



Standard Specification for Precast Reinforced Concrete Monolithic Box Sections for Culverts, Storm Drains, and Sewers (Metric)¹

This standard is issued under the fixed designation C1433M; 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 reinforced concrete box sections cast monolithically and intended to be used for the construction of culverts and for the conveyance of storm water industrial wastes and sewage.

1.2 This specification is the SI companion to Specification C1433.

NOTE 1—This specification is primarily a manufacturing and purchasing specification. However, standard designs are included and the criteria used to develop these designs are given in [Appendix X1](#). The successful performance of this product depends upon the proper selection of the box section, bedding, backfill, and care that the installation conforms to the construction specifications. The purchaser of the precast reinforced concrete box sections specified herein is cautioned that he must properly correlate the loading conditions and the field requirements with the box section specified and provide for inspection at the construction site.

2. Referenced Documents

2.1 *ASTM Standards*:²

- [A615/A615M](#) Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
- [A1064/A1064M](#) Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
- [A706/A706M](#) Specification for Deformed and Plain Low-Alloy Steel Bars for Concrete Reinforcement
- [C31/C31M](#) Practice for Making and Curing Concrete Test Specimens in the Field
- [C33/C33M](#) Specification for Concrete Aggregates
- [C39/C39M](#) Test Method for Compressive Strength of Cylindrical Concrete Specimens
- [C150/C150M](#) Specification for Portland Cement
- [C260/C260M](#) Specification for Air-Entraining Admixtures for Concrete

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 For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

- [C309](#) Specification for Liquid Membrane-Forming Compounds for Curing Concrete
- [C494/C494M](#) Specification for Chemical Admixtures for Concrete
- [C497M](#) Test Methods for Concrete Pipe, Manhole Sections, or Tile (Metric)
- [C595/C595M](#) Specification for Blended Hydraulic Cements
- [C618](#) Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
- [C822](#) Terminology Relating to Concrete Pipe and Related Products
- [C989/C989M](#) Specification for Slag Cement for Use in Concrete and Mortars
- [C990](#) Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants
- [C1017/C1017M](#) Specification for Chemical Admixtures for Use in Producing Flowing Concrete
- [C1116/C1116M](#) Specification for Fiber-Reinforced Concrete
- [C1602/C1602M](#) Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete
- [C1619](#) Specification for Elastomeric Seals for Joining Concrete Structures
- [C1675](#) Practice for Installation of Precast Reinforced Concrete Monolithic Box Sections for Culverts, Storm Drains, and Sewers
- [C1677](#) Specification for Joints for Concrete Box, Using Rubber Gaskets

2.2 *AASHTO Standards*:³

- [Standard Specifications for Highway Bridges](#)

3. Terminology

3.1 *Definitions*—For definitions of terms relating to concrete pipe, see Terminology [C822](#).

4. Types

4.1 Precast reinforced concrete box sections manufactured in accordance with this specification shall be one of two types

³ Available from American Association of State Highway and Transportation Officials (AASHTO), 444 N. Capitol St., NW, Suite 249, Washington, DC 20001.

identified in **Tables 1 and 2**, and shall be designated by type, span, rise, and design earth cover.

5. Basis of Acceptance

5.1 Acceptability of the box sections produced in accordance with Section 7 shall be determined by the results of the concrete compressive strength tests described in Section 11, by the material requirements described in Section 6, and by inspection of the finished box sections.

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

6. Material

6.1 *Reinforced Concrete*—The reinforced concrete shall consist of cementitious materials, mineral aggregates, admixtures if used, 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 **C150/C150M** or shall be portland blast-furnace slag cement, portland-limestone cement, or portland-pozzolan cement conforming to the requirements of Specification **C595/C595M**, 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 **C618**, Class F or Class C.

6.2.3 *Slag Cement*—Slag cement shall conform to the requirements of Grade 100 or 120 of Specification **C989/C989M**.

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,
- 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, slag cement, and fly ash, or
- 6.2.4.8 A combination of portland-pozzolan cement and fly ash.

6.3 *Aggregates*—Aggregates shall conform to Specification **C33/C33M**, except that the requirements for gradation shall not apply.

6.4 *Admixtures*—The following admixtures and blends are allowable:

- 6.4.1 Air-entraining admixture conforming to Specification **C260/C260M**;
- 6.4.2 Chemical admixture conforming to Specification **C494/C494M**;
- 6.4.3 Chemical admixture for use in producing flowing concrete conforming to Specification **C1017/C1017M**; and
- 6.4.4 Chemical admixture or blend approved by the owner.

6.5 *Steel Reinforcement*—Reinforcement shall consist of welded wire reinforcement conforming to Specification **A1064/A1064M**. Circumferential reinforcement areas in **Tables 1 and 2** are based solely on the use of welded wire reinforcement, refer to 12.6 if alternate steel designs utilizing steel bars, Grade 420, in conjunction with or in lieu of welded wire reinforcement are to be submitted for the owner's approval. Longitudinal distribution reinforcement shall be allowed to consist of welded wire reinforcement or deformed billet-steel bars conforming to either Specification **A615/A615M**, Grade 420, or Specification **A706/A706M**, Grade 420.

6.6 *Fibers*—Synthetic fibers and nonsynthetic fibers shall be allowed to be used, at the manufacturer's option, in concrete pipe as a nonstructural manufacturing material. Synthetic fibers (Type II and Type III) and nonsynthetic fiber (Type 1) designed and manufactured specifically for use in concrete and conforming to the requirements of Specification **C1116/C1116M** shall be accepted.

6.7 *Water*—Water used in the production of concrete shall be potable or non-potable water that meets the requirements of Specification **C1602/C1602M**.

7. Design

7.1 *Design Tables*—The box section dimensions, compressive strength of the concrete, and reinforcement details shall be as prescribed in **Table 1** or **Table 2** and **Figs. 1-4**, subject to the provisions of Section 12. **Table 1** sections are designed for combined earth dead load and AASHTO HS20 live load conditions. **Table 2** sections are designed for combined earth dead load and interstate live load conditions when the interstate live loading exceeds the HS20 live loading. Criteria used to develop **Tables 1 and 2** are given in **Appendix X1**.

NOTE 2—The tabular designs in this specification were prepared according to AASHTO Standard Specifications for Highway Bridges, 1997 Edition.

7.2 *Modified and Special Designs for Monolithic Structures*—The manufacturer shall request approval by the purchaser of modified designs which differ from the designs in Section 7.1, or special designs for sizes and loads other than those shown in **Tables 1 and 2**. When spans are required that exceed those prescribed in **Table 1** or **Table 2**, the design shall be based on the criteria given in **Appendix X1**. In addition, the span shall be designed to have adequate stiffness to limit deflection as given in Section 8.9 of *AASHTO Standard Specification for Highway Bridges* (latest edition).

NOTE 3—Construction procedures, such as heavy equipment movement or stockpiling of material over or adjacent to a box structure, can induce higher loads than those used for the structure's final design. These construction and surcharge loads are approved as long as the final steel areas in the box are larger than those the box will experience in the final installation condition. The design engineer should take into consideration the potential for higher loads induced by construction procedures in determining the final design of the box structure.

7.3 *Placement of Reinforcement*—The cover of concrete over the circumferential reinforcement shall be 25 mm, subject to the provisions of Section 12. The inside circumferential reinforcement shall extend into the tongue portion of the joint and the outside circumferential reinforcement shall extend into the groove portion of the joint. The clear distance of the end

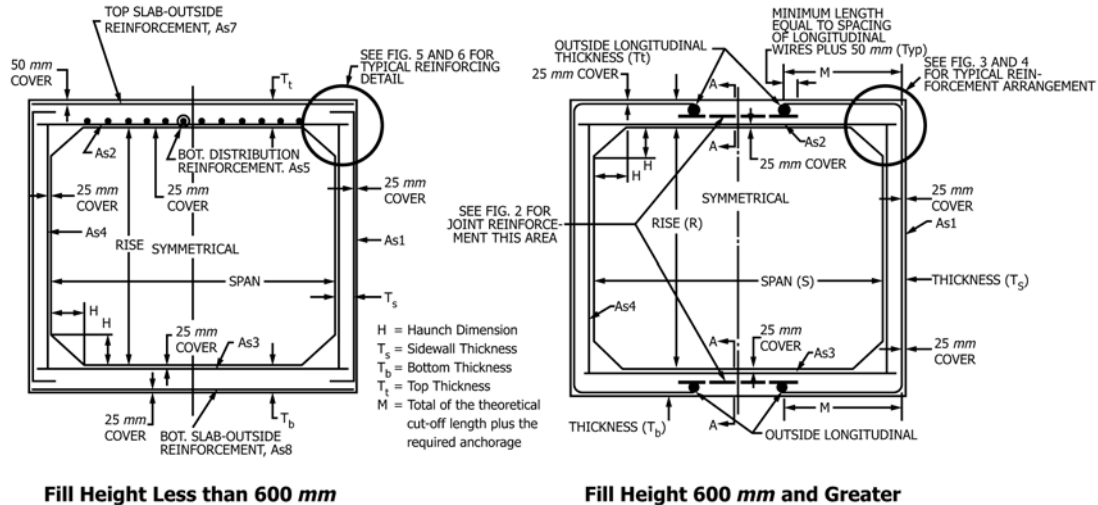


FIG. 1 Typical Box Sections

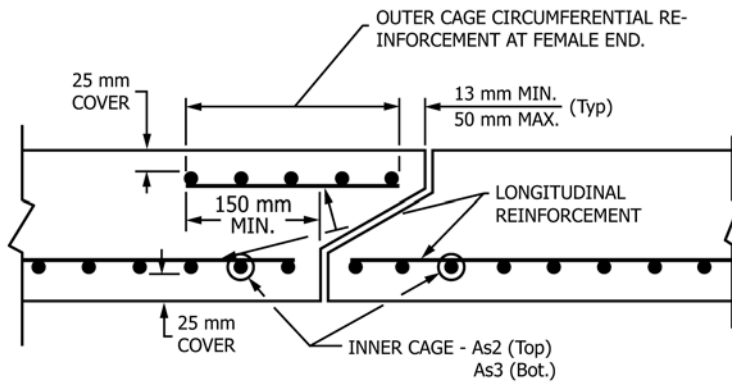


FIG. 2 Section A-A Top and Bottom Slab Joint Reinforcement

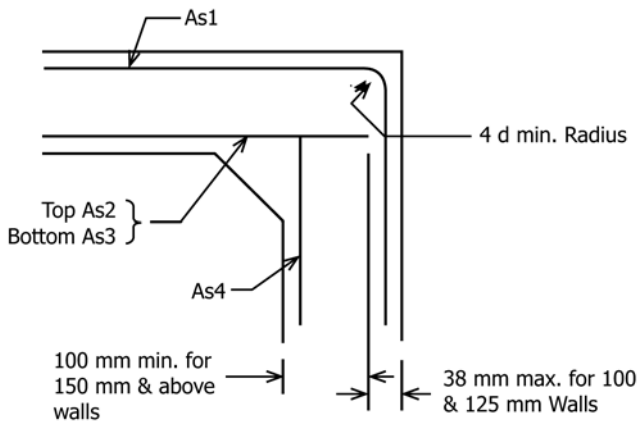


FIG. 3 Detail Inner Reinforcement

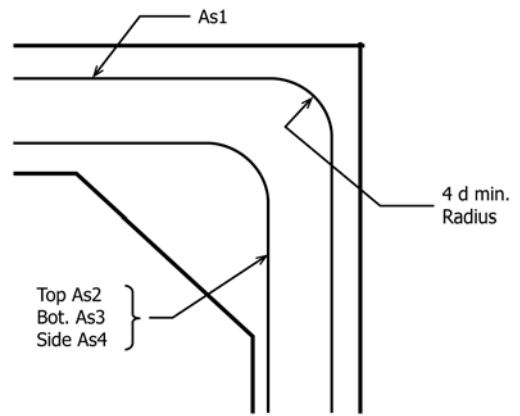


FIG. 4 Detail Option (see Fig. 3)

circumferential wires shall be not less than 13 mm nor more than 50 mm from the ends of the box section. Reinforcement shall be assembled utilizing any combination of single or multiple layers of welded-wire reinforcement. Multiple layers shall not be separated by more than the thickness of one longitudinal wire plus 6 mm. The multiple layers shall be fastened together to form a single cage. All other specification requirements such as laps, welds, and tolerances of placement

in the wall of the box section shall apply to this method of fabricating a reinforcement cage. A common reinforcement unit may be utilized for both A_{s2} (or A_{s3}) and A_{s4} , and also for both A_{s7} (or A_{s8}) and A_{s1} , with the largest area requirement governing, bending the reinforcement at the corners and waiving the extension requirements of Fig. 3 (see Fig. 5). When a single cage of multiple circumferential steel areas is used for A_{s2} (or A_{s3}) and A_{s4} reinforcement, the slab or wall requiring the larger steel area shall have this additional