



Designation: C 1504 – 01^{ε1}

Standard Specification for Manufacture of Precast Reinforced Concrete Three-Sided Structures for Culverts, Storm Drains, and Sewers¹

This standard is issued under the fixed designation C 1504; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

^{ε1} NOTE—Paragraph 10.3.3.3 was inadvertently retained in the revision approved 9/10/01. It was deleted editorially in April 2002.

1. Scope

1.1 This specification covers single-cell precast conventionally reinforced concrete three-sided structures intended to be used for the construction of culverts and for the conveyance of storm water and sewage.

1.2 A complete metric companion to Specification C 1504 has been developed—C 1504M; therefore, no metric equivalents are presented in this specification.

NOTE 1—This specification is primarily a manufacturing and purchasing specification. The successful performance of this product depends upon the proper selection of the geometric section, bedding, backfill, and care that the installation conforms to the construction specifications. The purchaser of the precast reinforced concrete three-sided structure specified herein is cautioned that he must properly correlate the loading conditions and the field requirements with the geometric section specified and provide for inspection at the construction site.

2. Referenced Documents

2.1 ASTM Standards:

- A 82 Specification for Steel Wire, Plain, for Concrete Reinforcement²
- A 185 Specification for Steel Welded Wire Fabric, Plain, for Concrete Reinforcement²
- A 496 Specification for Steel Wire, Deformed, for Concrete Reinforcement²
- A 497 Specification for Steel Welded Wire Fabric, Deformed, for Concrete Reinforcement²
- A 615/A 615M Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement²
- A 616/A 616M Specification for Rail-Steel Deformed and Plain Bars for Concrete Reinforcement²
- A 617/A 617M Specification for Axle-Steel Deformed and Plain Bars for Concrete Reinforcement²
- C 31/C 31M Practice for Making and Curing Concrete Test

Specimens in the Field³

- C 33 Specification for Concrete Aggregates³
- C 39 Test Method for Compressive Strength of Cylindrical Concrete Specimens³
- C 150 Specification for Portland Cement⁴
- C 309 Specification for Liquid Membrane-Forming Compounds for Curing Concrete³
- C 494/C 494M Specification for Chemical Admixtures for Concrete³
- C 497 Test Methods for Concrete Pipe, Manhole Sections, or Tile⁵
- C 595 Specification for Blended Hydraulic Cements⁴
- C 618 Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete³
- C 822 Terminology Relating to Concrete Pipe and Related Products⁵

2.2 AASHTO Standard:

Standard Specifications for Highway Bridges⁶

3. Terminology

3.1 *Definitions*—For definitions of terms relating to geometric sections, see Terminology C 822.

4. Types

4.1 Precast reinforced concrete three-sided structures shall be produced by manufacturers that meet the requirements of the purchasers, and shall designate each section by span, rise, and design earth cover.

5. Basis of Acceptance

5.1 Acceptability of the three-sided sections produced in accordance with Section 7 shall be determined by the results of the concrete compressive strength tests described in Section 10, by the material requirements described in Section 6, and by inspection of the finished three-sided sections.

¹ This specification is under the jurisdiction of ASTM Committee C13 on Concrete Pipe and is the direct responsibility of Subcommittee C13.07 on Acceptance Specifications and Precast Concrete Box Sections.

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² *Annual Book of ASTM Standards*, Vol 01.04.

³ *Annual Book of ASTM Standards*, Vol 04.02.

⁴ *Annual Book of ASTM Standards*, Vol 04.01.

⁵ *Annual Book of ASTM Standards*, Vol 04.05.

⁶ American Association of State Highway and Transportation Officials (AASHTO), 444 N. Capitol St., NW, Suite 249, Washington, DC 20001.

5.2 Three-sided sections shall be considered ready for acceptance when they conform to the requirements of this specification.

6. Materials

6.1 *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 Specification C 150 or shall be portland blast-furnace slag cement or portland-pozzolan cement conforming to the requirements of Specification C 595, except that the pozzolan constituent in the Type IP portland pozzolan cement shall be fly ash and shall not exceed 25 % by weight.

6.2.2 *Fly Ash*—Fly ash shall conform to the requirements of Specification C 618, Class F or Class C.

6.2.3 *Allowable Cementitious, or Combinations of Cementitious Materials*—The combination of cementitious materials used in concrete shall be one of the following:

6.2.3.1 Portland cement.

6.2.3.2 Portland blast furnace slag cement.

6.2.3.3 Portland pozzolan cement.

6.2.3.4 A combination of portland cement and fly ash wherein the proportion of fly ash between 5 and 25 % by weight of total cementitious material (portland cement plus fly ash).

6.3 *Aggregates*—Aggregates shall conform to Specification C 33, except that the requirements for gradation shall not apply.

6.4 *Admixtures and Blends*—Admixtures and blends may be used with the approval of the purchaser.

6.4.1 *Air Entraining Admixtures*—Air entraining will be required on all products produced with positive slump, wet-cast concrete and shall conform to the requirements of Specification C 494/C 494M.

6.5 *Steel Reinforcement*—Reinforcement shall consist of welded wire fabric conforming to Specifications A 185 or A 497 or deformed and plain steel bars for reinforced concrete conforming to Specification A 615/A 615M, Grade 60, A 616/A 616M, or A 617/A 617M. Longitudinal distribution reinforcement may consist of welded wire fabric or deformed billet-steel bars conforming to Specification A 615/A 615M, Grade 60.

NOTE 2—This specification does not address reinforcement with prestressing strand or any other form of pre-tensioning or post-tensioning.

7. Design

7.1 *Design Criteria*—The three-sided section's dimensions and reinforcement details shall be as required by design, in accordance with Section 17.8 of the AASHTO Standard Specifications for Highway Bridges. The minimum concrete compressive strength shall be 5000 psi, and the minimum steel yield strength shall be 65 000 psi for welded-wire fabric and 60 000 psi for deformed billet-steel bars.

7.2 *Placement of Reinforcement*—The cover of concrete over the circumferential reinforcement shall be 1 in., subject to the provisions of Section 11. The clear distance of the end

circumferential wires shall be not less than ½ in. nor more than 2 in. from the ends of each section. For three-sided sections covered by less than 2 ft of fill, minimum cover for the reinforcement in the top of the top slab shall be 2-in., subject to the provisions of Section 11. Reinforcement shall be assembled utilizing any combination of single or multiple layers of welded-wire fabric, not to exceed three layers or utilizing single or multiple layers of deformed billet steel bars, not to exceed two layers. The welded-wire fabric on 7.3 shall be composed of circumferential and longitudinal wires meeting the spacing requirements of 7.3 and shall contain sufficient longitudinal wires extending through the three-sided section to maintain the shape and position of reinforcement. Longitudinal distribution reinforcement may be welded-wire fabric or deformed billet-steel bars and shall meet the spacing requirements of 7.3. The ends of the longitudinal distribution reinforcement shall not be more than 2 in. from the ends of a three-sided section. The exposure of the ends of longitudinals, stirrups, and spacers used to position the reinforcement shall not be a cause for rejection.

7.3 *Laps, Welds, and Spacing*—Splices in the circumferential reinforcement shall be made by lapping. The overlap measured between the outermost longitudinal wires of each fabric sheet or the outermost bars shall not be less than the spacing of the longitudinal wires plus 2 in. but not less than 10 in. The spacing center to center of the circumferential wires or bars shall not be less than 2 in. nor more than 4 in. The spacing center to center of the longitudinal wires or bars shall not be more than 8 in. for deformed billet steel bars; the overlap shall meet the requirements of AASHTO.

8. Joints

8.1 The precast reinforced concrete three-sided structures shall be produced with tongue and groove ends, fiat butt ends or key-way ends. The ends shall be of such design and the ends of the three-sided sections so formed that each section can be laid together to make a continuous line of sections compatible with the permissible variations given in Section 11.

9. Manufacture

9.1 *Mixture*—The aggregates shall be sized, graded, proportioned, and mixed with such proportions of cementitious materials and water as will produce a homogeneous concrete mixture of such quality that each section 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 weights. Cementitious materials shall be as specified in 6.2 and shall be added to the mix in a proportion not less than 470 lb/yd³ unless mix designs with a lower cementitious materials content demonstrate that the quality and performance of the three-sided sections meet the requirements of this specification.

9.2 *Curing*—The three-sided sections shall be cured for a sufficient length of time so that the concrete will develop the specified compressive strength in 28 days or less. Any one of the following methods of curing or combinations thereof may be used:

9.2.1 *Steam Curing*—The three-sided section may be low