved compacted subbase, excavate and reconstruct subbase with new material meeting specified requirements, at no additional cost to Government.

3.3 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.

3.4 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.
- 3.5 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.
- 3.6 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 - 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.

3.9 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.

3.10 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.

3.11 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.

3.12 CONSTRUCTION JOINTS

- A. Locate 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.

3.13 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.

3.14 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.
- 3.15 FIELD QUALITY CONTROL
- A. Field Tests: Performed by testing laboratory specified in Section 01 45 29, TESTING LABORATORY SERVICES.
1. Concrete: Testing specified in Section 03 30 53 SHORT FORM CAST-IN-PLACE CONCRETE.
 - a. Delivery samples.
 - b. Field samples.
- 3.16 CLEANING
- A. After completing curing:

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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.
- 3.17 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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