Designation: C1577 – 20ε1

Standard Specification for Precast Reinforced Concrete Monolithic Box Sections for Culverts, Storm Drains, and Sewers Designed According to AASHTO LRFD[1]

This standard is issued under the fixed designation C1577; 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.

ε[1] NOTE—Editorially corrected references in 7.3 in July 2022.

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.

NOTE 1—This specification is primarily a manufacturing and purchasing specification. However, standard designs per the AASHTO LRFD Bridge Design Specifications 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 proper correlation of the loading conditions and the field requirements with the box section specified, and provision for inspection at the construction site, are required.

1.2 The values stated in inch-pound units are to be regarded as standard. No other units of measurement are included in this standard.

1.3 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

A1064/A1064M Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete

A615/A615M Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement

A706/A706M Specification for Deformed and Plain Low-Alloy Steel Bars for Concrete Reinforcement

C33/C33M Specification for Concrete Aggregates

C150/C150M Specification for Portland Cement

C260/C260M Specification for Air-Entraining Admixtures for Concrete

C309 Specification for Liquid Membrane-Forming Compounds for Curing Concrete

C494/C494M Specification for Chemical Admixtures for Concrete

C497 Test Methods for Concrete Pipe, Concrete Box Sections, Manhole Sections, or Tile

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 (Withdrawn 2022)[3]

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

[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.

Current edition approved Nov. 15, 2020. Published November 2020. Originally approved in 2005. Last previous edition approved in 2019 as C1577 – 19b. DOI: 10.1520/C1577-20E01.

[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.

[3] The last approved version of this historical standard is referenced on www.astm.org.

*A Summary of Changes section appears at the end of this standard

2.2 *AASHTO Standards:*[4]
AASHTO LRFD Bridge Design Specifications
AASHTO LRFD Bridge Construction Specifications
2.3 *ASCE Standard:*[5]
ASCE 26–97 Standard Practice for Direct Design of Buried Precast Concrete Box Sections

[4] Available from American Association of State Highway and Transportation Officials (AASHTO), 444 N. Capitol St., NW, Suite 249, Washington, DC 20001, http://www.transportation.org.
[5] Available from American Society of Civil Engineers (ASCE), 1801 Alexander Bell Dr., Reston, VA 20191, http://www.asce.org.

3. Terminology

3.1 *Definitions*—For definitions of terms relating to concrete pipe, see Terminology C822.

4. Designation

4.1 Precast reinforced concrete box sections manufactured in accordance with this specification shall be legibly marked with the specification designation, span, rise, and design earth cover.

TABLE 1 Design Requirements for Precast Concrete Box Sections Under Earth, Dead and HL-93 Live Load Conditions

NOTE 1—Design earth loads and reinforcement areas are based on the weight of a column of earth over the width of the box section multiplied by a soil structure interaction factor as defined in Appendix X1.

NOTE 2—Concrete design strength 5000 psi.

NOTE 3—Steel areas are based on an HL-93 live load without the lane load as permitted by AASHTO, using either the design truck or the design tandem and taking the controlling case.

NOTE 4—The design earth cover indicated is the height of fill above the top of the box section. Design requirements are based on the material and soil properties, loading data, and typical section as included in Appendix X1. For alternative or special designs, see 7.2.

NOTE 5—Design steel area in square inches per linear foot of box section at those locations which are indicated on the typical section shown in Fig. 1.

NOTE 6—The top section designation, for example, 3 ft by 2 ft by 4 in. indicates (interior horizontal span in feet) by (interior vertical rise in feet) by (wall and slab thickness in inches).

NOTE 7—In accordance with the acceptance criteria in 7.2, the manufacturer is not prohibited from interpolating steel area requirements or submitting independent designs for fill heights between noted increments.

NOTE 8—The "M" dimension given in the tables is the required distance that A_{s1} shall be extended into the top and bottom slabs if it is used as reinforcement for the negative moment in these areas. This distance is based on the location where the negative moment in the slab becomes zero, plus an additional development length. Because the live load can be applied at any location along the top slab as the truck drives over it, it is possible for the "M" dimension to exceed one-half the length of the slab.

NOTE 9—(Advisory)—The reinforcing areas are based on 4 inch circumferential wire spacing. Under design conditions where crack control governs, an analysis following the design criteria in Table X1.1 with closer steel spacing may result in a reduction in steel area over those in the table.

3 ft by 2 ft by 4 in.								
Design Earth Cover, ft	Circumferential Reinforcement Areas, in.^{2}/ft							
	A_{s1}	A_{s2}	A_{s3}	A_{s4}	A_{s5}	A_{s7}	A_{s8}	"M," in.
0<2[A]	0.17	0.25	0.16	0.10	0.17	0.17	0.14	
2<3	0.13	0.19	0.18	0.10				31
3-5	0.10	0.11	0.12	0.10				31
10	0.10	0.10	0.10	0.10				31
15	0.10	0.13	0.13	0.10				31
20	0.11	0.17	0.17	0.10				31
25	0.14	0.21	0.21	0.10				31
30	0.17	0.25	0.25	0.10				31
35	0.20	0.29	0.30	0.10				31

[A] Top slab 7 in., bottom slab 6 in.

3 ft by 3 ft by 4 in.								
Design Earth Cover, ft	Circumferential Reinforcement Areas, in.^{2}/ft							
	A_{s1}	A_{s2}	A_{s3}	A_{s4}	A_{s5}	A_{s7}	A_{s8}	"M," in.
0<2[A]	0.17	0.27	0.17	0.10	0.17	0.17	0.14	
2<3	0.10	0.22	0.21	0.10				31
3-5	0.10	0.14	0.14	0.10				31
10	0.10	0.11	0.11	0.10				31
15	0.10	0.14	0.15	0.10				31
20	0.10	0.18	0.19	0.10				31
25	0.10	0.23	0.23	0.10				31
30	0.12	0.27	0.28	0.10				31
35	0.14	0.32	0.32	0.10				31

[A] Top slab 7 in., bottom slab 6 in.

4 ft by 2 ft by 5 in.								
Design Earth Cover, ft	Circumferential Reinforcement Areas, in.²/ft							
	A_{s1}	A_{s2}	A_{s3}	A_{s4}	A_{s5}	A_{s7}	A_{s8}	"M," in.
0<2[A]	0.18	0.27	0.15	0.12	0.18	0.18	0.14	
2<3	0.18	0.19	0.17	0.12				38
3-5	0.13	0.13	0.13	0.12				38
10	0.12	0.12	0.12	0.12				38
15	0.14	0.16	0.16	0.12				38
20	0.18	0.20	0.21	0.12				38
25	0.23	0.25	0.25	0.12				38
30	0.28	0.30	0.30	0.12				38

[A] Top slab 7.5 in., bottom slab 6 in.

4 ft by 3 ft by 5 in.								
Design Earth Cover, ft	Circumferential Reinforcement Areas, in.²/ft							
	A_{s1}	A_{s2}	A_{s3}	A_{s4}	A_{s5}	A_{s7}	A_{s8}	"M," in.
0<2[A]	0.18	0.31	0.18	0.12	0.18	0.18	0.14	
2<3	0.15	0.23	0.20	0.12				38
3-5	0.12	0.16	0.16	0.12				38
10	0.12	0.14	0.14	0.12				38
15	0.12	0.18	0.18	0.12				38
20	0.14	0.23	0.24	0.12				38
25	0.17	0.29	0.29	0.12				38
30	0.21	0.35	0.35	0.12				38

[A] Top slab 7.5 in., bottom slab 6 in.

4 ft by 4 ft by 5 in.								
Design Earth Cover, ft	Circumferential Reinforcement Areas, in.²/ft							
	A_{s1}	A_{s2}	A_{s3}	A_{s4}	A_{s5}	A_{s7}	A_{s8}	"M," in.
0<2[A]	0.18	0.33	0.20	0.12	0.18	0.18	0.14	
2<3	0.12	0.26	0.23	0.12				38
3-5	0.12	0.18	0.18	0.12				38
10	0.12	0.15	0.15	0.12				38
15	0.12	0.19	0.20	0.12				38
20	0.12	0.25	0.25	0.12				38
25	0.14	0.31	0.31	0.12				38
30	0.17	0.37	0.37	0.12				38

[A] Top slab 7.5 in., bottom slab 6 in.

5 ft by 2 ft by 6 in.								
Design Earth Cover, ft	Circumferential Reinforcement Areas, in.²/ft							
	A_{s1}	A_{s2}	A_{s3}	A_{s4}	A_{s5}	A_{s7}	A_{s8}	"M," in.
0<2[A]	0.19	0.27	0.18	0.14	0.19	0.19	0.17	
2<3	0.22	0.20	0.16	0.14				44
3-5	0.16	0.14	0.14	0.14				44
10	0.15	0.14	0.14	0.14				36
15	0.20	0.18	0.18	0.14				36
20	0.26	0.23	0.24	0.14				36
25	0.33	0.29	0.29	0.14				36
30	0.39	0.34	0.35	0.14				36

[A] Top slab 8 in., bottom slab 7 in.

5 ft by 3 ft by 6 in.								
Design Earth Cover, ft	Circumferential Reinforcement Areas, in.²/ft							
	A_{s1}	A_{s2}	A_{s3}	A_{s4}	A_{s5}	A_{s7}	A_{s8}	"M," in.
0<2[A]	0.19	0.31	0.21	0.14	0.19	0.19	0.17	
2<3	0.18	0.24	0.19	0.14				45
3-5	0.14	0.17	0.16	0.14				36
10	0.14	0.16	0.17	0.14				36
15	0.16	0.21	0.22	0.14				35
20	0.21	0.27	0.28	0.14				35
25	0.26	0.34	0.34	0.14				35
30	0.31	0.41	0.41	0.14				35

[A] Top slab 8 in., bottom slab 7 in.