Designation: C 1504 – 03

Standard Specification for Manufacture of Precast Reinforced Concrete Three-Sided Structures for Culverts and Storm Drains[1]

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.

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.

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 Reinforcement[2]

A 185 Specification for Steel Welded Wire Reinforcement, Plain, for Concrete[2]

A 496 Specification for Steel Wire, Deformed, for Concrete Reinforcement[2]

A 497 Specification for Steel Welded Wire Reinforcement, Deformed, for Concrete[2]

A 615/A 615M Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement[2]

A 616/A 616M Specification for Rail-Steel Deformed and Plain Bars for Concrete Reinforcement[3]

A 617/A 617M Specification for Axle-Steel Deformed and Plain Bars for Concrete Reinforcement[3]

A 706/A 706M Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement[2]

C 31/C 31M Practice for Making and Curing Concrete Test Specimens in the Field[4]

C 33 Specification for Concrete Aggregates[4]

C 39 Test Method for Comprehensive Strength of Cylindrical Concrete Specimens[4]

C 150 Specification for Portland Cement[5]

C 309 Specification for Liquid Membrane-Forming Compounds for Curing Concrete[4]

C 494/C 494M Specification for Chemical Admixtures for Concrete[4]

C 497 Test Methods for Concrete Pipe, Manhole Sections, or Tile[6]

C 595 Specification for Blended Hydraulic Cements[5]

C 618 Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete[4]

C 822 Terminology Relating to Concrete Pipe and Related Products[6]

C 1116 Specification for Fiber-Reinforced Concrete and Shotcrete

2.2 *AASHTO Standard:*

Standard Specifications for Highway Bridges[7]

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 manufactured in accordance with this specification shall be designated 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] Discontinued. See 1998 *Annual Book of ASTM Standards*, Vol 01.04. Replaced by A 996/A 996M.

[4] *Annual Book of ASTM Standards*, Vol 04.02.

[5] *Annual Book of ASTM Standards*, Vol 04.01.

[6] *Annual Book of ASTM Standards*, Vol 04.05.

[7] 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.

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.

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 pre-stressing strand or any other form of pre-tensioning or post-tensioning.

6.6 *Synthetic Fibers*—Collated fibrillated virgin polypropylene fibers may be used, at the manufacturer's option, in three-sided structures as a nonstructural manufacturing material. Only type III synthetic fibers designed and manufactured specifically for use in concrete and conforming to the requirements of Specification C 1116 shall be accepted.

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. For welded wire fabric, 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. For splices of deformed billet steel bars, the overlap shall meet the requirements of AASHTO. The outside circumferential reinforcement in the top slab shall be continuous with or be lapped with the outside circumferential reinforcement in the sides. If welds are made to welded wire fabric circumferential reinforcement, they shall be made only to selected circumferential wires that are not less than 18 in. apart along the longitudinal axis of the three-sided section. When spacers are welded to circumferential wires, they shall be welded only to these selected circumferential wires. There shall be no welding to other circumferential wires. No welds shall be made to the inside circumferential wires in the middle third of the top span. No welds shall be made to the outside circumferential wires in the top span within one fourth of the span from the corners or in any location in either leg. Welding of deformed billet steel bar circumferential reinforcement is prohibited in all cases. When distribution reinforcement is to be fastened to a cage by welding, it shall be welded only to longitudinal wires or bars and only near the ends of the three-sided section. The spacing center to center of the circumferential reinforcement shall not be less than 2 in. nor more than 4 in. for welded wire fabric or less than 2 in. nor more than 8 in. for deformed billet steel bars. The spacing center to center of the longitudinal reinforcement shall not be more than 8 in. for welded wire fabric or more than 12 in. for deformed billet steel bars. If welds are made to Grade 60 reinforcing bars, weldable bars conforming to Specification A 706 shall be used.