Designation: C 1433M – 04

METRIC

Standard Specification for Precast Reinforced Concrete Box Sections for Culverts, Storm Drains, and Sewers [Metric][1]

This standard is issued under the fixed designation C 1433M; 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 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 companion to inch-pound Specification C 1433.

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]

A 82 Specification for Steel Wire, Plain, for Concrete Reinforcement

A 185 Specification for Steel Welded Wire Fabric, Plain, for Concrete Reinforcement

A 496 Specification for Steel Wire, Deformed, for Concrete Reinforcement

A 497 Specification for Steel Welded Wire Fabric, Deformed, for Concrete Reinforcement

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

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

C 33 Specification for Concrete Aggregates

C 39 Test Method for Compressive Strength of Cylindrical Concrete Specimens

C 150 Specification for Portland Cement

C 309 Specification for Liquid Membrane-Forming Compounds for Curing Concrete

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

C 595 Specification for Blended Hydraulic Cements

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

C 822 Terminology Relating to Concrete Pipe and Related Products

2.2 *AASHTO Standards:*[3]

Specifications for Highway Bridges, 1997 Edition

3. Terminology

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

4. Types

4.1 Precast reinforced concrete box sections manufactured in accordance with this specification shall be one of two types identified in Tables 1 and 2, and shall be designated by type, span, rise, and design earth cover.

[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.

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

TABLE 1 Design Requirements for Precast Concrete Box Sections Under Earth Dead and HS20 Live Load Conditions

NOTE 1—Design earth covers and reinforcement areas are based on the weight of a column of earth over the width of the box section as defined in Appendix X1.

NOTE 2—Concrete design strength 35 MPa.

NOTE 3—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 4—Design steel area in millimetres per linear metre of box section at those locations which are indicated on the typical section included in Appendix X1.

NOTE 5—The top section designation, for example, 900 by 600 by 100 mm indicates (interior horizontal span in millimetres) by (interior vertical rise in millimetres) by (wall and slab thickness in millimetres).

NOTE 6—In accordance with the acceptance criteria in 7.2, the manufacturer may interpolate the steel area requirements for fill heights between noted increments or may submit independent designs.

900 by 600 by 100 mm

Design Earth Cover, m	Circumferential Reinforcement Areas, mm^2/m								
	A_{s1}	A_{s2}	A_{s3}	A_{s4}	A_{s5}	A_{s6}	A_{s7}	A_{s8}	"M," mm
0<0.6[A]	360	830	470	210	400	360	360	300	
0.6<0.9	320	570	570	210					770
0.9-1.5	210	250	250	210					770
3.0	210	210	210	210					460
4.6	210	280	300	210					460
6.1	230	360	380	210					460
7.6	300	470	470	210					460
9.1	360	550	550	210					460

[A] Top slab 175 mm, bottom slab 150 mm.

900 by 900 by 100 mm

Design Earth Cover, m	Circumferential Reinforcement Areas, mm^2/m								
	A_{s1}	A_{s2}	A_{s3}	A_{s4}	A_{s5}	A_{s6}	A_{s7}	A_{s8}	"M," mm
0<0.6[A]	360	870	490	210	420	360	360	300	
0.6<0.9	230	660	660	210					770
0.9-1.5	210	300	300	210					770
3.0	210	230	230	210					640
4.6	210	320	320	210					460
6.1	210	400	420	210					460
7.6	210	490	510	210					460
9.1	250	590	610	210					460

[A] Top slab 175 mm, bottom slab 150 mm.

1200 by 600 by 125 mm

Design Earth Cover, m	Circumferential Reinforcement Areas, mm^2/m								
	A_{s1}	A_{s2}	A_{s3}	A_{s4}	A_{s5}	A_{s6}	A_{s7}	A_{s8}	"M," mm
0<0.6[A]	380	890	470	250	440	380	380	300	
0.6<0.9	510	610	530	250					940
0.9-1.5	260	300	300	250					460
3.0	250	250	250	250					460
4.6	320	340	340	250					460
6.1	400	440	440	250					460
7.6	510	550	550	250					460
9.1	590	660	660	250					460

[A] Top slab 200 mm, bottom slab 150 mm.

1200 by 900 by 125 mm

Design Earth Cover, m	Circumferential Reinforcement Areas, mm^2/m								
	A_{s1}	A_{s2}	A_{s3}	A_{s4}	A_{s5}	A_{s6}	A_{s7}	A_{s8}	"M," mm
0<0.6[A]	380	970	530	250	490	380	380	300	
0.6<0.9	420	740	660	250					940
0.9-1.5	250	360	360	250					690
3.0	250	300	300	250					460
4.6	250	400	400	250					460
6.1	300	510	530	250					460
7.6	380	640	640	250					460
9.1	440	760	760	250					460

[A] Top slab 200 mm, bottom slab 150 mm.

1200 by 1200 by 125 mm

Design Earth Cover, m	Circumferential Reinforcement Areas, mm^2/m								
	A_{s1}	A_{s2}	A_{s3}	A_{s4}	A_{s5}	A_{s6}	A_{s7}	A_{s8}	"M," mm
0<0.6[A]	380	1020	570	250	510	380	380	300	
0.6<0.9	340	800	720	250					940
0.9-1.5	250	380	380	250					690
3.0	250	320	320	250					690
4.6	250	420	440	250					460
6.1	250	550	550	250					460
7.6	320	660	680	250					460
9.1	360	800	800	250					460

[A] Top slab 200 mm, bottom slab 150 mm.

1500 by 900 by 150 mm

Design Earth Cover, m	Circumferential Reinforcement Areas, mm^2/m								
	A_{s1}	A_{s2}	A_{s3}	A_{s4}	A_{s5}	A_{s6}	A_{s7}	A_{s8}	"M," mm
0<0.6[A]	410	990	510	300	470	410	410	360	
0.6<0.9	550	760	590	300					1120
0.9-1.5	300	400	400	300					740
3.0	300	340	340	300					460
4.6	360	470	470	300					460
6.1	440	590	610	300					460
7.6	550	740	740	300					460
9.1	680	890	890	300					460

[A] Top slab 200 mm, bottom slab 175 mm.

1500 by 1200 by 150 mm

Design Earth Cover, m	Circumferential Reinforcement Areas, mm^2/m								
	A_{s1}	A_{s2}	A_{s3}	A_{s4}	A_{s5}	A_{s6}	A_{s7}	A_{s8}	"M," mm
0<0.6[A]	400	1060	570	300	510	410	410	360	
0.6<0.9	470	870	700	300					1120
0.9-1.5	300	440	440	300					740
3.0	300	360	380	300					460
4.6	300	510	530	300					460
6.1	380	660	680	300					460
7.6	470	800	830	300					460
9.1	550	970	970	300					460

[A] Top slab 200 mm, bottom slab 175 mm.

1500 by 1500 by 150 mm

Design Earth Cover, m	Circumferential Reinforcement Areas, mm^2/m								
	A_{s1}	A_{s2}	A_{s3}	A_{s4}	A_{s5}	A_{s6}	A_{s7}	A_{s8}	"M," mm
0<0.6[A]	410	1100	610	300	510	410	410	360	
0.6<0.9	400	910	740	300					1120
0.9-1.5	300	470	470	300					740
3.0	300	380	400	300					740
4.6	300	530	550	300					460
6.1	320	680	700	300					460
7.6	400	850	870	300					460
9.1	490	990	1020	300					460

[A] Top slab 200 mm, bottom slab 175 mm.

1800 by 900 by 175 mm

Design Earth Cover, m	Circumferential Reinforcement Areas, mm^2/m								
	A_{s1}	A_{s2}	A_{s3}	A_{s4}	A_{s5}	A_{s6}	A_{s7}	A_{s8}	"M," mm
0<0.6[A]	530	1020	490	360	440	410	400	360	
0.6<0.9	640	800	550	360					1300
0.9-1.5	360	420	360	360					790
3.0	360	380	380	360					460
4.6	490	530	530	360					460

6.1	610	680	680	360					460
7.6	760	830	850	360					460
9.1	910	990	990	360					740

[A] Top slab 200 mm.

1800 by 1200 by 175 mm

Design Earth Cover, m	Circumferential Reinforcement Areas, mm^2/m								
	A_{s1}	A_{s2}	A_{s3}	A_{s4}	A_{s5}	A_{s6}	A_{s7}	A_{s8}	"M," mm
0<0.6[A]	420	1100	550	360	470	410	410	360	
0.6<0.9	550	890	660	360					1300
0.9-1.5	360	490	440	360					790
3.0	360	420	440	360					460
4.6	400	590	590	360					460
6.1	530	760	760	360					460
7.6	640	930	950	360					460
9.1	760	1100	1120	360					460

[A] Top slab 200 mm.

1800 by 1500 by 175 mm

Design Earth Cover, m	Circumferential Reinforcement Areas, mm^2/m								
	A_{s1}	A_{s2}	A_{s3}	A_{s4}	A_{s5}	A_{s6}	A_{s7}	A_{s8}	"M," mm
0<0.6[A]	410	1160	610	360	510	410	410	360	
0.6<0.9	490	950	720	360					1300
0.9-1.5	360	510	470	360					790
3.0	360	440	490	360					460
4.6	360	610	660	360					460
6.1	440	800	830	360					460
7.6	550	970	1020	360					460
9.1	660	1190	1230	360					460

[A] Top slab 200 mm.

1800 by 1800 by 175 mm

Design Earth Cover, m	Circumferential Reinforcement Areas, mm^2/m								
	A_{s1}	A_{s2}	A_{s3}	A_{s4}	A_{s5}	A_{s6}	A_{s7}	A_{s8}	"M," mm
0<0.6[A]	410	1210	660	360	530	410	410	360	
0.6<0.9	440	1020	760	360					1300
9.0-1.5	360	530	490	360					1300
3.0	360	470	510	360					790
4.6	360	660	680	360					460
6.1	400	830	870	360					460
7.6	490	1020	1040	360					460
9.1	590	1230	1290	360					460

[A] Top slab 200 mm.

2100 by 1200 by 200 mm

Design Earth Cover, m	Circumferential Reinforcement Areas, mm^2/m								
	A_{s1}	A_{s2}	A_{s3}	A_{s4}	A_{s5}	A_{s6}	A_{s7}	A_{s8}	"M," mm
0<0.6	590	1120	510	400	440	410	410	400	
0.6<0.9	640	910	610	400					1480
0.9-1.5	410	510	410	400					1100
3.0	410	470	490	400					1050
4.6	530	660	680	400					1050
6.1	680	850	850	400					1050
7.6	830	1040	1040	400					1050
9.1	990	1230	1250	400					1050

2100 by 1500 by 200 mm

Design Earth Cover, m	Circumferential Reinforcement Areas, mm^2/m								
	A_{s1}	A_{s2}	A_{s3}	A_{s4}	A_{s5}	A_{s6}	A_{s7}	A_{s8}	"M," mm
0<0.6	530	1190	590	400	470	410	410	400	
0.6<0.9	570	990	700	400					1480
0.9-1.5	400	550	470	400					1100
3.0	400	510	530	400					1100
4.6	470	700	720	400					1050
6.1	590	910	930	400					1050
7.6	720	1100	1140	400					1050
9.1	870	1350	1400	400					1050

2100 by 1800 by 200 mm

Design Earth Cover, m	Circumferential Reinforcement Areas, mm^2/m								
	A_{s1}	A_{s2}	A_{s3}	A_{s4}	A_{s5}	A_{s6}	A_{s7}	A_{s8}	"M," mm
0<0.6	470	1230	640	410	490	410	410	400	
0.6<0.9	510	1040	740	400					1480
0.9-1.5	400	570	490	410					1480
3.0	400	550	570	410					1100
4.6	420	740	780	410					1050
6.1	530	950	970	410					1050
7.6	640	1160	1210	410					1050
9.1	760	1440	1550	410					1050

2100 by 2100 by 200 mm

Design Earth Cover, m	Circumferential Reinforcement Areas, mm^2/m								
	A_{s1}	A_{s2}	A_{s3}	A_{s4}	A_{s5}	A_{s6}	A_{s7}	A_{s8}	"M," mm
0<0.6	490	1270	660	400	510	410	410	400	
0.6<0.9	470	1080	780	400					1480
0.9-1.5	400	590	510	400					1480
3.0	400	570	610	400					1480
4.6	400	760	800	400					1100
6.1	490	970	1020	400					1100
7.6	590	1190	1230	400					1050
9.1	700	1480	1630	400					1050

2400 by 1200 by 200 mm

Design Earth Cover, m	Circumferential Reinforcement Areas, mm^2/m								
	A_{s1}	A_{s2}	A_{s3}	A_{s4}	A_{s5}	A_{s6}	A_{s7}	A_{s8}	"M," mm
0<0.6	720	1230	570	410	400	410	410	400	
0.6<0.9	780	1060	700	400					1630
0.9-1.5	490	610	530	410					1150
3.0	550	590	610	410					1150
4.6	760	830	850	410					1050
6.1	970	1060	1080	410					1050
7.6	1210	1330	1350	410					1050

2400 by 1500 by 200 mm

Design Earth Cover, m	Circumferential Reinforcement Areas, mm^2/m								
	A_{s1}	A_{s2}	A_{s3}	A_{s4}	A_{s5}	A_{s6}	A_{s7}	A_{s8}	"M," mm
0<0.6	640	1310	640	400	490	410	410	400	
0.6<0.9	740	1140	780	400					1630
0.9-1.5	420	660	550	400					1270
3.0	490	640	680	400					1150
4.6	680	890	910	400					1050
6.1	870	1140	1190	400					1050
7.6	1060	1500	1550	400					1050

2400 by 1800 by 200 mm

Design Earth Cover, m	Circumferential Reinforcement Areas, mm^2/m								
	A_{s1}	A_{s2}	A_{s3}	A_{s4}	A_{s5}	A_{s6}	A_{s7}	A_{s8}	"M," mm
0<0.6	590	1350	700	400	510	400	400	400	
0.6<0.9	680	1210	850	400					1630
0.9-1.5	400	700	570	400					1270
3.0	440	680	720	400					1150
4.6	610	950	970	400					1050
6.1	780	1210	1250	400					1050
7.6	950	1630	1670	400					1050

2400 by 2100 by 200 mm

Design Earth Cover, m	Circumferential Reinforcement Areas, mm^2/m								
	A_{s1}	A_{s2}	A_{s3}	A_{s4}	A_{s5}	A_{s6}	A_{s7}	A_{s8}	"M," mm
0<0.6	570	1400	740	400	510	410	410	400	
0.6<0.9	610	1270	890	400					1630
0.9-1.5	400	700	610	400					1630
3.0	420	720	760	400					1270
4.6	570	970	1040	400					1150
6.1	720	1270	1310	400					1150
7.6	890	1690	1780	400					1050

2400 by 2400 by 200 mm

Design Earth Cover, m	Circumferential Reinforcement Areas, mm^2/m								
	A_{s1}	A_{s2}	A_{s3}	A_{s4}	A_{s5}	A_{s6}	A_{s7}	A_{s8}	"M," mm
0<0.6	640	1440	760	400	530	400	400	400	
0.6<0.9	570	1290	910	400					1630
0.9-1.5	400	720	660	400					1630
3.0	400	740	800	400					1270
4.6	530	1020	1080	400					1150
6.1	680	1290	1380	400					1150
7.6	830	1760	1840	400					1050

2700 by 1500 by 225 mm

Design Earth Cover, m	Circumferential Reinforcement Areas, mm^2/m								
	A_{s1}	A_{s2}	A_{s3}	A_{s4}	A_{s5}	A_{s6}	A_{s7}	A_{s8}	"M," mm
0<0.6	680	1250	610	470	470	460	460	470	
0.6<0.9	780	1140	740	470					1810
0.9-1.5	470	680	550	470					1250
3.0	590	700	720	470					1250
4.6	800	950	970	470					1120
6.1	1040	1230	1250	470					1120
7.6	1270	1590	1630	470					1120

2700 by 1800 by 225 mm

Design Earth Cover, m	Circumferential Reinforcement Areas, mm^2/m								
	A_{s1}	A_{s2}	A_{s3}	A_{s4}	A_{s5}	A_{s6}	A_{s7}	A_{s8}	"M," mm
0<0.6	610	1310	660	470	460	460	460	470	
0.6<0.9	720	1210	800	470					1810
0.9-1.5	470	720	590	470					1380
3.0	550	740	780	470					1250
4.6	740	1020	1060	470					1120
6.1	930	1310	1350	470					1120
7.6	1140	1740	1780	470					1120

2700 by 2100 by 225 mm

Design Earth Cover, m	Circumferential Reinforcement Areas, mm^2/m								
	A_{s1}	A_{s2}	A_{s3}	A_{s4}	A_{s5}	A_{s6}	A_{s7}	A_{s8}	"M," mm
0<0.6	570	1350	700	470	460	470	460	470	
0.6<0.9	660	1270	870	470					1810
0.9-1.5	470	740	640	470					1380
3.0	510	780	830	470					1250
4.6	680	1060	1120	470					1120
6.1	870	1380	1420	470					1120
7.6	1060	1840	1950	470					1120

2700 by 2400 by 225 mm

Design Earth Cover, m	Circumferential Reinforcement Areas, mm^2/m								
	A_{s1}	A_{s2}	A_{s3}	A_{s4}	A_{s5}	A_{s6}	A_{s7}	A_{s8}	"M," mm
0<0.6	590	1380	740	470	490	460	460	470	
0.6<0.9	610	1310	890	470					1810
0.9-1.5	470	700	740	470					1810
3.0	470	800	870	470					1380
4.6	640	1100	1160	470					1250
6.1	800	1400	1500	470					1120
7.6	970	1910	2070	470					1120

2700 by 2700 by 225 mm

Design Earth Cover, m	Circumferential Reinforcement Areas, mm^2/m								
	A_{s1}	A_{s2}	A_{s3}	A_{s4}	A_{s5}	A_{s6}	A_{s7}	A_{s8}	"M," mm
0<0.6	660	1400	740	470	490	460	460	470	
0.6<0.9	570	1330	910	470					1810
0.9-1.5	470	740	740	460					1810
3.0	470	830	910	460					1810
4.6	590	1120	1210	460					1250
6.1	760	1440	1570	460					1250
7.6	930	1970	2180	460					1250

3000 by 1500 by 250 mm

Design Earth Cover, m	Circumferential Reinforcement Areas, mm^2/m								
	A_{s1}	A_{s2}	A_{s3}	A_{s4}	A_{s5}	A_{s6}	A_{s7}	A_{s8}	"M," mm
0<0.6	700	1210	570	510	510	510	510	510	
0.6<0.9	830	1160	720	510					1480
0.9-1.5	530	700	570	510					1330
3.0	680	740	760	510					1330
4.6	930	1020	1040	510					1200
6.1	1210	1290	1330	510					1200
7.6	1480	1650	1690	510					1200

3000 by 1800 by 250 mm

Design Earth Cover, m	Circumferential Reinforcement Areas, mm^2/m								
	A_{s1}	A_{s2}	A_{s3}	A_{s4}	A_{s5}	A_{s6}	A_{s7}	A_{s8}	"M," mm
0<0.6	640	1270	640	510	510	510	510	510	
0.6<0.9	780	1230	780	510					1480
0.9-1.5	510	740	610	510					1330
3.0	640	780	830	510					1330
4.6	850	1080	1120	510					1200
6.1	1100	1400	1440	510					1200
7.6	1350	1820	1930	510					1200

3000 by 2100 by 250 mm

Design Earth Cover, m	Circumferential Reinforcement Areas, mm^2/m								
	A_{s1}	A_{s2}	A_{s3}	A_{s4}	A_{s5}	A_{s6}	A_{s7}	A_{s8}	"M," mm
0<0.6	590	1310	680	510	510	510	510	510	
0.6<0.9	720	1270	850	510					1630
0.9-1.5	510	760	660	510					1480
3.0	590	830	890	510					1330
4.6	780	1140	1190	510					1200
6.1	1020	1460	1520	510					1200
7.6	1230	1950	2140	510					1200

3000 by 2400 by 250 mm

Design Earth Cover, m	Circumferential Reinforcement Areas, mm^2/m								
	A_{s1}	A_{s2}	A_{s3}	A_{s4}	A_{s5}	A_{s6}	A_{s7}	A_{s8}	"M," mm
0<0.6	550	1330	720	510	510	510	510	510	
0.6<0.9	660	1310	890	510					1990
0.9-1.5	510	780	720	510					1480
3.0	550	870	930	510					1330
4.6	740	1190	1250	510					1200
6.1	930	1520	1590	510					1200
7.6	1140	2050	2310	510					1200

3000 by 2700 by 250 mm

Design Earth Cover, m	Circumferential Reinforcement Areas, mm^2/m								
	A_{s1}	A_{s2}	A_{s3}	A_{s4}	A_{s5}	A_{s6}	A_{s7}	A_{s8}	"M," mm
0<0.6	610	1380	740	510	510	510	510	510	
0.6<0.9	610	1350	910	510					1990
0.9-1.5	510	780	760	510					1630
3.0	530	910	970	510					1480
4.6	700	1230	1290	510					1330
6.1	890	1570	1690	510					1200
7.6	1080	2140	2460	510					1200

3000 by 3000 by 250 mm

Design Earth Cover, m	Circumferential Reinforcement Areas, mm^2/m								
	A_{s1}	A_{s2}	A_{s3}	A_{s4}	A_{s5}	A_{s6}	A_{s7}	A_{s8}	"M," mm
0<0.6	680	1380	780	510	510	510	510	510	
0.6<0.9	570	1380	930	510					1990
0.9-1.5	510	780	800	510					1990
3.0	510	930	1020	510					1630
4.6	680	1250	1350	510					1330
6.1	850	1610	1760	510					1330
7.6	1040	2180	2560	510					1330

3300 by 1200 by 275 mm

Design Earth Cover, m	Circumferential Reinforcement Areas, mm^2/m								
	A_{s1}	A_{s2}	A_{s3}	A_{s4}	A_{s5}	A_{s6}	A_{s7}	A_{s8}	"M," mm
0<0.6	800	1100	550	560	560	560	560	550	1580
0.6<0.9	950	1080	590	550					1580
0.9-1.5	640	640	550	560					1400
3.0	850	700	720	560					1400
4.6	1190	970	990	560					1400
6.1	1520	1250	1270	560					1400
7.6	1880	1520	1550	560					1400

3300 by 1800 by 275 mm

Design Earth Cover, m	Circumferential Reinforcement Areas, mm^2/m								
	A_{s1}	A_{s2}	A_{s3}	A_{s4}	A_{s5}	A_{s6}	A_{s7}	A_{s8}	"M," mm
0<0.6	680	1230	610	560	560	560	560	550	
0.6<0.9	800	1230	760	550					1580
0.9-1.5	550	740	640	560					1400
3.0	720	830	870	560					1400
4.6	990	1140	1190	560					1270
6.1	1270	1460	1500	560					1270
7.6	1550	1910	2050	560					1270

3300 by 2400 by 275 mm

Design Earth Cover, m	Circumferential Reinforcement Areas, mm^2/m								
	A_{s1}	A_{s2}	A_{s3}	A_{s4}	A_{s5}	A_{s6}	A_{s7}	A_{s8}	"M," mm
0<0.6	570	1310	700	550	560	560	560	550	
0.6<0.9	700	1330	870	550					1760
0.9-1.5	550	800	740	550					1580
3.0	640	930	990	550					1400
4.6	870	1270	1330	550					1270
6.1	1080	1630	1690	550					1270
7.6	1330	2270	2540	550					1270

3300 by 3000 by 275 mm

Design Earth Cover, m	Circumferential Reinforcement Areas, mm^2/m								
	A_{s1}	A_{s2}	A_{s3}	A_{s4}	A_{s5}	A_{s6}	A_{s7}	A_{s8}	"M," mm
0<0.6	640	1350	760	550	560	560	560	550	
0.6<0.9	610	1380	910	550					1260
0.9-1.5	550	800	830	550					1760
3.0	590	990	1080	550					1580
4.6	780	1350	1440	550					1400
6.1	970	1740	1880	550					1270
7.6	1190	2460	2860	550					1270

3300 by 3300 by 275 mm

Design Earth Cover, m	Circumferential Reinforcement Areas, mm^2/m								
	A_{s1}	A_{s2}	A_{s3}	A_{s4}	A_{s5}	A_{s6}	A_{s7}	A_{s8}	"M," mm
0<0.6	720	1350	830	550	560	560	560	550	
0.6<0.9	570	1400	950	550					2160
0.9-1.5	550	830	890	560					2160
3.0	570	1040	1140	560					1760
4.6	740	1380	1500	560					1400
6.1	930	1780	1970	560					1400
7.6	1140	2500	2960	560					1400

3600 by 1200 by 300 mm

Design Earth Cover, m	Circumferential Reinforcement Areas, mm^2/m								
	A_{s1}	A_{s2}	A_{s3}	A_{s4}	A_{s5}	A_{s6}	A_{s7}	A_{s8}	"M," mm
0<0.6	830	1060	610	610	610	610	610	610	
0.6<0.9	1020	1080	610	610					1860
0.9-1.5	700	640	610	610					1680
3.0	970	740	760	610					1500
4.6	1330	1020	1040	610					1500
6.1	1710	1310	1330	610					11500
7.6	2120	1610	1630	610					15000

3600 by 1800 by 300 mm

Design Earth Cover, m	Circumferential Reinforcement Areas, mm^2/m								
	A_{s1}	A_{s2}	A_{s3}	A_{s4}	A_{s5}	A_{s6}	A_{s7}	A_{s8}	"M," mm
0<0.6	700	1210	610	610	610	610	610	610	
0.6<0.9	850	1230	740	610					1680
0.9-1.5	610	760	660	610					1500
3.0	830	890	910	610					1500
4.6	1120	1210	1250	610					1350
6.1	1440	1550	1590	610					1350
7.6	1760	1990	2160	610					11350

3600 by 2400 by 300 mm

Design Earth Cover, m	Circumferential Reinforcement Areas, mm^2/m								
	A_{s1}	A_{s2}	A_{s3}	A_{s4}	A_{s5}	A_{s6}	A_{s7}	A_{s8}	"M," mm
0<0.6	610	1290	700	610	610	610	610	610	
0.6<0.9	740	1330	850	610					1680
0.9-1.5	610	830	760	610					1500
3.0	740	970	1040	610					1500
4.6	970	1330	1400	610					1350
6.1	1250	1710	1780	610					1350
7.6	1520	2430	2730	610					1350

3600 by 3000 by 300 mm

Design Earth Cover, m	Circumferential Reinforcement Areas, mm^2/m								
	A_{s1}	A_{s2}	A_{s3}	A_{s4}	A_{s5}	A_{s6}	A_{s7}	A_{s8}	"M," mm
0<0.6	610	1330	760	610	610	610	610	610	
0.6<0.9	660	1400	910	610					2340
0.9-1.5	610	850	870	610					1680
3.0	680	1060	1160	610					1500
4.6	890	1440	1550	610					1350
6.1	1120	1840	1990	610					1350
7.6	1350	2710	3110	610					1350

3600 by 3600 by 300 mm

Design Earth Cover, m	Circumferential Reinforcement Areas, mm^2/m								
	A_{s1}	A_{s2}	A_{s3}	A_{s4}	A_{s5}	A_{s6}	A_{s7}	A_{s8}	"M," mm
0<0.6	740	1350	870	700	610	610	610	610	
0.6<0.9	610	1420	1020	610					2340
0.9-1.5	610	890	950	610					2340
3.0	610	1120	1250	610					1860
4.6	830	1500	1650	610					1500
6.1	1020	1970	2180	610					1500
7.6	1250	2840	3410	610					1500

TABLE 2 Design Requirements for Precast Concrete Box Sections Under Earth Dead and Interstate Live Load Conditions

NOTE 1—Design earth covers and reinforcement areas are based on the weight of a column of earth over the width of the box section as defined in Appendix X1.

NOTE 2—Concrete design strength 35 MPa.

NOTE 3—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 4—Design steel area in square millimetres per linear metre of box section at those locations which are indicated on the typical section included in Appendix X1.

NOTE 5—The top section designation, for example, 900 by 600 by 100 mm, indicates (interior horizontal span in millimetres) by (interior vertical rise in millimetres) by (wall and slab thickness in millimetres).

NOTE 6—In accordance with the acceptance criteria in 7.2, the manufacturer may interpolate the steel area requirements for fill heights between noted increments or may submit independent designs.

900 by 600 by 100 mm

Design Earth Cover, m	Circumferential Reinforcement Areas, mm^2/m								
	A_{s1}	A_{s2}	A_{s3}	A_{s4}	A_{s5}	A_{s6}	A_{s7}	A_{s8}	"M," mm
0<0.6[A]	360	830	470	210	400	360	360	300	
0.6<0.9	320	570	570	210					770
0.9-1.5	210	250	250	210					770
3.0	210	210	210	210					460
4.6	210	300	300	210					460
6.1	250	380	380	210					460
7.6	300	470	470	210					460
9.1	360	550	550	210					460

[A] Top slab 175 mm, bottom slab 150 mm.

900 by 900 by 100 mm

Design Earth Cover, m	Circumferential Reinforcement Areas, mm^2/m								
	A_{s1}	A_{s2}	A_{s3}	A_{s4}	A_{s5}	A_{s6}	A_{s7}	A_{s8}	"M," mm
0<0.6[A]	360	870	490	210	420	360	360	300	
0.6<0.9	230	660	660	210					770
0.9-1.5	210	300	300	210					640
3.0	210	230	230	210					640
4.6	210	320	340	210					460
6.1	210	400	420	210					460
7.6	210	510	510	210					460
9.1	250	590	610	210					460

[A] Top slab 175 mm, bottom slab 150 mm.

1200 by 600 by 125 mm

Design Earth Cover, m	Circumferential Reinforcement Areas, mm^2/m								
	A_{s1}	A_{s2}	A_{s3}	A_{s4}	A_{s5}	A_{s6}	A_{s7}	A_{s8}	"M," mm
0<0.6[A]	380	890	470	250	440	380	380	300	
0.6<0.9	510	610	530	250					940
0.9-1.5	260	300	300	250					460
3.0	250	250	250	250					460
4.6	320	360	360	250					460
6.1	400	440	440	250					460
7.6	510	550	550	250					460
9.1	620	660	660	250					460

[A] Top slab 162.5 mm, bottom slab 150 mm.

1200 by 900 by 125 mm

Design Earth Cover, m	Circumferential Reinforcement Areas, mm^2/m								
	A_{s1}	A_{s2}	A_{s3}	A_{s4}	A_{s5}	A_{s6}	A_{s7}	A_{s8}	"M," mm
0<0.6[A]	380	970	530	250	490	380	380	300	
0.6<0.9	420	740	660	250					940
0.9-1.5	250	360	360	250					690
3.0	250	300	300	250					460
4.6	250	400	420	250					460
6.1	320	530	530	250					460
7.6	380	640	660	250					460
9.1	440	760	760	250					460

[A] Top slab 162.5 mm, bottom slab 150 mm.

1200 by 1200 by 125 mm

Design Earth Cover, m	Circumferential Reinforcement Areas, mm^2/m								
	A_{s1}	A_{s2}	A_{s3}	A_{s4}	A_{s5}	A_{s6}	A_{s7}	A_{s8}	"M," mm
0<0.6[A]	380	1020	570	250	510	380	380	300	
0.6<0.9	340	800	720	250					940
0.9-1.5	250	380	380	250					690
3.0	250	320	340	250					690
4.6	250	420	440	250					460
6.1	250	550	570	250					460
7.6	320	680	700	250					460
9.1	380	800	830	250					460

[A] Top slab 162.5 mm, bottom slab 150 mm.

1500 by 900 by 150 mm

Design Earth Cover, m	Circumferential Reinforcement Areas, mm^2/m								
	A_{s1}	A_{s2}	A_{s3}	A_{s4}	A_{s5}	A_{s6}	A_{s7}	A_{s8}	"M," mm
0<0.6[A]	420	990	640	300	470	410	410	360	
0.6<0.9	550	760	590	300					1120
0.9-1.5	300	400	400	300					740
3.0	300	340	360	300					460
4.6	360	470	490	300					460
6.1	470	610	610	300					460
7.6	570	740	760	300					460
9.1	680	890	910	300					460

[A] Top slab 200 mm, bottom slab 175 mm.

1500 by 1200 by 150 mm

Design Earth Cover, m	Circumferential Reinforcement Areas, mm^2/m								
	A_{s1}	A_{s2}	A_{s3}	A_{s4}	A_{s5}	A_{s6}	A_{s7}	A_{s8}	"M," mm
0<0.6[A]	410	1060	720	300	510	410	410	360	
0.6<0.9	470	870	700	300					1120
0.9-1.5	300	440	440	300					740
3.0	300	380	400	300					460
4.6	300	510	530	300					460
6.1	380	660	680	300					460
7.6	470	800	830	300					460
9.1	550	970	990	300					460

[A] Top slab 200 mm, bottom slab 175 mm.

1500 by 1500 by 150 mm

Design Earth Cover, m	Circumferential Reinforcement Areas, mm^2/m								
	A_{s1}	A_{s2}	A_{s3}	A_{s4}	A_{s5}	A_{s6}	A_{s7}	A_{s8}	"M," mm
0<0.6[A]	410	1100	760	300	510	410	410	360	
0.6<0.9	400	910	740	300					1120
0.9-1.5	300	470	470	300					740
3.0	300	400	420	300					740
4.6	300	550	570	300					460
6.1	340	700	720	300					460
7.6	400	850	870	300					460
9.1	490	1020	1040	300					460

[A] Top slab 200 mm, bottom slab 175 mm.

1800 by 900 by 175 mm

Design Earth Cover, m	Circumferential Reinforcement Areas, mm^2/m								
	A_{s1}	A_{s2}	A_{s3}	A_{s4}	A_{s5}	A_{s6}	A_{s7}	A_{s8}	"M," mm
0<0.6[A]	530	1020	680	360	440	410	410	360	
0.6<0.9	640	800	550	360					1300
0.9-1.5	360	420	360	360					790
3.0	360	380	400	360					460
4.6	490	530	550	360					460