12.6.6.1—Trench Installations

Replace the 1st paragraph with the following:

The minimum trench width shall provide a 24-in. minimum side wall clearance between the pipe and the trench wall to ensure sufficient working room to properly and safely place and compact backfill material.

C12.6.6.1

Replace the 1st paragraph with the following:

The use of specially designed equipment may enable satisfactory installation and embedment even in narrower trenches. If the use of such equipment provides an installation meeting the requirements of this Article, narrower trench widths may be used as approved by the Engineer.

Replace the 2nd paragraph with the following:

For trenches excavated in rock or high-bearing soils, decreased trench widths may be used up to the limits required for compaction. For these conditions, the use of a flowable backfill material, as specified in Article 12.4.1.3, allows the envelope to be decreased to within 6.0 in. along each side of the pipe for pipes up to and including 42 inches in diameter or span, or 12 inches for pipes over 42 inches in diameter or span.

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12.6.6.2—Embankment Installations

C12.6.6.2

Replace Table C12.6.6.2-1 with the following:

Table C12.6.6.2-1—Minimum Width of Soil Envelope

Diameter, *S* (in.)	Minimum Envelope Width (ft)
<24	2.0
24–108	2.0
>108	5.0

12.6.6.3—Minimum Cover

Replace Table 12.6.6.3-1 with the following:

Table 12.6.6.3-1—Minimum Cover

Type	Condition	Minimum Cover*
Corrugated Metal Pipe		$S/8 \geq 24.0$ in.
Spiral Rib Metal Pipe	Steel Conduit	$S/4 \geq 24.0$ in.
	Aluminum Conduit where $S \leq 48.0$ in.	$S/2 \geq 24.0$ in.
	Aluminum Conduit where $S > 48.0$ in.	$S/2.75 \geq 24.0$ in.
Structural Plate Pipe Structures		$S/8 \geq 24.0$ in.
Long-Span Structural Plate Pipe Structures		Refer to Table 12.8.3.1.1-1
Structural Plate Box Structures		1.4 ft as specified in Article 12.9.1
Deep Corrugated Structural Plate Structures		See Article 12.8.9.4
Fiberglass Pipe		24.0 in.
Thermoplastic Pipe	Under unpaved areas	$ID/8 \geq 24.0$ in.
	Under paved roads	$ID/2 \geq 24.0$ in.
Steel-Reinforced Thermoplastic Culverts		$S/5 \geq 24.0$ in.
* Minimum cover taken from top of rigid pavement or bottom of flexible pavement		
Reinforced Concrete Pipe	Under unpaved areas or top of flexible pavement	$B_c/8$ or $B'_c/8$ whichever is greater, ≥ 24.0 in.
Reinforced Concrete Pipe	Under bottom of rigid pavement	12.0 in.

12.10.2.1—Standard Installations

Replace Table 12.10.2.1-1 with the following:

Table 12.10.2.1-1—Standard Embankment Installation Soils and Minimum Compaction Requirements

Installation Type	Bedding Thickness	Haunch and Outer Bedding	Lower Side
Type 1	For soil foundation, use B_c/2.0 in. minimum, not less than 3.0 in. For rock foundation, use B_c in. minimum, not less than 6.0 in.	95% SW	90% SW, 95% ML, or 100% CL
Type 2—Installations are available for horizontal elliptical, vertical elliptical, and arch pipe	For soil foundation, use B_c/2.0 in. minimum, not less than 3.0 in. For rock foundation, use B_c in. minimum, not less than 6.0 in.	90% SW or 95% ML	85% SW, 90% ML, or 95% CL
Type 3—Installations are available for horizontal elliptical, vertical elliptical, and arch pipe	For soil foundation, use B_c/2.0 in. minimum, not less than 3.0 in. For rock foundation, use B_c in. minimum, not less than 6.0 in.	85% SW, 90% ML, or 95% CL	85% SW, 90% ML, or 95% CL

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12.10.2.1—Standard Installations

Replace Table 12.10.2.1-2 with the following:

Table 12.10.2.1-2—Standard Trench Installation Soils and Minimum Compaction Requirements

Installation Type	Bedding Thickness	Haunch and Outer Bedding	Lower Side
Type 1	For soil foundation, use B_c/2.0 in. minimum, not less than 3.0 in. For rock foundation, use B_c in. minimum, not less than 6.0 in.	95% SW	90% SW, 95% ML, or 100% CL, or natural soils of equal firmness
Type 2—Installations are available for horizontal elliptical, vertical elliptical, and arch pipe	For soil foundation, use B_c/2.0 in. minimum, not less than 3.0 in. For rock foundation, use B_c in. minimum, not less than 6.0 in.	90% SW or 95% ML	85% SW, 90% ML, 95% CL, or natural soils of equal firmness
Type 3—Installations are available for horizontal elliptical, vertical elliptical, and arch pipe	For soil foundation, use B_c/4.0 in. minimum, not less than 3.0 in. For rock foundation, use B_c in. minimum, not less than 6.0 in.	85% SW, 90% ML or 95% CL	85% SW, 90% ML, 95% CL, or natural soils of equal firmness

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12.10.2.1—Standard Installations

Replace Table 12.10.2.1-3 with the following:

Table 12.10.2.1-3—Coefficients for Use with Figure 12.10.2.1-1

	Installation Type		
	1	2	3
VAF	1.35	1.40	1.40
HAF	0.45	0.40	0.37
A1	0.62	0.85	1.05
A2	0.73	0.55	0.35
A3	1.35	1.40	1.40
A4	0.19	0.15	0.10
iA5	0.08	0.08	0.10
A6	0.18	0.17	0.17
a	1.40	1.45	1.45
b	0.40	0.40	0.36
c	0.18	0.19	0.20
e	0.08	0.10	0.12
f	0.05	0.05	0.05
u	0.80	0.82	0.85
v	0.80	0.70	0.60

12.10.2.3—Live Loads

Add the following to the end of the article:

The unfactored live load W_L shall be determined as:

$$W_L = P_L \times C_L \times B_C \qquad (12.10.2.3\text{-}1)$$

where:

W_L = live load on pipe (kip/ft)
P_L = live load pressure as defined in Eq. 3.6.1.2.6b-7 (ksf)

$$C_L = \frac{L_w}{B_c} \leq 1.0$$

L_w = live load distribution length in the circumferential direction as specified in Article 3.6.1.2.6 (ft)

Add an additional article with a paragraph and three figures:

12.10.2.4—Non-Standard Installations

When non-standard installations are used, the unfactored earth pressure on the structure shall be the prism of earth weight (prism load) above the pipe multiplied by a soil-structure interaction factor. The unit weight of soil shall not be less than 120 lb/cu. ft. In the case that a more accurate estimate of the unit weight of soil is required, the maximum unit weight can be verified through a lab test by geotechnical engineers. Pressure distribution shall be determined by an appropriate soil-structure interaction analysis. Acceptable pressure distributions for non-standard installations are: the Olander/Modified Olander Radial Pressure Distribution - see Figure 12.10.2.4-1(a), or the Paris/Manual Uniform Pressure Distribution - see Figure 12.10.2.4-1(b). For bedding angles and lateral pressures used with the latter distributions see Figure 12.10.2.4-2 and Figure 12.10.2.4-3. Other methods for determining total load and pressure distribution may be used, if based on successful design practice or tests that reflect the appropriate design condition.

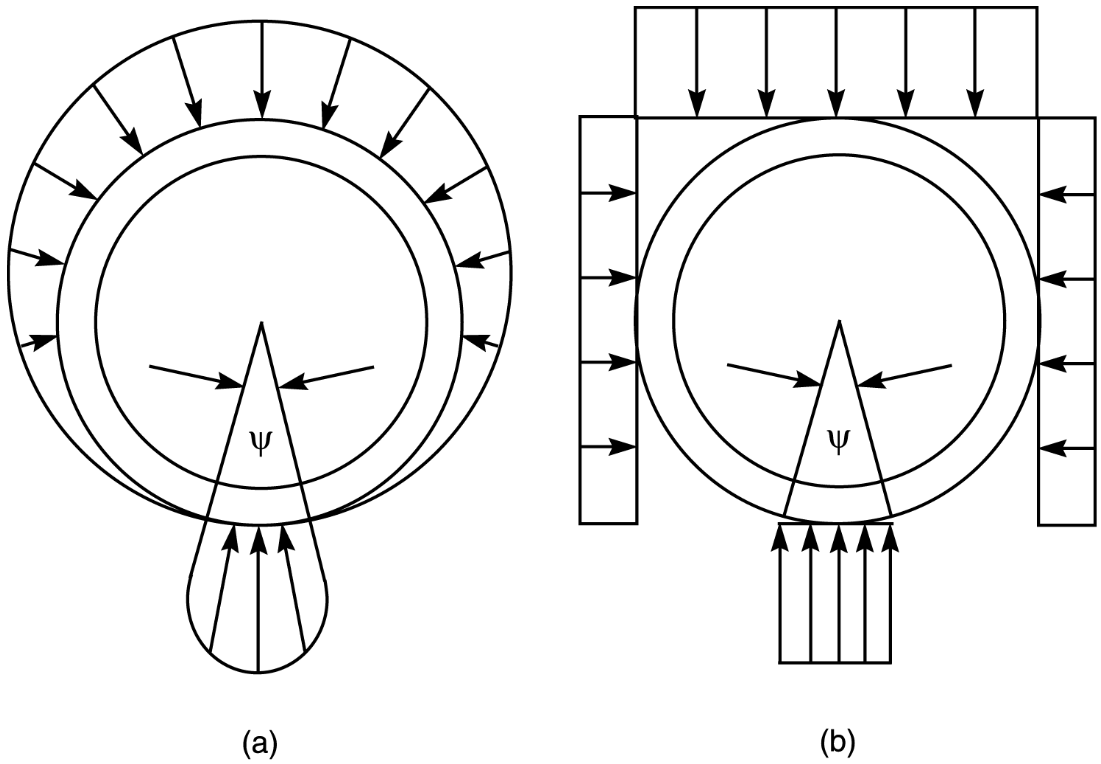


Figure 12.10.2.4-1(a)—Olander/Modified Olander Radial Pressure Distribution Diagram
Figure 12.10.2.4-1(b)—Paris/Manual Uniform Pressure Distribution Diagram

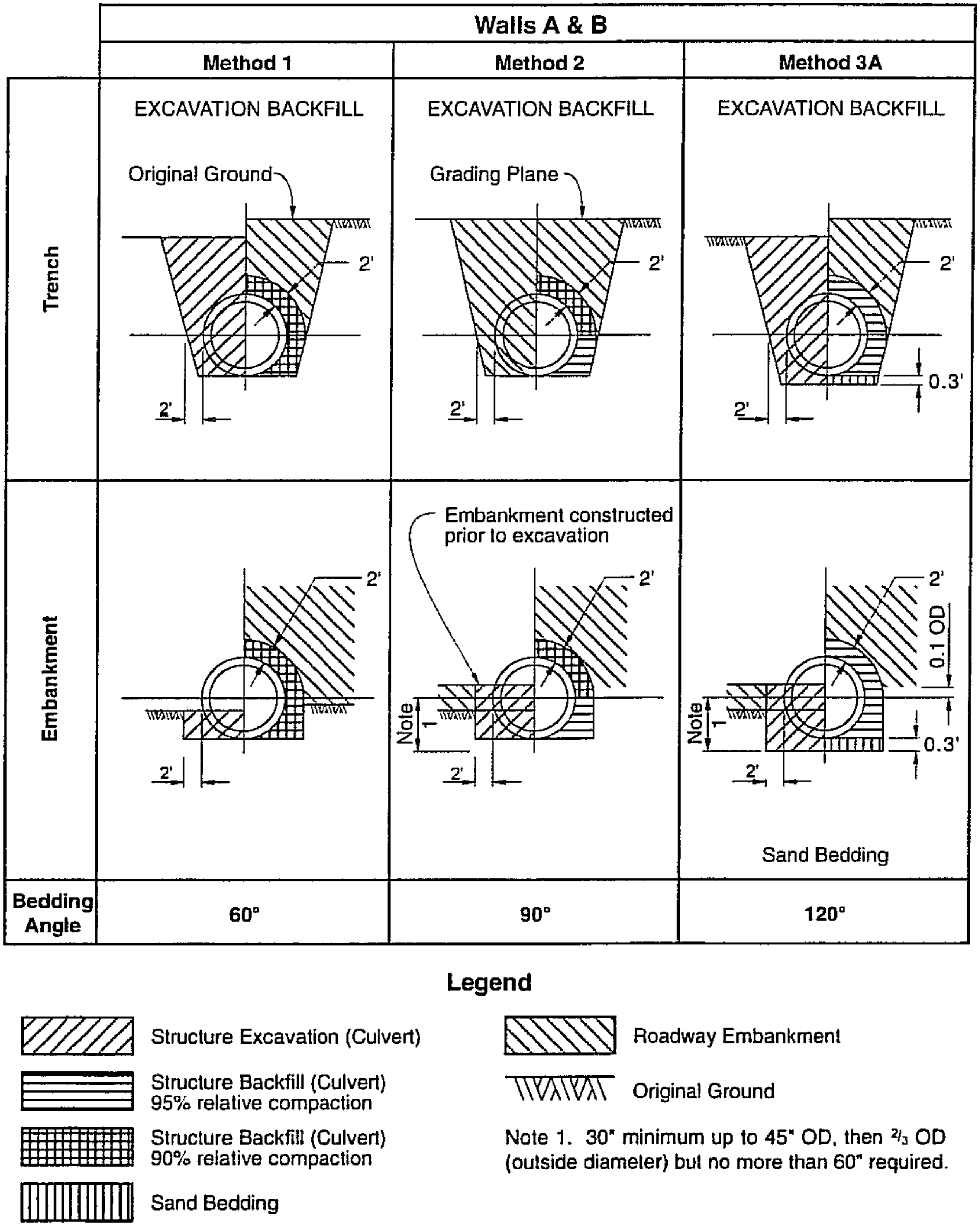
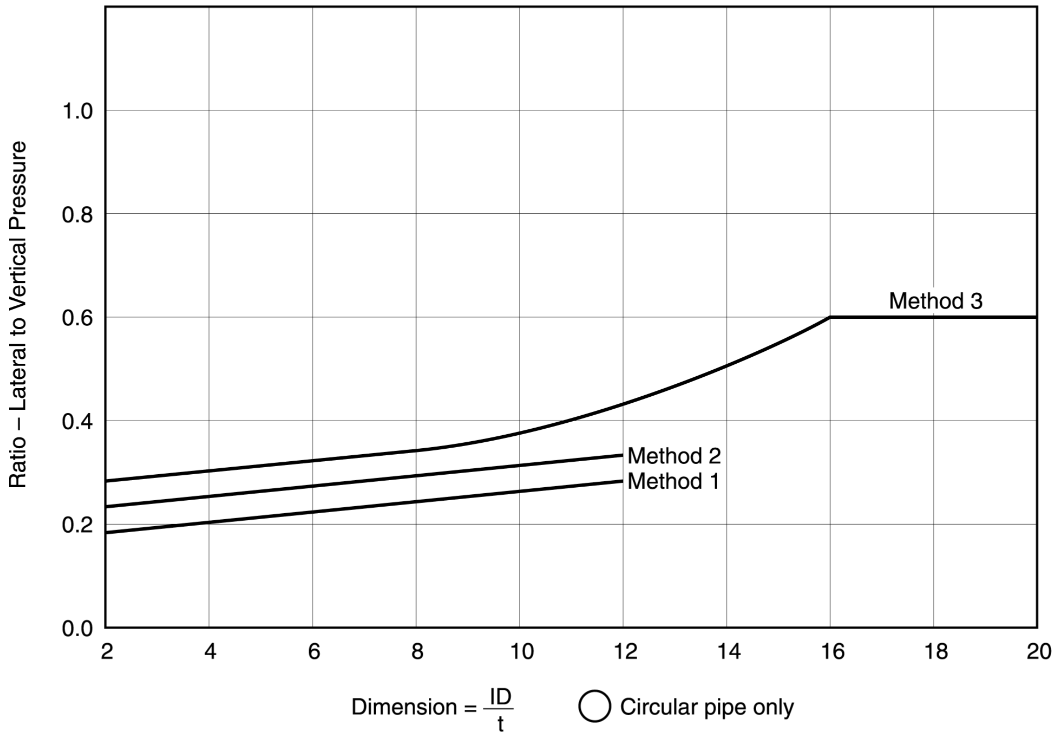


Figure 12.10.2.4-2—Trench and Embankment Backfill Bedding Angles



LATERAL PRESSURE

Legend
ID = inside diameter of pipe, t = wall thickness of pipe

Figure 12.10.2.4-3—Non-Standard Installation Lateral Pressures Distribution

12.10.4.3—Indirect Design Method

12.10.4.3.1—Bearing Resistance

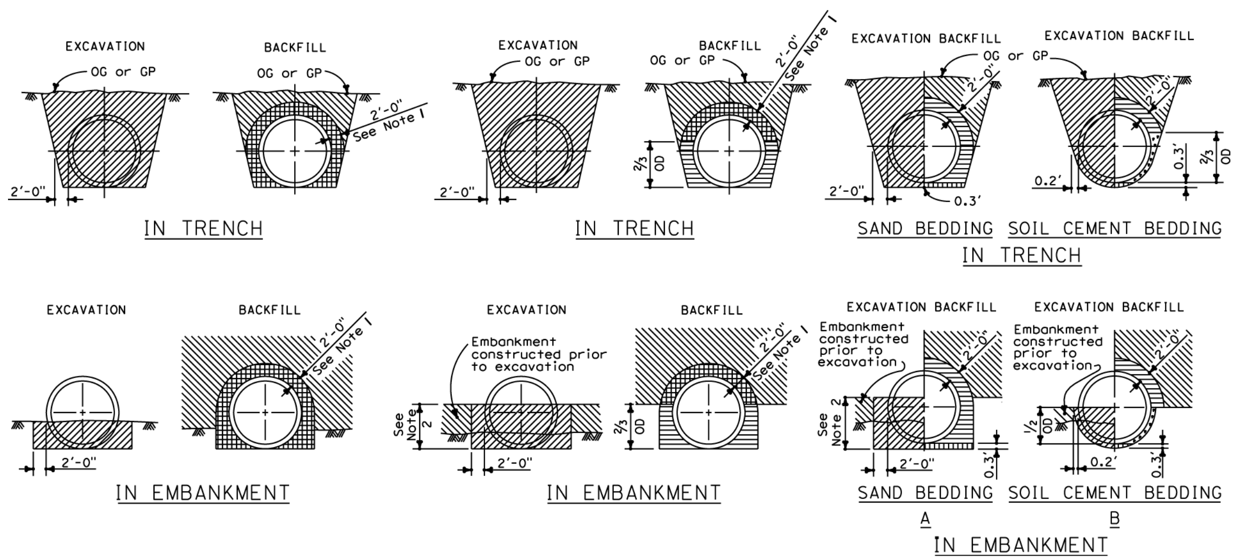
Add a new 2nd paragraph, a figure and a table after the 1st paragraph as follows:

Reinforced concrete pipe culvert excavation/backfill criteria for Caltrans non-standard installation Methods 1, 2, and 3 are summarized in Figure 12.10.4.3.1-1 below. Associated fill heights and pipe classes are indicated in the adjacent D-Load Overfill Table 12.10.4.3.1-1. Pipe backfill is to be placed over the full width of excavation except where dimensions are shown for specific backfill width or thickness. Dimensions shown are minimums.

C12.10.4.3.1—Bearing Resistance

Add a new paragraph to the end of the commentary as follows:

Above information is based on Caltrans research (*Transportation Record* 878) and Caltrans *Standard Plans* 2015 A62D



METHOD 1 **METHOD 2** **METHOD 3**

Notes:

1. Embankment compaction requirements govern over the 90% relative compaction backfill requirement within 2′-6″ of finished grade.
2. Embankment height prior to excavation for installation of all classes of RCP under Method 2 and Method 3A shall be as follows:

Pipe sizes 1′-0″ to 3′-6″ H = 2′-6″
Pipe sizes 4′-0″ to 7′-0″ H = 2/3 OD
Pipe sizes larger than 7′-0″ H = 5′-0″

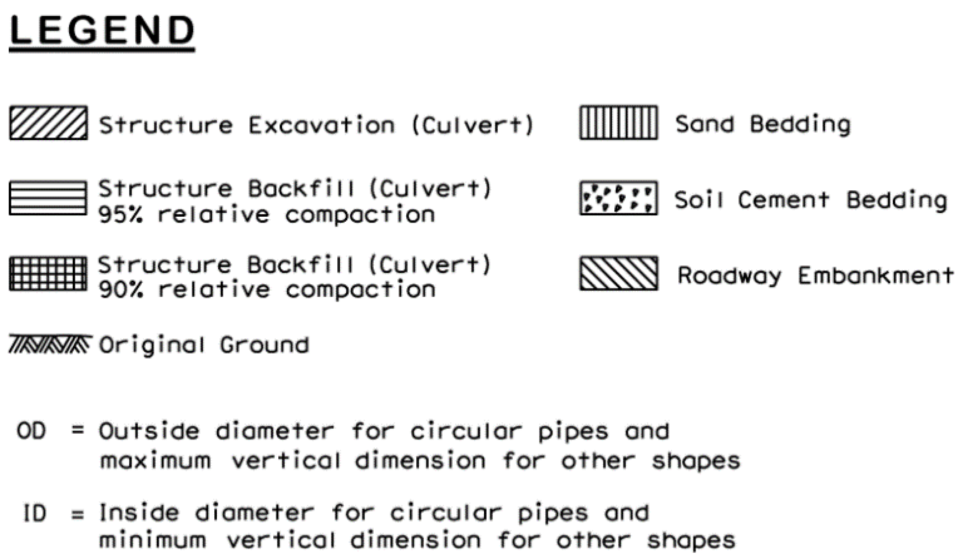


Figure 12.10.4.3.1-1—Non-Standard Installation Excavation and Backfill

Table 12.10.4.3.1-1—D-Load Overfill Table

MINIMUM ALLOWABLE CLASSES OF RCP FOR METHOD 1

COVER	MINIMUM CLASS AND D-LOAD
5.9′	Class II 1000D
6.0′ - 7.9′	Class III 1350D
8.0′ - 9.9′	Class III Special 1700D
10.0′ - 11.9′	Class IV 2000D
12.0′ - 13.9′	Class IV Special 2500D
14.0′ - 16.9′	Class V 3000D
17.0′ - 20.0′	Class V Special 3600D

METHOD 1

MINIMUM ALLOWABLE CLASSES OF RCP FOR METHOD 2

COVER	MINIMUM CLASS AND D-LOAD
15.9′	Class II 1000D
16.0′ - 19.9′	Class III 1350D
20.0′ - 24.9′	Class III Special 1700D
25.0′ - 27.9′	Class IV 2000D
28.0′ - 34.9′	Class IV Special 2500D
35.0′ - 41.9′	Class V 3000D
42.0′ - 50.0′	Class V Special 3600D

METHOD 2

MINIMUM ALLOWABLE CLASSES OF RCP FOR METHOD 3

COVER	MINIMUM CLASS AND D-LOAD
25.9′	Class II 1000D
26.0′ - 31.9′	Class III 1350D
32.0′ - 37.9′	Class III Special 1700D
38.0′ - 44.9′	Class IV 2000D
45.0′ - 55.9′	Class IV Special 2500D
56.0′ - 67.9′	Class V 3000D
68.0′ - 80.0′	Class V Special 3600D

METHOD 3

REINFORCED CONCRETE PIPE

Note: The maximum size for all classes or RCP placed under Method 1 is 78″ ID.

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12.10.4.3.2a—Earth Load Bedding Factor for Circular Pipe

Replace Table 12.10.4.3.2a-1 with the following:

Table 12.10.4.3.2a-1—Bedding Factors for Circular Pipe

Pipe Diameter, in.	Standard Installations		
	Type 1	Type 2	Type 3
12	4.4	3.2	2.5
24	4.2	3.0	2.4
36	4.0	2.9	2.3
72	3.8	2.8	2.2
144	3.6	2.8	2.2

12.10.4.3.2c—Live Load Bedding Factors

Replace the entire article with the following:

The bedding factor B_{FLL} for live load, W_L, for circular, arch, and elliptical pipe shall be taken as specified in Table 12.10.4.3.2c-1. For pipe diameters not listed in Table 12.10.4.3.2c-1, the bedding factor may be determined by interpolation.

C12.10.4.3.2c

Replace the commentary with the following:

When the live load becomes essentially uniform across the top of the pipe, the basic live load bedding factor is 2.2. For larger pipe this occurs at a greater depth. For shallow depths the live load will be concentrated over only a small portion of a large diameter pipe, thus resulting in a higher moment (lower bedding factor) for the same total load.

Table 12.10.4.3.2c-1—Bedding Factors, B_{FLL}

Fill Height, ft	Pipe Diameter, in.										
	12	24	36	48	60	72	84	96	108	120	144
0.5	2.2	1.7	1.4	1.3	1.3	1.1	1.1	1.1	1.1	1.1	1.1
1.0	2.2	2.2	1.7	1.5	1.4	1.3	1.3	1.3	1.1	1.1	1.1
1.5	2.2	2.2	2.1	1.8	1.5	1.4	1.4	1.3	1.3	1.3	1.1
2.0	2.2	2.2	2.2	2.0	1.8	1.5	1.5	1.4	1.4	1.3	1.3
2.5	2.2	2.2	2.2	2.2	2.0	1.8	1.7	1.5	1.4	1.4	1.3
3.0	2.2	2.2	2.2	2.2	2.2	2.2	1.8	1.7	1.5	1.5	1.4
3.5	2.2	2.2	2.2	2.2	2.2	2.2	1.9	1.8	1.7	1.5	1.4
4.0	2.2	2.2	2.2	2.2	2.2	2.2	2.1	1.9	1.8	1.7	1.5
4.5	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.0	1.9	1.8	1.7
5.0	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.0	1.9	1.8
5.5	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.0	1.9
6.0	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.1	2.0
6.5	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2	2.2