
Standard Specification for Reinforced Concrete D-Load Culvert, Storm Drain, and Sewer Pipe

AASHTO Designation: M 242M/M 242-20¹

Technical Subcommittee: 4a, Concrete Drainage Structures

Release: Group 2 (June)

ASTM Designation: C655M-15 and C655-15



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1. SCOPE

1.1. This specification covers reinforced concrete pipe designed for specific D-loads and intended to be used for the conveyance of sewage, industrial wastes, and storm water, and for the construction of culverts.

1.2. This specification is applicable for orders in either SI units (M 242M) or in inch-pound units (M 242). SI units and inch-pound units are not necessarily equivalent. Inch-pound units are shown in brackets in the text for clarity, but they are the applicable values when the material is ordered to M 242.

Note 1—Experience has shown that the successful performance of this product depends on the proper selection of the pipe strength, the type of bedding and backfill, the care that the installation conforms to the construction specifications, and provision for adequate inspection at the construction site. This specification does not include requirements for bedding, backfill, the relationship between field load conditions and the strength designation of pipe, or durability under unusual environmental conditions. These requirements should be included in the project specification.

2. REFERENCED DOCUMENTS

2.1. *AASHTO Standards:*

- M 6, Fine Aggregate for Hydraulic Cement Concrete
- M 31M/M 31, Deformed and Plain Carbon and Low-Alloy Steel Bars for Concrete Reinforcement
- M 80, Coarse Aggregate for Hydraulic Cement Concrete
- M 85, Portland Cement
- M 157, Ready-Mixed Concrete
- M 240M/M 240, Blended Hydraulic Cement
- M 262, Concrete Pipe and Related Products
- M 295, Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
- M 302, Slag Cement for Use in Concrete and Mortars

- M 336M/M 336, Steel Wire and Welded Wire, Plain and Deformed, for Concrete Reinforcement
- T 280, Concrete Pipe, Manhole Sections, or Tile

2.2. *ASTM Standards:*

- C33/C33M, Standard Specification for Concrete Aggregates
- C1116/C1116M, Standard Specification for Fiber-Reinforced Concrete
- E105, Standard Practice for Probability Sampling of Materials
- MNL7, *Manual on Presentation of Data and Control Chart Analysis*, 9th Edition, 2018. Committee E-11 on Quality and Statistics
- STP15C, *ASTM Manual on Quality Control of Materials*

3. TERMINOLOGY

- 3.1. *Definitions*—For definitions of terms relating to concrete pipe, see M 262.

4. BASIS OF ACCEPTANCE

- 4.1. The acceptability of the pipe design shall be determined in accordance with Section 9. After the pipe design has been accepted, or if the pipe design has been accepted previously in accordance with Section 9, the owner may select and have applied the basis of acceptance described in either Section 4.1.1 or Section 4.1.2. Unless designated by the owner at the time of, or before placing an order, either basis of acceptance shall be permitted.
- 4.1.1. *Acceptance on the Basis of Pipe Load and Material Tests and Inspection of Manufactured Pipe for Defects*—Determine in accordance with Sections 5, 6, 8, and 10.
Note 2—It is necessary that samples be selected at random. For guidance, see ASTM E105.
- 4.1.2. *Acceptance on the Basis of Concrete Compression and Materials Tests and Inspection of Manufactured Pipe for Defects*—Determine in accordance with Sections 5, 6, 8, and 11.
- 4.2. *Age for Acceptance*—Pipe shall be considered ready for acceptance when they conform to the requirements.

5. DESIGN AND MANUFACTURING DATA

- 5.1. *The manufacturer shall provide the following information regarding the pipe unless waived by the owner:*
- 5.1.1. Basis of acceptance, and
- 5.1.2. Pipe design strength.
- 5.1.3. *Physical Characteristics:*
- 5.1.3.1. Diameter, wall thickness, laying length, and joint details;
- 5.1.4. Design concrete strength, minimum $f'_c = 27.6$ MPa [4000 psi]; and

- 5.1.5. Admixtures.
- 5.2. *Reinforcement:*
- 5.2.1.1. Type of reinforcement, applicable reinforcement specification, and grade; and
- 5.2.1.2. Placement, placement tolerances, diameter, spacing and cross-sectional area of circumferential, longitudinal, and special reinforcement.
- 5.2.2. Manufacturing and curing process.

6. **MATERIALS AND MANUFACTURE**

- 6.1. *Materials:*
- 6.1.1. *Reinforced Concrete*—The reinforced concrete shall consist of cementitious materials, mineral aggregates, and water, in which steel has been embedded in such a manner that the steel and concrete act together.
- 6.2. *Cementitious Materials:*
- 6.2.1. *Cement*—Cement shall conform to the requirements for portland cement of M 85 or shall be portland blast-furnace slag cement, portland-limestone cement, or portland-pozzolan cement conforming to the requirements of M 240M/M 240, except that the pozzolan constituent in the Type IP portland-pozzolan cement shall be fly ash.
- 6.2.2. *Fly Ash*—Fly ash shall conform to the requirements of M 295, Class F or Class C.
- 6.2.3. *Slag Cement*—Slag cement shall conform to the requirements of Grade 100 or 120 of M 302.
- 6.2.4. *Allowable Combinations of Cementitious Materials*—The combination of cementitious materials used in the concrete shall be one of the following:
 - 6.2.4.1. Portland cement only,
 - 6.2.4.2. Portland blast-furnace slag cement only,
 - 6.2.4.3. Portland-pozzolan cement only, or
 - 6.2.4.4. Portland-limestone cement only,
 - 6.2.4.5. A combination of portland cement or portland-limestone cement and fly ash,
 - 6.2.4.6. A combination of portland cement or portland-limestone cement and slag cement,
 - 6.2.4.7. A combination of portland cement or portland-limestone cement, slag cement, and fly ash, or
 - 6.2.4.8. A combination of portland-pozzolan cement and fly ash.
- 6.2.5. *Aggregates*—Aggregates shall conform to the requirements of M 6 and M 80, except that the requirements for gradation shall not apply.
- 6.2.6. *Admixtures and Blends*—Admixtures and blends shall be allowed unless prohibited by the owner.

- 6.2.7. *Steel Reinforcement*—Reinforcement shall consist of wire or wire fabric conforming M 336M/M 336 or of bars of Grade 300 [40] steel conforming to M 31M/M 31.
- 6.2.8. *Water*—Mix water shall conform with M 157, Section 4.1.4, with a maximum limit of 0.15 percent chloride.
- 6.3. *Manufacture:*
- 6.3.1. *Mixture*—The aggregates shall be sized, graded, proportioned, and mixed with such proportions of cementitious materials, water, and admixtures, if any, to produce a thoroughly mixed concrete of such quality that the pipe will conform to the test and design requirements of this specification. All concrete shall have a water-cementitious materials ratio not exceeding 0.53 by mass. Cementitious materials shall be as specified in Section 6.1 and shall be added to the mix in a proportion not less than 280 kg/m³ [470 lb/yd³] unless mix designs with a lower cementitious material content demonstrate that the quality and performance of the pipe meet the requirements of this specification.
- 6.3.2. *Reinforcement:*
- 6.3.2.1. *Placement*—Reinforcement shall be placed as indicated in Section 5.1.6.2, subject to the tolerances given in Sections 5.1.6.2 and 8.2.2. Minimum design protective cover of concrete over the circumferential reinforcement in the barrel of the pipe shall be 25 mm [1 in.] for wall thicknesses of 63 mm [2½ in.] or greater, and 19 mm [¾ in.] for wall thicknesses less than 63 mm [2½ in.], subject to the tolerances given in Section 8.2.2.
- 6.3.2.2. *Splices*—The strength of the pipe shall not be adversely affected by the splice.
- 6.3.2.3. *Spacing*—The spacing center-to-center of adjacent rings of circumferential reinforcement in a cage shall not exceed 100 mm [4 in.] for pipe with a wall thickness up to and including 100 mm [4 in.] and shall not exceed the wall thickness or 150 mm [6 in.], whichever is smaller, for larger pipe.
- 6.3.3. *Joints*—The joints shall be of such design and the ends of the concrete pipe sections so formed that when the sections are laid together, they will make a continuous line of pipe with a smooth interior free of appreciable irregularities in the flow line, all compatible with the permissible variations given in Section 8.
- 6.3.4. *Lift Holes*—When agreed upon by the owner, lift eyes or holes are permitted in each pipe for the purpose of handling.
- 6.4. *Synthetic Fibers*—Collated fibrillated virgin polypropylene fibers shall be allowed to be used, at the owner's option, in concrete pipe as a nonstructural manufacturing material. Only Type III synthetic fibers designed and manufactured specifically for use in concrete and conforming to the requirements of ASTM C1116/C1116M shall be accepted.

7. PHYSICAL REQUIREMENTS

- 7.1. *Strength*—The design strength designation of the pipe shall be the D-load to produce the 0.3-mm [0.01-in.] crack when tested in accordance with T 280. The relationship of ultimate strength D-load to the design strength D-load shall be determined using a factor of 1.5 for design strength designations up to 100 N/m·mm [2000 lbf/ft·ft] of diameter, a factor varying in linear proportions from 1.5 to 1.25 for design strength designations from 100 N/m·mm [2000 lbf/ft·ft] through 150 N/m·mm [3000 lbf/ft·ft], and a factor of 1.25 for design strength designations in excess of 150 N/m·mm [3000 lbf/ft·ft].