Designation: C 1433M – 02

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:*

A 82 Specification for Steel Wire, Plain, for Concrete Reinforcement[2]

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

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

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

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

C 31/C 31M Practice for Making and Curing Concrete Test Specimens in the Field[3]

C 33 Specification for Concrete Aggregates[3]

C 39 Test Method for Compressive Strength of Cylindrical Concrete Specimens[3]

C 150 Specification for Portland Cement[4]

C 309 Specification for Liquid Membrane-Forming Compounds for Curing Concrete[3]

C 497M Test Methods for Concrete Pipe, Manhole Sections, or Tile [Metric][5]

C 595 Specification for Blended Hydraulic Cements[4]

C 618 Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete[3]

C 822 Terminology Relating to Concrete Pipe and Related Products[5]

2.2 *AASHTO Standards:*[6]

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] *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] 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					460
0.9-1.5	210	250	250	210					460
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					460
0.9-1.5	210	300	300	210					460
3.0	210	230	230	210					460
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					460
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					460
0.9-1.5	250	360	360	250					460
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					460
0.9-1.5	250	380	380	250					460
3.0	250	320	320	250					460
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					460
0.9-1.5	300	400	400	300					460
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					460
0.9-1.5	300	440	440	300					460
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					460
0.9-1.5	300	470	470	300					460
3.0	300	380	400	300					460
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					460
0.9-1.5	360	420	360	360					460
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					460
0.9-1.5	360	490	440	360					460
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					460
0.9-1.5	360	510	470	360					460
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					460
9.0-1.5	360	530	490	360					460
3.0	360	470	510	360					460
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					460
0.9-1.5	410	510	410	400					460
3.0	410	470	490	400					460
4.6	530	660	680	400					460
6.1	680	850	850	400					460
7.6	830	1040	1040	400					460
9.1	990	1230	1250	400					790

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					460
0.9-1.5	400	550	470	400					460
3.0	400	510	530	400					460
4.6	470	700	720	400					460
6.1	590	910	930	400					460
7.6	720	1100	1140	400					460
9.1	870	1350	1400	400					460

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					460
0.9-1.5	400	570	490	410					460
3.0	400	550	570	410					460
4.6	420	740	780	410					460
6.1	530	950	970	410					460
7.6	640	1160	1210	410					460
9.1	760	1440	1550	410					460

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					460
0.9-1.5	400	590	510	400					460
3.0	400	570	610	400					460
4.6	400	760	800	400					460
6.1	490	970	1020	400					460
7.6	590	1190	1230	400					460
9.1	700	1480	1630	400					460

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					940
0.9-1.5	490	610	530	410					460
3.0	550	590	610	410					460
4.6	760	830	850	410					460
6.1	970	1060	1080	410					460
7.6	1210	1330	1350	410					910

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					460
0.9-1.5	420	660	550	400					460
3.0	490	640	680	400					460
4.6	680	890	910	400					460
6.1	870	1140	1190	400					460
7.6	1060	1500	1550	400					790

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					460
0.9-1.5	400	700	570	400					460
3.0	440	680	720	400					460
4.6	610	950	970	400					460
6.1	780	1210	1250	400					460
7.6	950	1630	1670	400					790

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					460
0.9-1.5	400	700	610	400					460
3.0	420	720	760	400					460
4.6	570	970	1040	400					460
6.1	720	1270	1310	400					460
7.6	890	1690	1780	400					790

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					460
0.9-1.5	400	720	660	400					460
3.0	400	740	800	400					460
4.6	530	1020	1080	400					460
6.1	680	1290	1380	400					460
7.6	830	1760	1840	400					790

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					460
0.9-1.5	470	680	550	470					460
3.0	590	700	720	470					460
4.6	800	950	970	470					460
6.1	1040	1230	1250	470					460
7.6	1270	1590	1630	470					840

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					460
0.9-1.5	470	720	590	470					460
3.0	550	740	780	470					460
4.6	740	1020	1060	470					460
6.1	930	1310	1350	470					460
7.6	1140	1740	1780	470					840

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	990
0.6<0.9	660	1270	870	470					460
0.9-1.5	470	740	640	470					460
3.0	510	780	830	470					460
4.6	680	1060	1120	470					460
6.1	870	1380	1420	470					460
7.6	1060	1840	1950	470					840

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					460
0.9-1.5	470	700	740	470					460
3.0	470	800	870	470					460
4.6	640	1100	1160	470					460
6.1	800	1400	1500	470					460
7.6	970	1910	2070	470					840

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					460
0.9-1.5	470	740	740	460					460
3.0	470	830	910	460					460
4.6	590	1120	1210	460					460
6.1	760	1440	1570	460					460
7.6	930	1970	2180	460					840

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					460
0.9-1.5	530	700	570	510					460
3.0	680	740	760	510					460
4.6	930	1020	1040	510					460
6.1	1210	1290	1330	510					460
7.6	1480	1650	1690	510					1020

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					460
0.9-1.5	510	740	610	510					460
3.0	640	780	830	510					460
4.6	850	1080	1120	510					460
6.1	1100	1400	1440	510					460
7.6	1350	1820	1930	510					890

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					460
0.9-1.5	510	760	660	510					460
3.0	590	830	890	510					460
4.6	780	1140	1190	510					460
6.1	1020	1460	1520	510					460
7.6	1230	1950	2140	510					890

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					460
0.9-1.5	510	780	720	510					460
3.0	550	870	930	510					460
4.6	740	1190	1250	510					460
6.1	930	1520	1590	510					460
7.6	1140	2050	2310	510					890

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					460
0.9-1.5	510	780	760	510					460
3.0	530	910	970	510					460
4.6	700	1230	1290	510					460
6.1	890	1570	1690	510					460
7.6	1080	2140	2460	510					890

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					460
0.9-1.5	510	780	800	510					460
3.0	510	930	1020	510					460
4.6	680	1250	1350	510					460
6.1	850	1610	1760	510					460
7.6	1040	2180	2560	510					890

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	460
0.6<0.9	950	1080	590	550					460
0.9-1.5	640	640	550	560					460
3.0	850	700	720	560					460
4.6	1190	970	990	560					460
6.1	1520	1250	1270	560					1070
7.6	1880	1520	1550	560					1120

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					460
0.9-1.5	550	740	640	560					460
3.0	720	830	870	560					460
4.6	990	1140	1190	560					460
6.1	1270	1460	1500	560					460
7.6	1550	1910	2050	560					910

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					460
0.9-1.5	550	800	740	550					460
3.0	640	930	990	550					460
4.6	870	1270	1330	550					460
6.1	1080	1630	1690	550					460
7.6	1330	2270	2540	550					910

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					460
0.9-1.5	550	800	830	550					160
3.0	590	990	1080	550					460
4.6	780	1350	1440	550					460
6.1	970	1740	1880	550					460
7.6	1190	2460	2860	550					910

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					460
0.9-1.5	550	830	890	560					460
3.0	570	1040	1140	560					460
4.6	740	1380	1500	560					460
6.1	930	1780	1970	560					460
7.6	1140	2500	2960	560					910

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					460
0.9-1.5	700	640	610	610					460
3.0	970	740	760	610					460
4.6	1330	1020	1040	610					460
6.1	1710	1310	1330	610					1170
7.6	2120	1610	1630	610					1170

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					460
0.9-1.5	610	760	660	610					460
3.0	830	890	910	610					460
4.6	1120	1210	1250	610					460
6.1	1440	1550	1590	610					460
7.6	1760	1990	2160	610					1120

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					460
0.9-1.5	610	830	760	610					460
3.0	740	970	1040	610					460
4.6	970	1330	1400	610					460
6.1	1250	1710	1780	610					460
7.6	1520	2430	2730	610					970

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					460
0.9-1.5	610	850	870	610					460
3.0	680	1060	1160	610					460
4.6	890	1440	1550	610					460
6.1	1120	1840	1990	610					460
7.6	1350	2710	3110	610					970

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					460
0.9-1.5	610	890	950	610					460
3.0	610	1120	1250	610					460
4.6	830	1500	1650	610					460
6.1	1020	1970	2180	610					460
7.6	1250	2840	3410	610					970

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					460
0.9-1.5	210	250	250	210					460
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					460
0.9-1.5	210	300	300	210					460
3.0	210	230	230	210					460
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					460
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					460
0.9-1.5	250	360	360	250					460
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					460
0.9-1.5	250	380	380	250					460
3.0	250	320	340	250					460
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					460
0.9-1.5	300	400	400	300					460
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					460
0.9-1.5	300	440	440	300					460
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					460
0.9-1.5	300	470	470	300					460
3.0	300	400	420	300					460
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					460
0.9-1.5	360	420	360	360					460
3.0	360	380	400	360					460
4.6	490	530	550	360					460

6.1	610	680	700	360					460
7.6	760	850	850	360					460
9.1	930	990	1020	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]	470	1100	760	360	470	410	410	360	
0.6<0.9	550	890	660	360					460
0.9-1.5	360	490	440	360					460
3.0	360	440	440	360					460
4.6	420	590	610	360					460
6.1	530	760	780	360					460
7.6	640	930	950	360					460
9.1	760	1120	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	830	360	510	410	410	360	
0.6<0.9	490	950	720	360					460
0.9-1.5	360	510	470	360					460
3.0	360	470	490	360					460
4.6	360	640	660	360					460
6.1	470	800	830	360					460
7.6	550	990	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	870	360	530	410	410	360	
0.6<0.9	440	1020	760	360					460
0.9-1.5	360	530	490	360					460
3.0	360	490	530	360					460
4.6	360	660	700	360					460
6.1	400	850	870	360					460
7.6	510	1020	1060	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	570	1120	760	410	440	410	410	400	
0.6<0.9	660	910	890	400					460
0.9-1.5	410	510	410	410					460
3.0	410	490	510	410					460
4.6	530	660	680	410					460
6.1	680	850	870	410					460
7.6	850	1040	1060	410					460
9.1	990	1230	1250	410					790

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	490	1190	830	410	410	410	410	400	
0.6<0.9	570	990	970	400					460
0.9-1.5	410	550	470	410					460
3.0	410	530	550	410					460
4.6	470	720	740	410					460
6.1	590	910	930	410					460
7.6	720	1120	1140	410					460
9.1	870	1350	1400	410					460

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	440	1230	890	410	490	410	410	400	
0.6<0.9	510	1040	1040	400					460
0.9-1.5	410	570	490	410					460
3.0	410	550	590	410					460
4.6	420	760	780	410					460
6.1	530	950	990	410					460
7.6	660	1160	1210	410					460
9.1	780	1460	1570	410					460

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	930	410	510	410	410	400	
0.6<0.9	440	1080	1100	400					460
0.9-1.5	410	590	510	410					460
3.0	410	570	610	410					460
4.6	410	780	830	410					460
6.1	490	990	1040	410					460
7.6	590	1210	1250	410					460
9.1	690	1500	1650	410					460

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	740	1230	830	410	440	410	410	400	1070
0.6<0.9	910	1060	990	400					940
0.9-1.5	490	610	530	410					460
3.0	570	610	640	410					460
4.6	760	830	850	410					460
6.1	970	1080	1100	410					460
7.6	1210	1330	1380	410					460

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	660	1310	910	410	490	410	410	400	
0.6<0.9	800	1160	1080	400					460
0.9-1.5	420	660	570	410					460
3.0	510	660	680	410					460
4.6	680	910	930	410					460
6.1	870	1160	1190	410					460
7.6	1080	1500	1550	410					790

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	970	410	510	410	410	400	
0.6<0.9	720	1250	1160	400					460
0.9-1.5	400	680	590	410					460
3.0	470	700	740	410					460
4.6	610	950	990	410					460
6.1	780	1230	1270	410					460
7.6	970	1630	1690	410					790

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	590	1400	1020	410	510	410	410	400	
0.6<0.9	640	1290	1230	400					460
0.9-1.5	410	700	640	410					460
3.0	420	740	780	410					460
4.6	570	990	1040	410					460
6.1	720	1270	1330	410					460
7.6	890	1710	1800	410					790

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	1060	510	530	410	410	400	
0.6<0.9	590	1330	1270	400					460
0.9-1.5	410	720	680	410					460
3.0	410	760	830	410					460
4.6	550	1040	1080	410					460
6.1	680	1310	1400	410					460
7.6	830	1760	1860	410					790

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	780	1250	850	460	460	460	460	470	
0.6<0.9	910	1210	1040	470					460
0.9-1.5	530	720	700	460					460
3.0	590	700	740	460					460
4.6	800	970	990	460					460
6.1	1040	1250	1270	460					460
7.6	1270	1590	1630	460					840

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	720	1310	930	460	460	460	460	470	
0.6<0.9	830	1270	1120	470					460
0.9-1.5	470	740	740	460					460
3.0	550	760	780	460					460
4.6	740	1040	1060	460					460
6.1	950	1310	1350	460					460
7.6	1160	1740	1800	460					840

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	660	1350	970	460	460	460	460	470	
0.6<0.9	740	1350	1190	470					460
0.9-1.5	460	780	780	460					460
3.0	510	800	850	460					460
4.6	680	1080	1120	460					460
6.1	870	1380	1440	460					460
7.6	1060	1840	1970	460					840

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	610	1380	1020	470	460	460	460	470	
0.6<0.9	700	1400	1250	470					460
0.9-1.5	460	800	800	470					460
3.0	490	830	890	470					460
4.6	640	1120	1190	470					460
6.1	800	1420	1500	470					460
7.6	990	1930	2120	470					840

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	1060	550	460	470	460	470	
0.6<0.9	660	1440	1270	470					460
0.9-1.5	460	800	800	470					460
3.0	460	850	930	470					460
4.6	610	1140	1230	470					460
6.1	760	1460	1590	470					460
7.6	930	1970	2200	470					840

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	870	1210	800	510	510	510	510	510	
0.6<0.9	1020	1230	990	510					460
0.9-1.5	590	740	700	510					460
3.0	700	740	780	510					460
4.6	950	1020	1060	510					460
6.1	1210	1310	1330	510					460
7.6	1500	1650	1690	510					1020

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	780	1270	890	510	510	510	510	510	
0.6<0.9	930	1310	1080	510					460
0.9-1.5	530	780	740	510					460
3.0	660	800	850	510					460
4.6	870	1100	1140	510					460
6.1	1100	1400	1440	510					460
7.6	1350	1840	1970	510					890

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	720	1310	950	510	510	510	510	510	
0.6<0.9	850	1380	1160	510					460
0.9-1.5	510	830	780	510					460
3.0	610	850	910	510					460
4.6	800	1160	1210	510					460
6.1	1020	1480	1520	510					460
7.6	1250	1970	2180	510					890

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	680	1330	990	510	510	510	510	510	
0.6<0.9	780	1440	1230	510					460
0.9-1.5	510	850	800	510					460
3.0	570	890	950	510					460
4.6	760	1210	1270	510					460
6.1	950	1550	1610	510					460
7.6	1160	2100	2350	510					890

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	640	1380	1020	510	510	510	510	510	
0.6<0.9	740	1480	1270	510					460
0.9-1.5	510	850	830	510					460
3.0	550	930	990	510					460
4.6	720	1250	1310	510					460
6.1	890	1590	1710	510					460
7.6	1080	2180	2500	510					890

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	1060	590	510	510	510	510	
0.6<0.9	700	1500	1290	510					460
0.9-1.5	510	870	850	510					460
3.0	510	950	1040	510					460
4.6	680	1270	1380	510					460
6.1	850	1630	1780	510					460
7.6	1040	2220	2600	510					890

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	950	1100	680	560	560	560	560	550	
0.6<0.9	1210	1140	850	550					1120
0.9-1.5	740	700	590	560					460
3.0	890	720	740	560					460
4.6	1210	990	990	560					460
6.1	1550	1270	1270	560					1120
7.6	1910	1550	1570	560					1120

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	850	1230	850	560	560	560	560	550	
0.6<0.9	1020	1330	1060	550					460
0.9-1.5	590	800	720	560					460
3.0	740	850	890	560					460
4.6	990	1160	1210	560					460
6.1	1270	1480	1520	560					460
7.6	1570	1930	2100	560					910

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	720	1310	950	560	560	560	560	550	
0.6<0.9	870	1480	1190	550					460
0.9-1.5	560	890	800	560					460
3.0	660	950	1020	560					460
4.6	870	1290	1350	560					460
6.1	1100	1630	1710	560					460
7.6	1330	2310	2580	560					910

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	1040	560	560	560	560	550	
0.6<0.9	780	1550	1270	550					460
0.9-1.5	560	910	870	560					460
3.0	590	1020	1120	560					460
4.6	780	1380	1460	560					460
6.1	970	1760	1910	560					460
7.6	1190	2500	2900	560					910

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	1040	550	550	560	560	550	
0.6<0.9	720	1590	1290	550					460
0.9-1.5	550	910	910	560					460
3.0	570	1060	1160	560					460
4.6	760	1400	1520	560					460
6.1	950	1800	1990	560					460
7.6	1140	2560	3010	560					910

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	990	1060	760	610	610	610	610	610	
0.6<0.9	1290	1160	800	610					1170
0.9-1.5	830	700	660	610					460
3.0	990	760	780	610					460
4.6	1350	1040	1060	610					460
6.1	1740	1310	1330	610					1170
7.6	2140	1610	1630	610					1170

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	890	1210	830	610	610	610	610	610	
0.6<0.9	1100	1350	1020	610					460
0.9-1.5	680	850	760	610					460
3.0	850	910	930	610					460
4.6	1140	1230	1270	610					460
6.1	1460	1570	1610	610					460
7.6	1780	2030	2220	610					1120

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	780	1290	930	610	610	610	610	610	460
0.6<0.9	950	1500	1160	610					460
0.9-1.5	610	910	850	610					460
3.0	760	1020	1080	610					460
4.6	990	1350	1420	610					460
6.1	1250	1740	1800	610					460
7.6	1520	2500	2770	610					970

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	680	1330	1020	610	610	610	610	610	
0.6<0.9	850	1590	1270	610					460
0.9-1.5	610	950	950	610					460
3.0	680	1100	1190	610					460
4.6	890	1460	1570	610					460
6.1	1120	1860	2010	610					460
7.6	1350	2750	3180	610					970

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	1060	610	610	610	610	610	
0.6<0.9	760	1650	1310	610					460
0.9-1.5	610	950	1060	610					460
3.0	640	1160	1290	610					460
4.6	830	1550	1670	610					460
6.1	1040	1990	2200	610					460
7.6	1250	2880	3450	610					970

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 10, 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 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 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, or

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 shall be allowed to be used with the approval of the purchaser.

6.5 *Steel Reinforcement*—Reinforcement shall consist of welded wire fabric conforming to Specifications A 185 or A 497. Circumferential reinforcement areas in Tables 1 and 2 are based solely on the use of welded wire fabric, refer to 11.6 if alternate steel designs utilizing steel bars, Grade 60, in conjunction with or in lieu of welded wire fabric are to be submitted for the owner's approval. Longitudinal distribution reinforcement shall be allowed to consist of welded wire fabric or deformed billet-steel bars conforming to Specification A 615/A 615M, Grade 60.

7. Design

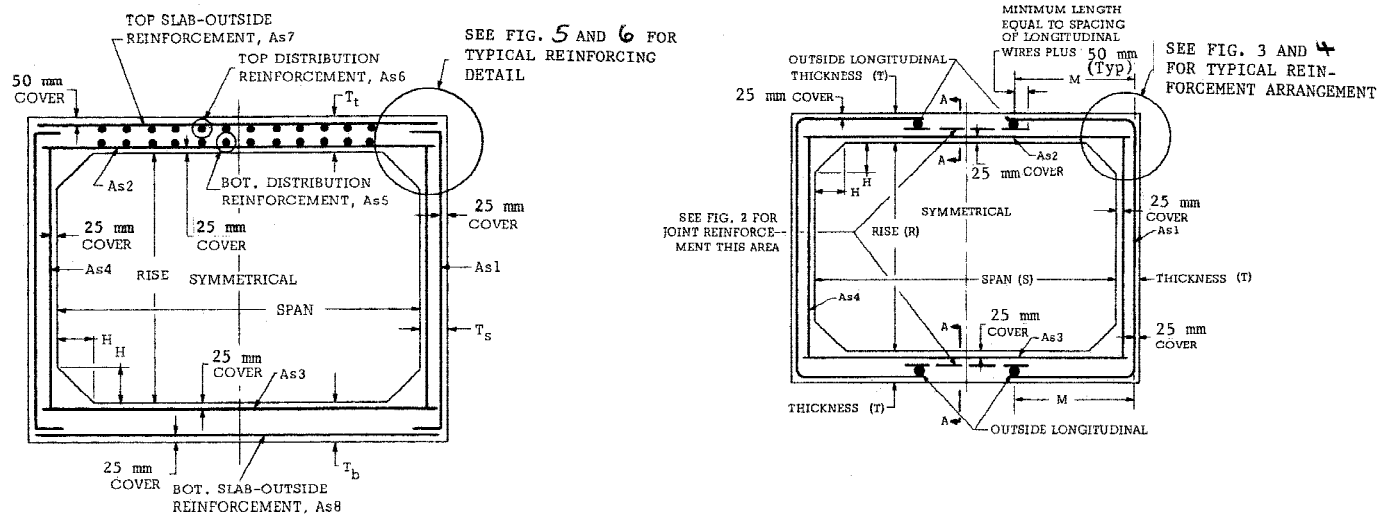
7.1 *Design Tables*—The box section dimensions, compressive strength of the concrete, and reinforcement details shall be as prescribed in Table 1 or Table 2 and Figs. 1-4, subject to the provisions of Section 11. Table 1 sections are designed for combined earth dead load and AASHTO HS20 live load conditions. 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*—The manufacturer shall be allowed to request approval by the purchaser of modified designs which differ from the designs in Section 7, or special designs for sizes and loads other than those shown in Tables 1 and 2.

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 11. 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 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 fabric. 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 90° at the corners and waiving the extension requirements of Fig. 3 (see Fig. 5). When a single cage of multiple circumferential steel



Fill Height Less than 600 mm

Fill Height 600 mm and Greater

FIG. 1 Typical Box Sections

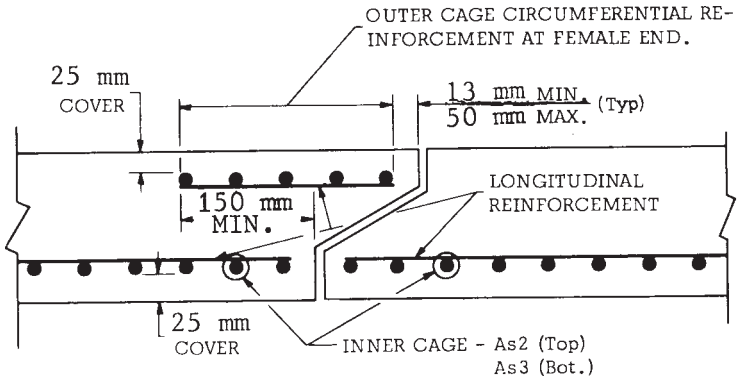


FIG. 2 Section A-A Top and Bottom Slab Joint Reinforcement

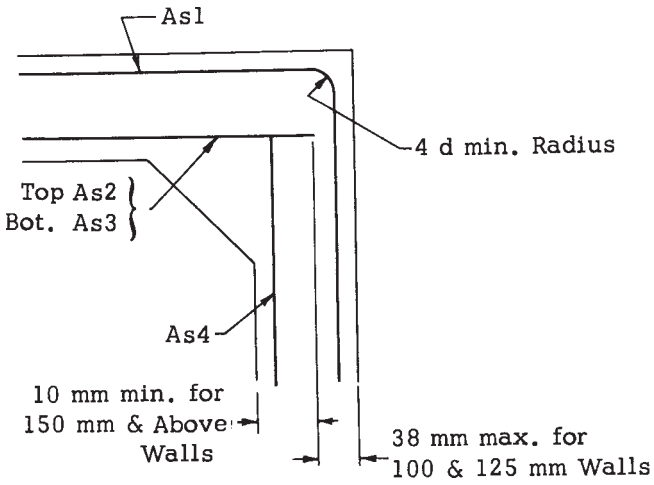


FIG. 3 Detail Inner Reinforcement

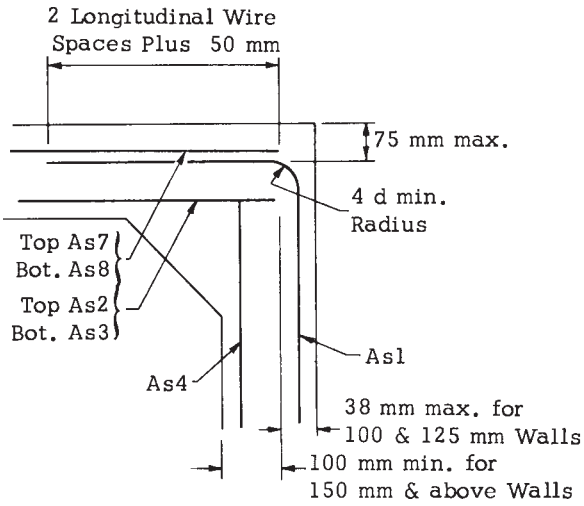


FIG. 5 Detailed Reinforcement Arrangement

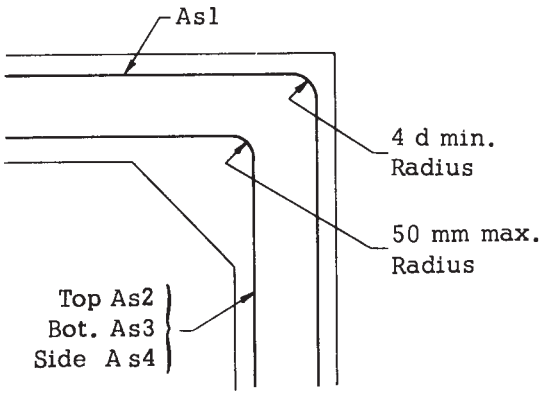


FIG. 4 Detail Option (see Fig. 3)

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 circumferential steel extending for the full length of the slab or wall. The welded-wire fabric shall be composed of circumferential and longitudinal wires meeting the spacing requirements of 7.4 and shall contain sufficient longitudinal wires extending through the box 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 7.4. The ends of the longitudinal distribution reinforcement shall not be more than 2 in. from the ends of the box section. The exposure of the ends of longitudinals, stirrups, and spacers used to position the reinforcement shall not be a cause for rejection.

7.4 *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 shall not be less than the spacing of the longitudinal wires plus 50 mm but not less than 250 mm. If A_{s1} is extended to the middle of either slab and connected, welded splices are not prohibited in the connection. When used, A_{s7} and A_{s8} shall be lapped with A_{s1} as shown in Figs. 5 and 6. If welds are made to circumferential reinforcement, they shall be made only to selected circumferential wires that are not less than 450 mm apart along the longitudinal axis of the box section. Also, 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, except it is not prohibited for A_{s4} to be lapped and welded at any location or connected by welding at the corners to A_{s2} and A_{s3}. No weld shall be made to A_{s2} or A_{s3} circumferential wires in the middle third of the span. When distribution reinforcement is to be fastened to a cage by welding, it shall be welded only to longitudinal wires and only near the ends of the box section. The spacing center to center of the circumferential wires shall not be less than 50 mm nor more than 100 mm. The spacing center to center of the longitudinal wires shall not be more than 200 mm.

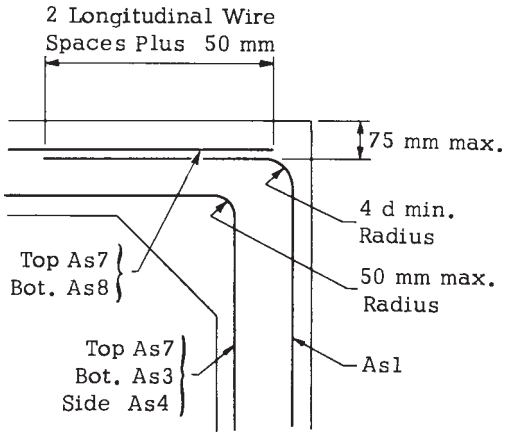


FIG. 6 Detail Option

8. Joints

8.1 The precast reinforced concrete box sections shall be produced with tongue and groove ends. The ends shall be of such design and the ends of the box sections so formed that the sections can be laid together to make a continuous line of box sections compatible with the permissible variations given in Section 11.

8.2 Outer cage circumferential reinforcement as shown in Figs. 1 and 2 shall be placed in the top and bottom slabs at the groove portion of the joint when A_{s1} is not continuous over the span. The minimum area of such reinforcement in square millimeters per linear meter of box section length shall be the same as the areas specified for A_{s4} in Tables 1 and 2.

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 the pipe 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 weight. Cementitious materials shall be as specified in 6.2 and shall be added to the mix in a proportion not less than 280 kg/m^3 unless mix designs with a lower cementitious materials content demonstrate that the quality and performance of the pipe meet the requirements of this specification.

9.2 *Curing*—The box 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 shall be allowed to be used:

9.2.1 *Steam Curing*—The box sections shall be allowed to be low pressure, steam-cured by a system that will maintain a moist atmosphere.

9.2.2 *Water Curing*—The box sections shall be allowed to be water-cured by any method that will keep the sections moist.

9.2.3 *Membrane Curing*—A sealing membrane conforming to the requirements of Specification C 309 may be applied and shall be left intact until the required concrete compressive strength is attained. The concrete temperature at the time of application shall be within 6°C of the atmospheric temperature. All surfaces shall be kept moist prior to the application of the compounds and shall be damp when the compound is applied.

9.3 *Forms*—The forms used in manufacture shall be sufficiently rigid and accurate to maintain the box section dimensions within the permissible variations given in Section 11. All casting surfaces shall be of smooth nonporous material.

9.4 *Handling*—Handling devices or holes shall be permitted in each box section for the purpose of handling and laying.

10. Physical Requirements

10.1 *Type of Test Specimen*—Compression tests for determining concrete compressive strength shall be allowed to be made on either standard rodded concrete cylinders or concrete cylinders compacted and cured in like manner as the box sections, or on cores drilled from the box section.

10.2 *Compression Testing of Cylinders*:

10.2.1 Cylinders shall be obtained and tested for compressive strength in accordance with the provisions of Practice C 31/C 31M and Test Method C 39, except that the cylinders may be prepared by methods comparable to those used to consolidate and cure the concrete in the actual box section manufactured. Cylindrical specimens of sizes other than 150 by 300 mm may be used provided all other requirements of Practice C 31/C 31M are met. If the concrete is of a consistency too stiff for compaction by rodding or internal vibration, the alternate method described in Section II of Test Methods C 497M may be used. Cylinders shall be exposed to the same curing conditions as the manufactured box sections and shall remain with the sections until tested.

10.2.2 Prepare not less than three test cylinders from each concrete mix used within a group (one day's production) of box sections.

10.2.3 *Acceptability on the Basis of Cylinder Test Results*:

10.2.3.1 When the average compressive strength of all cylinders tested is equal to or greater than the design concrete strength, not more than 10 % of the cylinders tested have a compressive strength less than the design concrete strength, and no cylinder tested has a compressive strength less than 80 % of the design concrete strength, the lot shall be accepted.

10.2.3.2 When the compressive strength of the cylinders tested does not conform to the acceptance criteria stated in 10.2.3.1, the acceptability of the lot shall be determined in accordance with the provisions of 10.3.

10.3 *Compression Testing of Cores*:

10.3.1 Cores shall be obtained and tested for compressive strength in accordance with the provisions of Test Methods C 497M.

10.3.2 One core shall be cut from a section selected at random from each group of 15 box sections or fraction thereof, of a single size from each continuous production run.

10.3.3 *Acceptability by Core Tests*:

10.3.3.1 The compressive strength of the concrete in each group of box sections defined in 10.1 is acceptable when concrete compressive strength of the core is equal to or greater than 80 % of the specified strength of the concrete.

10.3.3.2 When the compressive strength of the core tested is less than 80 % of the design concrete strength, the box section from which that core was taken may be recored. When the compressive strength of the recore is equal to or greater than 80 % of the specified strength of the concrete, the compressive

strength of the concrete in that group of box sections is acceptable.

10.3.3.3 When the compressive strength of any recore is less than 80 % of the specified strength of the concrete, the box section from which the core was taken shall be rejected. Two box sections from the remainder of the group shall be selected at random and one core shall be taken from each. If the compressive strength of either of the two cores tested is less than 80 % of the specified strength of the concrete, the remainder of the group of box sections shall be rejected, or, at the option of the manufacturer, each box section of the remainder of the group shall be cored and accepted individually, and any of these box sections that have cores with less than 80 % of the specified strength of the concrete shall be rejected.

10.4 *Plugging Core Holes*—The core holes shall be plugged and sealed by the manufacturer in a manner such that the box section will meet all of the test requirements of this specification. Box sections so sealed shall be considered as satisfactory for use.

10.5 *Test Equipment*—Every manufacturer furnishing box sections under this specification shall furnish all facilities and personnel necessary to carry out the tests required.

11. Permissible Variations

11.1 *Internal Dimensions*—The internal dimension shall not vary more than 1 % from the design dimensions. The haunch dimensions shall not vary more than 6 mm from the design dimensions.

11.2 *Slab and Wall Thickness*—The slab and wall thickness shall not be less than that shown in the design by more than 5 % or 5 mm, whichever is greater. A thickness more than that required in the design shall not be a cause for rejection.

11.3 *Length of Opposite Surfaces*—Variations in laying lengths of two opposite surfaces of the box section shall not be more than 10 mm/m of internal span, with a maximum of 16 mm for all sizes through 2100 mm internal span, and a maximum of 19 mm for internal spans greater than 2100 mm, except where beveled ends for laying of curves are specified by the purchaser.

11.4 *Length of Section*—The underrun in length of a section shall not be more than 10 mm/m of length with a maximum of 13 mm in any box section.

11.5 *Position of Reinforcement*—The maximum variation in the position of the reinforcement for 125 mm or less slab and wall thickness shall be ± 10 mm, and for greater than 125 mm slab and wall thickness shall be ± 13 mm. In no case, however, shall the cover over the reinforcement be less than 16 mm, as measured to the internal surface or the external surface except the cover over the reinforcement for the external surface of the top slab for boxes with under 6 m of cover shall not be less than 40 mm. The preceding minimum cover limitation does not apply at the mating surfaces of the joint.

11.6 *Area of Reinforcement*—The areas of steel reinforcement shall be the design steel areas as shown in Tables 1 and 2. Steel areas greater than those required shall not be cause for rejection. The permissible variation in diameter of any wire in finished fabric shall conform to the tolerances prescribed for the wire before fabrication by either Specification A 82 or A 496 as applicable. If steel bars (Grade 60) are used in lieu of welded wire fabric, the steel areas presented in Tables 1 and 2 shall be increased to account for the difference in steel yield strength, steel spacing, concrete cover, and crack control between the welded wire fabric and steel bars.

11.7 *Haunch Dimensions*—The minimum vertical and horizontal dimensions shall be equal to the slab thickness. Haunch configurations greater than those specified in Tables 1 and 2 shall be permitted, provided no reductions are made to the required steel areas.

12. Repairs

12.1 Box sections shall be repaired, if necessary, because of imperfections in manufacture or handling damage and will be acceptable if, in the opinion of the purchaser, the repaired box section conforms to the requirements of this specification.

13. Inspection

13.1 The quality of materials, the process of manufacture, and the finished box sections shall be subject to inspection by the purchaser.

14. Rejection

14.1 Box sections shall be subject to rejection on account of failure to conform to any of the specification requirements. Individual box sections shall be allowed to be rejected because of any of the following:

14.1.1 Fractures or cracks passing through the wall, except for a single end crack that does not exceed the depth of the joint,

14.1.2 Defects that indicate mixing and molding not in compliance with 9.1, or honeycombed or open texture that would adversely affect the function of the box sections,

14.1.3 Abnormalities in the ends of the box sections to the walls and center line of the box section, within the limits of variations given in Section 11, except where beveled ends are specified, or

14.1.4 Damaged ends, where such damage would prevent making a satisfactory joint.

15. Marking

15.1 The following information shall be legibly marked on each box section by indentation, waterproof paint, or other approved means:

15.1.1 Box section span, rise, table number, maximum and minimum design earth cover, and specification designation,

15.1.2 Date of manufacture, and

15.1.3 Name or trademark of the manufacturer.

15.2 Each section shall be clearly marked by indentation on either the inner or outer surface during the process of manufacture so that the location of the top will be evident immediately after the forms are stripped. In addition, the word “top” shall be lettered with waterproof paint on the inside top surface.

APPENDIX

(Nonmandatory Information)

X1. DESIGN CRITERIA USED TO DEVELOP TABLES 1 AND 2

X1.1 *Bedding and Backfill Assumptions*:

X1.1.1 The bedding is assumed to provide a slightly yielding, uniformly distributed support over the bottom width of the box section.

X1.1.2 The design earth covers 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 (see Table X1.1).

X1.2 *Criteria for Loads*:

X1.2.1 Design loads are based on the American Association of State Highway and Transportation Officials (AASHTO) *Standard Specifications for Highway Bridges*, Eighteenth edition, 1997.

X1.2.2 Live loads for designs given in Table 1 are HS20 loadings as defined in the AASHTO specifications. Live loads for designs given in Table 2 are interstate loadings as defined in U.S. Dept. of Commerce, Bureau of Public Roads Circular Memorandum 22-40, 22 April 1957.[7] Impact allowances are in accordance with AASHTO specifications. For box sections with greater than 600 mm of cover, wheel loads are distributed over a width of [1200 mm + 0.06H × (span minus one haunch)], in millimetres, perpendicular to the span by use of longitudinal distribution reinforcement in top and bottom of top slab. Live loads are applied parallel to the span as concentrated point loads. Box section with 2 ft or more of cover have the live load applied as a concentrated point load on the surface and distributed over a length equal to 1.75 H in each direction. The maximum distribution in the direction perpendicular to the span for each wheel load is one 1.8–m lane width. This is equivalent to assuming the maximum wheel loads occur simultaneously in each lane. Live loads are applied for all depths and are not cut off at any preset depth.

X1.2.3 Cover loads for designs given in Tables 1 and 2 are the weight of a column of earth of a width equal to the outside width dimension of the box section and a height equal to the depth of cover over the top of the section multiplied by the maximum soil/structure interaction factor of 1.15 for embankment installations.

X1.2.4 Lateral earth pressure from weight of earth above and adjacent to a box section is taken as a minimum of 0.25

[7] Available from the U.S. Department of Commerce,

TABLE X1.1 Specific Criteria Used for Tables 1 and 2[A]

Material Properties:	
Welded wire fabric, minimum specified yield stress	450 MPa
Deformed bars, minimum specified yield stress	415 MPa
Concrete, minimum specified compressive strength	35 MPa
Soil Data:	
Unit weight	1920 kg/m^3
Ratio of lateral to vertical pressure from weight to earth	0.50 max to 0.25 min
Additional lateral pressure from approaching truck wheels	33.5 ÷ H, kPa or 5.5 kPa when H < 0.3 m, where H = earth cover, m
External water table	below box section invert
Soil structure interaction factor	1.15
Capacity reduction factors (from AASHTO Bridge Specifications):	
Shear	0.90
Axial compression combined with bending	0.95
Loading Data:	δ = 1.3
Load factor = δ (BDL + BLL)	B = 1.0 for D.L. B = 1.7 for L. L.
Truck axle load:	
H2O (Table 1)	14 000 kgf
Interstate (Table 2)	2 @ 10 900 kgf each
Impact (variable with depth) (see AASHTO Bridge Specifications):	0 to 30 %
Uniform internal pressure	0.0
Depth of water in box section	equal to inside height
External ground water pressure	0.0
Structural Arrangement:	
Concrete cover over steel	25 mm
Top slab	25 mm for fill heights 600 mm and greater, 50 mm for fill heights under 600 mm
Slab thickness	1/12 times inside span plus 25 mm up to 2 mm span, 1/12inside span above 2 mm span
Side wall thickness	equal to slab thickness
Haunch dimensions	vertical and horizontal dimensions both equal to slab thickness
Minimum reinforcing inside face slabs and side walls, outside face side walls and corners of slabs	0.002 bt

[A] The structural arrangement and details are shown in Fig. 1.

times the vertical pressure, and an additional 0.25 times vertical pressure is added when determining steel areas only when areas are increased by such increased lateral pressure. For Tables 1 and 2, additional lateral pressure in kPa from approaching truck wheel loads is taken as 33.5 divided by depth of earth cover in mm, or 38.3 where depth to surface is less than 300 mm, and is added when determining steel areas only at sections where area is increased by increased lateral pressure.

X1.3 *Methods of Analysis*—The structural effects of the loads described in X1.2 are evaluated based on the elastic method of structural analysis. Design moments, shears, and trusts are determined by computer analysis using the stiffness matrix method, and design is based on maximum stress resultants at critical sections caused by the most severe combination of design loads.

X1.4 *Method of Design*:

X1.4.1 Box section design is based on load factor design provisions given in AASHTO *Specifications for Bridges*,. Reinforcement areas are governed by either service live load fatigue stress limitation of 145 MPa, or service total load stress limitation of 250 MPa, or ultimate total load yield stress limitation of 450 MPa using a capacity reduction factor of 0.95 for flexure and axial compression, 0.90 for shear. Service load stress shall not be greater than permitted in the AASHTO *Specifications for Bridges*. This requirement does not govern the design of box section reinforcement with welded wire fabric circumferential reinforcement with a maximum spacing of 100 mm. Longitudinal distribution reinforcement called for in Tables 1 and 2 for top slab inside face is in accordance with distribution reinforcement formulas given in AASHTO specification for bridge decks and shall be either welded wire fabric or deformed Grade 60 bars.

X1.4.2 Some box section designs shown in Tables 1 and 2 have minimum practical steel area requirements. For such designs, the steel areas calculated for support of design loads are less than the minimum steel area which is specified for slabs in AASHTO specification, 0.002 bt, and thus, the minimum reinforcement areas are shown in Tables 1 and 2.

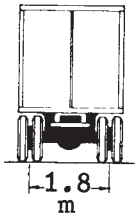
X1.4.3 For specific criteria used in Tables 1 and 2, refer to Table X1.1.

X1.4.4 The maximum height of earth cover shown in Tables 1 and 2 is determined by the shear strength of the box section without the use of special shear reinforcement and by the standard weight of the column of earth directly above the box section multiplied by the soil structure interaction factor.

X1.5 *Multiple Cell Installations*—The designs given herein are for single-cell precast reinforced concrete box sections. The units shall be allowed to be used in parallel for multicell installations if means of positive lateral bearing by continuous contact between the sides of adjacent boxes are provided. Compacted earth fill, granular backfill, flowable fill, or grouting between the units are considered means of providing such positive bearing.

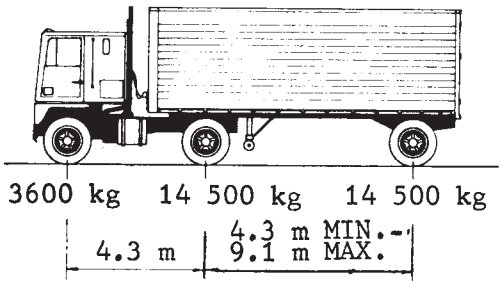
WHEEL SPACING

HS-20 Truck
and
Interstate Alternate Load



AXLE LOADS

HS-20 Load



AXLE LOADS

Interstate Alternate Load

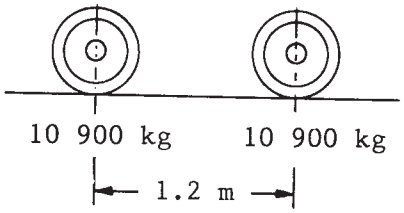


FIG. X1.1 Axle Loads for Box Section Standard Designs

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