

# **LRFD FILL HEIGHT TABLES**

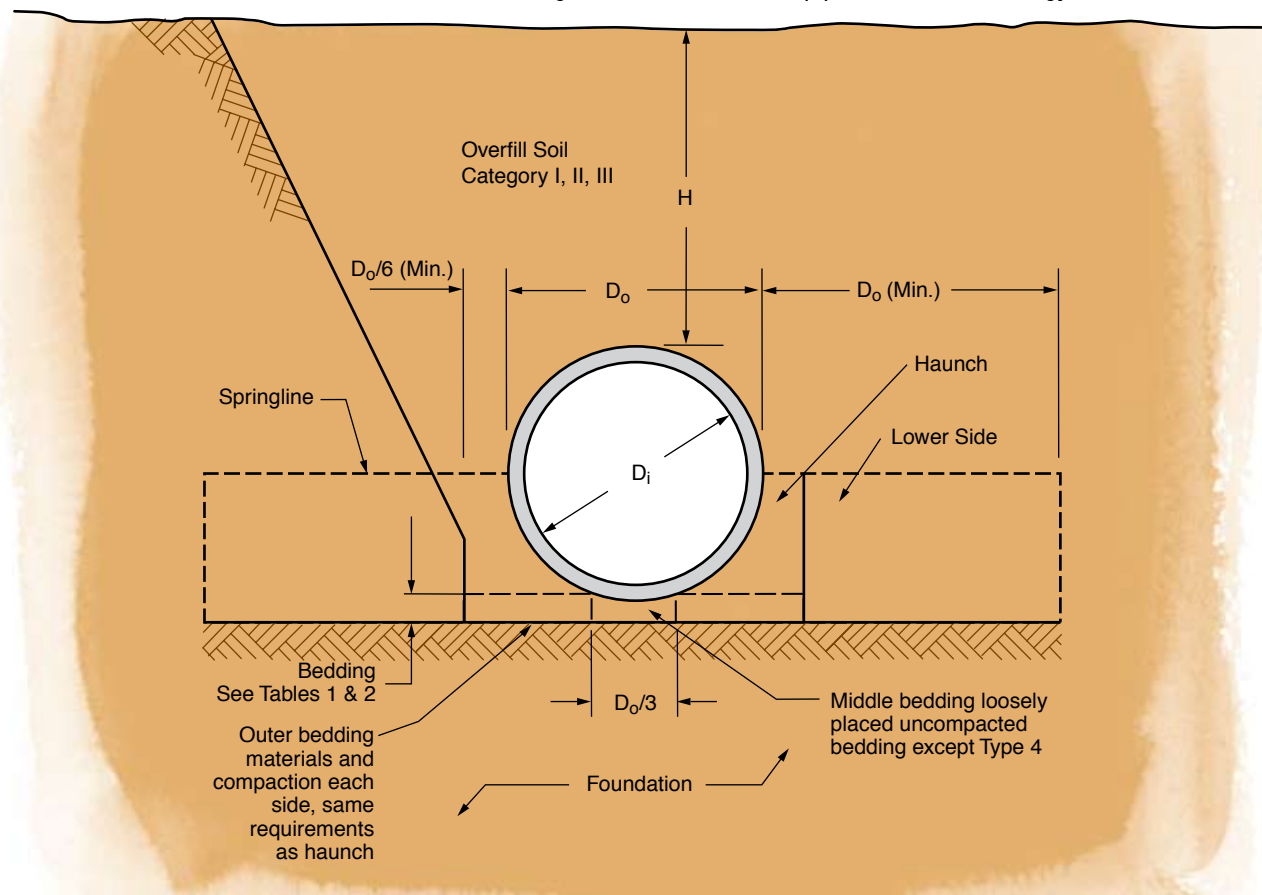
## **FOR CONCRETE PIPE**



American  
**Concrete Pipe**  
Association

## Standard Trench/Embankment Installation

Concrete pipe should be installed in accordance with the AASHTO LRFD Bridge Construction Specifications, Section 27 or ASTM C1479. Figure 1 shows the basic pipe and soil terminology.



There are four types of Standard Installations, each with its own soil and compaction requirements. Type 1 bedding provides the most support using highly compacted granular material, while Type 4 provides for less support allowing the use of silts and clay soils with little or no compaction. These four choices provide flexibility and versatility for the designer and contractor, as well as performance and economy for the owner that are not available with other types of pipe.

The soil and compaction requirements are provided in Table 1. Table 2 shows the equivalent soil designations per the Unified Soil Classification System (USCS) and AASHTO.

To facilitate your selection of the proper reinforced concrete pipe using the most beneficial Standard Installation for the conditions at the site, fill height tables are provided on the following pages. The required 0.01 inch crack D-Loads in units of lbs per linear foot per foot of diameter are provided numerically and the class of pipe per ASTM C76 (AASHTO M 170) meeting this requirement is designated by color of the cell.

**Table 1: Standard Installation Soils and Minimum Compaction Requirements**

Installation Type	Bedding Thickness	Haunch and Outer Bedding	Lower Side
Type 1	D <sub>o</sub> /24 minimum, not less than 3" (75 mm) If rock foundation, use D <sub>o</sub> /12 minimum, not less than 6" (150 mm)	95% Category I	90% Category I, 95% Category II, or 100% Category III
Type 2	D <sub>o</sub> /24 minimum, not less than 3" (75 mm) If rock foundation, use D <sub>o</sub> /12 minimum, not less than 6" (150 mm)	90% Category I or 95% Category II	85% Category I, 90% Category II, or 95% Category III
Type 3	D <sub>o</sub> /24 minimum, not less than 3" (75 mm) If rock foundation, use D <sub>o</sub> /12 minimum, not less than 6" (150 mm)	85% Category I, 90% Category II, or 95% Category III	85% Category I, 90% Category II, or 95% Category III
Type 4	No bedding required except if rock foundation, use D <sub>o</sub> /12 minimum, not less than 6" (150 mm)	No compaction required, except if Category III, use 85%	No compaction required, except if Category III, use 85%

Reference: ASCE 15-98, "Standard Practice for Direct Design of Buried Precast Concrete Pipe Using Standard Installations (SIDD)", 1998.

**Table 3: Reinforced Pipe Classes for 0.01 inch Crack Per ASTM C 76 (lbs/ft/ft)**

Class I	≤ 800
Class II	≤ 1000
Class III	≤ 1350
Class IV	≤ 2000
Class V	≤ 3000
Special Design	> 3000

**Table 2: Equivalent USCS and AASHTO Soil Classifications for Standard Installation Soil Designations**

Representative Soil Types			Percent Compaction	
SIDD	USCS	AASHTO	Standard Proctor	Modified Proctor
Gravelly Sand (Category I)	SW, SP, GW, GP	A1, A3	100	95
			95	90
			90	85
			85	80
			80	75
Sandy Silt (Category II)	GM, SM, ML, Also GC, SC with less than 20% passing #200 sieve	A2, A4	100	95
			95	90
			90	85
			85	80
			80	75
Silty Clay (Category III)	CL, MH, GC, SC	A5, A6	100	90
			95	85
			90	80
			85	75
			80	70
CH		A7	100	90
			95	85
			90	80
			45	40

Reference: ASCE 15-98, "Standard Practice for Direct Design of Buried Precast Concrete Pipe Using Standard Installations (SIDD)", 1998.

NOTES:

1. Compaction and soil symbols – i.e. "95% Category I" refers to Category I soil material with a minimum Standard Proctor compaction of 95%. See Table 2 for equivalent Modified Proctor values.
2. Soil in the outer bedding, haunch, and lower side zones shall be compacted to at least the same compaction as the majority of soil in the overfill zone.



The following Fill Height Tables have been developed by the American Concrete Pipe Association (ACPA) using the indirect design method in accordance with Section 12.10.4.3 of the AASHTO LRFD Bridge Design Specification, 4th Edition, 2007 with 2008 Interim. Live load was distributed through the pipe in accordance with Chapter 4 of the ACPA Concrete Pipe Design Manual.

**Fill Height Tables are based on:**

1.  $\gamma_s = 120$  pcf
2. AASHTO HL-93 live load
3. Positive Projecting Embankment Condition - this gives conservative results in comparison to trench conditions
4. A Type 1 installation requires greater soil stiffness from the surrounding soils than the Type 2, 3, and 4 installations, and is thus harder to achieve.

Therefore, field verification of soil properties and compaction levels should be performed.

**D-Load (lb/ft/ft) for Type 1 Bedding**

Class I	Class IV
Class II	Class V
Class III	Special Design

Fill Height (feet)															
Pipe i.d. (inches)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
12	1850	1100	800	700	650	625	650	675	700	750	800	825	900	950	1000
15	1725	1025	775	675	625	625	625	650	700	725	775	825	875	925	975
18	1550	975	750	650	600	600	625	650	675	725	775	800	875	925	975
21	1300	950	725	625	600	600	625	650	675	725	750	800	875	925	950
24	1150	925	700	625	600	600	625	650	675	725	750	800	875	925	950
27	1025	900	700	625	600	600	625	650	675	725	750	800	875	925	975
30	975	825	675	625	600	600	625	650	675	725	775	825	875	925	975
33	925	775	675	600	600	600	625	650	700	725	775	825	875	925	975
36	900	725	675	600	600	600	625	650	700	725	775	825	900	950	975
42	825	650	650	600	600	600	625	650	700	750	775	825	900	950	1000
48	875	650	600	600	600	600	625	675	700	750	800	825	900	950	1000
54	825	650	550	600	600	600	650	675	725	750	800	875	925	950	1000
60	825	650	550	550	600	625	650	675	725	775	800	875	925	975	1025
66	825	675	550	550	600	625	650	700	725	775	825	900	925	975	1025
72	800	700	550	550	600	625	675	700	750	775	825	900	950	1000	1050
78	725	675	600	600	600	625	675	700	750	800	875	900	950	1000	1050
84	700	650	625	600	625	650	675	725	750	800	875	925	975	1025	1075
90	650	650	625	600	625	650	675	725	775	825	875	925	975	1025	1075
96	625	625	625	625	625	650	700	725	775	825	900	950	1000	1050	1100
102	625	625	625	625	650	675	700	750	800	825	900	950	1000	1050	1100
108	650	600	625	625	650	675	725	750	800	875	925	975	1025	1075	1150

**Fill Height Tables are based on:**

1.  $\gamma_s = 120$  pcf
2. AASHTO HL-93 live load
3. Positive Projecting Embankment Condition -  
this gives conservative results in comparison to trench conditions
4. A Type 1 installation requires greater soil stiffness from the surrounding soils than the Type 2, 3, and 4 installations, and is thus harder to achieve.  
Therefore, field verification of soil properties and compaction levels should be performed.

**D-Load (lb/ft/ft) for Type 1 Bedding**

	Class I		Class IV
	Class II		Class V
	Class III		Special Design

Fill Height (feet)															
Pipe i.d. (inches)	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
12	1050	1100	1175	1225	1275	1325	1375	1450	1500	1550	1600	1650	1725	1775	1825
15	1025	1075	1150	1200	1250	1300	1350	1425	1475	1525	1575	1625	1700	1750	1800
18	1000	1050	1150	1175	1225	1275	1325	1375	1450	1525	1550	1600	1650	1725	1775
21	1000	1050	1150	1175	1225	1275	1325	1375	1450	1525	1550	1600	1650	1725	1750
24	1000	1050	1150	1175	1225	1275	1325	1375	1450	1525	1550	1575	1625	1700	1750
27	1000	1050	1150	1175	1225	1275	1325	1375	1450	1525	1550	1600	1650	1725	1775
30	1025	1050	1150	1175	1225	1275	1325	1375	1450	1525	1550	1600	1650	1725	1775
33	1025	1075	1150	1200	1250	1275	1325	1375	1450	1525	1550	1600	1650	1725	1775
36	1025	1075	1150	1200	1250	1300	1350	1425	1475	1525	1575	1625	1700	1750	1800
42	1025	1075	1150	1200	1250	1300	1350	1425	1475	1525	1575	1625	1700	1750	1800
48	1050	1100	1175	1225	1275	1325	1350	1425	1475	1525	1575	1625	1700	1750	1800
54	1050	1100	1175	1225	1275	1325	1375	1450	1500	1550	1600	1650	1725	1775	1825
60	1075	1150	1200	1250	1300	1325	1375	1450	1500	1550	1600	1650	1750	1800	1850
66	1075	1150	1200	1250	1300	1350	1425	1475	1525	1575	1625	1700	1750	1800	1850
72	1100	1175	1225	1275	1325	1375	1450	1500	1550	1600	1650	1725	1775	1825	1875
78	1100	1175	1225	1275	1325	1375	1450	1500	1550	1600	1650	1725	1775	1825	1875
84	1150	1200	1250	1300	1350	1425	1475	1525	1575	1625	1700	1750	1800	1850	1900
90	1150	1200	1250	1300	1350	1425	1475	1525	1575	1625	1700	1750	1800	1850	1900
96	1175	1225	1275	1325	1375	1450	1500	1550	1600	1650	1725	1775	1825	1875	1925
102	1175	1225	1275	1325	1375	1450	1500	1550	1600	1650	1725	1775	1825	1900	1975
108	1200	1250	1300	1350	1425	1475	1525	1575	1625	1700	1750	1800	1850	1900	1975

**Fill Height Tables are based on:**

1.  $\gamma_s = 120$  pcf
2. AASHTO HL-93 live load
3. Positive Projecting Embankment Condition -  
this gives conservative results in comparison to trench conditions
4. A Type 1 installation requires greater soil stiffness from the surrounding soils than the Type 2, 3, and 4 installations, and is thus harder to achieve.  
Therefore, field verification of soil properties and compaction levels should be performed.

**D-Load (lb/ft/ft) for Type 1 Bedding**

	Class I		Class IV
	Class II		Class V
	Class III		Special Design

Fill Height (feet)															
Pipe i.d. (inches)	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
12	1900	1975	2025	2075	2125	2175	2250	2300	2375	2425	2475	2550	2600	2650	2700
15	1850	1900	1975	2025	2075	2125	2175	2250	2300	2650	2400	2450	2550	2600	2650
18	1825	1875	1925	2000	2050	2100	2150	2200	2275	2625	2375	2425	2475	2550	2600
21	1800	1850	1900	1975	2025	2100	2150	2200	2275	2625	2375	2425	2475	2550	2600
24	1800	1850	1900	1975	2025	2075	2125	2175	2250	2600	2350	2400	2450	2525	2575
27	1825	1875	1925	2000	2050	2100	2150	2200	2275	2625	2375	2425	2475	2550	2600
30	1825	1875	1925	2000	2050	2100	2150	2200	2275	2625	2375	2425	2475	2550	2600
33	1825	1875	1925	2000	2050	2100	2150	2200	2275	2625	2375	2425	2475	2575	2625
36	1850	1900	1975	2025	2075	2125	2175	2250	2300	2650	2400	2450	2525	2575	2625
42	1850	1900	1975	2025	2075	2125	2175	2250	2300	2650	2400	2450	2525	2575	2625
48	1850	1900	1975	2025	2100	2150	2200	2275	2325	2675	2425	2475	2550	2600	2650
54	1875	1925	2000	2050	2100	2150	2200	2275	2325	2675	2425	2475	2550	2600	2650
60	1900	1975	2025	2075	2125	2175	2250	2300	2350	2400	2450	2525	2575	2625	2675
66	1900	1975	2025	2075	2125	2175	2250	2325	2375	2425	2475	2550	2600	2650	2700
72	1925	2000	2050	2100	2150	2200	2275	2325	2375	2425	2525	2575	2625	2675	2725
78	1925	2025	2075	2125	2175	2250	2300	2350	2400	2450	2525	2575	2625	2675	2725
84	1975	2025	2075	2125	2175	2250	2300	2350	2400	2475	2550	2600	2650	2700	2750
90	2000	2050	2100	2150	2200	2275	2325	2375	2425	2475	2550	2600	2650	2700	2750
96	2000	2050	2100	2150	2200	2275	2325	2400	2450	2525	2575	2625	2675	2725	2800
102	2025	2075	2125	2175	2250	2300	2350	2400	2450	2525	2575	2650	2700	2750	2825
108	2025	2075	2125	2200	2275	2325	2375	2425	2475	2550	2600	2650	2700	2750	2825

**Fill Height Tables are based on:**

1.  $\gamma_s = 120$  pcf
2. AASHTO HL-93 live load
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**D-Load (lb/ft/ft) for Type 1 Bedding**

	Class I		Class IV
	Class II		Class V
	Class III		Special Design

Fill Height (feet)															
Pipe i.d. (inches)	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
12	2750	2850	2900	2950	3000	3075	3125	3175	3250	3300	3375	3400	3475	3525	3575
15	2700	2750	2825	2875	2925	2975	3025	3100	3150	3200	3250	3350	3400	3450	3500
18	2650	2700	2750	2825	2875	2950	3000	3075	3125	3175	3225	3275	3350	3400	3450
21	2650	2700	2750	2825	2875	2925	2975	3025	3100	3150	3200	3250	3350	3375	3425
24	2625	2675	2725	2825	2875	2925	2975	3025	3100	3150	3200	3250	3350	3375	3425
27	2650	2700	2750	2825	2875	2925	2975	3025	3100	3150	3200	3250	3350	3375	3425
30	2650	2700	2750	2825	2875	2925	2975	3025	3100	3150	3200	3250	3350	3375	3425
33	2675	2725	2800	2850	2900	2950	3000	3050	3125	3175	3225	3275	3350	3400	3450
36	2675	2725	2800	2850	2900	2950	3025	3100	3150	3200	3250	3300	3375	3425	3475
42	2675	2725	2800	2875	2925	2975	3025	3100	3150	3200	3250	3300	3375	3425	3475
48	2700	2750	2825	2875	2925	2975	3025	3100	3150	3200	3250	3300	3375	3425	3475
54	2700	2750	2825	2875	2950	3000	3075	3125	3175	3225	3275	3350	3400	3450	3500
60	2725	2800	2850	2900	2950	3000	3075	3125	3175	3225	3300	3375	3425	3475	3525
66	2750	2825	2875	2925	2975	3025	3100	3150	3200	3250	3300	3375	3450	3500	3550
72	2800	2850	2900	2950	3000	3075	3125	3175	3225	3275	3350	3425	3475	3525	3575
78	2800	2850	2900	2975	3025	3100	3150	3200	3250	3300	3375	3425	3475	3525	3575
84	2825	2875	2925	2975	3025	3100	3150	3200	3250	3350	3400	3450	3500	3550	3625
90	2850	2900	2950	3000	3075	3125	3175	3225	3275	3350	3400	3450	3500	3575	3650
96	2850	2900	2950	3000	3075	3150	3200	3250	3300	3375	3425	3475	3525	3575	3650
102	2875	2925	2975	3025	3100	3150	3200	3250	3350	3400	3450	3500	3550	3625	3675
108	2900	2950	3000	3075	3125	3175	3225	3275	3350	3400	3450	3525	3575	3650	3700

**Fill Height Tables are based on:**

1.  $\gamma_s = 120$  pcf
2. AASHTO HL-93 live load
3. Positive Projecting Embankment Condition -  
this gives conservative results in comparison to trench conditions

**D-Load (lb/ft/ft) for Type 2 Bedding**

	Class I		Class IV
	Class II		Class V
	Class III		Special Design

Pipe i.d. (inches)	Fill Height (feet)														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
12	1700	1050	800	725	700	700	750	800	850	900	975	1050	1100	1175	1250
15	1575	975	775	700	675	700	725	775	825	900	950	1025	1075	1150	1225
18	1450	950	750	675	650	675	725	775	825	875	950	1025	1075	1150	1225
21	1225	900	725	675	650	675	725	775	825	875	950	1025	1075	1150	1225
24	1050	875	725	650	650	675	725	775	825	900	950	1025	1075	1150	1225
27	975	850	700	650	650	675	725	775	825	900	950	1025	1075	1150	1225
30	925	825	700	650	650	675	725	775	825	900	950	1025	1100	1150	1225
33	875	750	675	650	650	675	725	775	825	900	950	1025	1100	1150	1225
36	850	700	675	650	650	675	725	775	850	900	975	1025	1100	1175	1225
42	825	650	650	650	650	675	725	775	850	900	975	1050	1100	1175	1250
48	825	650	625	650	650	700	750	800	850	925	975	1050	1125	1175	1250
54	800	650	600	650	650	700	750	800	875	925	1000	1050	1125	1200	1275
60	800	675	600	625	675	700	750	825	875	950	1000	1075	1150	1200	1275
66	800	700	600	625	675	725	775	825	900	950	1025	1075	1150	1225	1300
72	775	725	600	650	675	725	775	850	900	975	1025	1100	1175	1225	1300
78	725	700	625	650	675	725	800	850	900	975	1050	1100	1175	1250	1325
84	675	675	650	650	700	750	800	850	925	975	1050	1125	1175	1250	1325
90	650	650	650	675	700	750	800	875	925	1000	1050	1125	1200	1275	1325
96	625	650	650	675	700	750	825	875	950	1000	1075	1150	1200	1275	1350
102	650	650	650	700	725	775	825	875	950	1025	1075	1150	1225	1275	1350
108	650	625	675	700	725	775	825	900	950	1025	1100	1150	1225	1300	1375



**Fill Height Tables are based on:**

1.  $\gamma_s = 120$  pcf
2. AASHTO HL-93 live load
3. Positive Projecting Embankment Condition -  
this gives conservative results in comparison to trench conditions

**D-Load (lb/ft/ft) for Type 2 Bedding**

	Class I		Class IV
	Class II		Class V
	Class III		Special Design

Fill Height (feet)															
Pipe i.d. (inches)	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
12	1325	1400	1475	1525	1600	1675	1750	1825	1900	1975	2050	2125	2200	2275	2350
15	1300	1375	1425	1500	1575	1650	1725	1800	1875	1950	2025	2075	2150	2225	2300
18	1275	1375	1425	1500	1575	1625	1700	1775	1850	1925	2025	2075	2150	2200	2275
21	1275	1375	1425	1500	1550	1625	1700	1775	1850	1925	2025	2075	2125	2200	2275
24	1300	1375	1425	1500	1575	1650	1700	1800	1850	1925	2025	2075	2150	2225	2300
27	1300	1375	1425	1500	1575	1650	1700	1775	1850	1925	2025	2075	2150	2225	2275
30	1300	1375	1425	1500	1575	1650	1725	1775	1850	1925	2025	2075	2150	2225	2300
33	1300	1375	1450	1500	1575	1650	1725	1800	1875	1925	2025	2075	2150	2225	2300
36	1300	1375	1450	1525	1600	1650	1725	1800	1875	1950	2025	2100	2150	2225	2300
42	1300	1375	1450	1525	1600	1675	1725	1800	1875	1950	2025	2100	2175	2225	2300
48	1325	1400	1450	1525	1600	1675	1750	1925	1875	1950	2025	2100	2175	2250	2325
54	1325	1400	1475	1550	1600	1675	1750	1825	1900	1975	2050	2100	2175	2250	2325
60	1350	1425	1475	1550	1625	1700	1775	1850	1900	1975	2050	2125	2200	2275	2350
66	1350	1425	1500	1575	1650	1725	1775	1850	1925	2000	2075	2150	2225	2275	2350
72	1375	1450	1525	1575	1650	1725	1800	1875	1950	2025	2100	2150	2225	2300	2375
78	1375	1450	1525	1600	1675	1725	1800	1875	1950	2025	2100	2175	2250	2300	2375
84	1400	1475	1525	1600	1675	1750	1815	1900	1950	2025	2100	2175	2250	2325	2400
90	1400	1475	1550	1625	1675	1750	1825	1900	1975	2050	2100	2175	2250	2325	2400
96	1425	1475	1550	1625	1700	1775	1825	1900	1975	2050	2125	2200	2250	2325	2400
102	1425	1500	1575	1625	1700	1775	1850	1925	1975	2050	2125	2200	2275	2350	2425
108	1425	1500	1575	1650	1725	1775	1850	1925	2000	2075	2150	2200	2275	2350	2425

**Fill Height Tables are based on:**

1.  $\gamma_s = 120$  pcf
2. AASHTO HL-93 live load
3. Positive Projecting Embankment Condition -  
this gives conservative results in comparison to trench conditions

**D-Load (lb/ft/ft) for Type 2 Bedding**

Class I	Class IV
Class II	Class V
Class III	Special Design

Fill Height (feet)										
Pipe i.d. (inches)	31	32	33	34	35	36	37	38	39	40
12	2425	2500	2575	2650	2725	2800	2875	2950	3050	3125
15	2375	2450	2525	2600	2675	2750	2725	2900	2975	3050
18	2350	2425	2500	2575	2650	2725	2800	2875	2950	3025
21	2350	2425	2500	2575	2650	2725	2800	2850	2925	3025
24	2350	2425	2500	2575	2650	2725	2800	2875	2950	3025
27	2350	2425	2500	2575	2650	2725	2800	2875	2950	3025
30	2350	2425	2500	2575	2650	2725	2800	2875	2950	3025
33	2375	2450	2500	2575	2650	2725	2800	2875	2950	3025
36	2375	2450	2525	2600	2675	2750	2825	2875	2950	3025
42	2375	2450	2525	2600	2675	2750	2800	2875	2950	3025
48	2375	2450	2525	2600	2675	2750	2825	2900	2950	3025
54	2400	2475	2550	2625	2675	2750	2825	2900	2975	3050
60	2400	2475	2550	2625	2700	2775	2850	2925	3000	3050
66	2425	2500	2575	2650	2725	2800	2850	2925	3000	3075
72	2450	2525	2600	2675	2725	2800	2875	2950	3025	3100
78	2450	2525	2600	2675	2750	2825	2875	2950	3025	3100
84	2450	2525	2600	2675	2750	2825	2900	2975	3025	3100
90	2475	2550	2600	2675	2750	2825	2900	2975	3050	3125
96	2475	2550	2625	2700	2775	2825	2900	2975	3050	3125
102	2475	2550	2625	2700	2775	2850	2925	2975	3050	3125
108	2500	2575	2650	2700	2775	2850	2925	3000	3075	3150

**Fill Height Tables are based on:**

1.  $\gamma_s = 120$  pcf
2. AASHTO HL-93 live load
3. Positive Projecting Embankment Condition -  
this gives conservative results in comparison to trench conditions

**D-Load (lb/ft/ft) for Type 3 Bedding**

	Class I		Class IV
	Class II		Class V
	Class III		Special Design

Fill Height (feet)															
Pipe i.d. (inches)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
12	1735	1100	875	800	800	850	900	975	1050	1125	1225	1300	1400	1475	1575
15	1600	1025	850	775	775	825	875	950	1025	1100	1200	1275	1375	1450	1525
18	1475	1000	825	775	775	825	875	925	1025	1100	1175	1250	1375	1425	1525
21	1250	950	800	750	750	825	875	925	1025	1075	1175	1250	1375	1425	1500
24	1075	925	775	750	750	825	850	925	1025	1075	1175	1250	1375	1425	1500
27	1000	900	775	750	750	825	875	925	1025	1100	1175	1250	1375	1425	1500
30	950	875	775	750	750	825	875	950	1025	1100	1175	1275	1375	1425	1525
33	925	825	750	750	750	825	875	950	1025	1100	1200	1275	1375	1450	1525
36	900	775	750	750	775	825	875	950	1025	1125	1200	1275	1375	1450	1550
42	850	700	750	750	775	825	900	975	1050	1125	1200	1300	1375	1475	1550
48	875	700	700	750	775	825	900	975	1050	1150	1225	1300	1400	1475	1575
54	850	725	700	750	800	850	925	1000	1075	1150	1250	1350	1400	1500	1575
60	875	750	700	750	800	850	925	1000	1100	1175	1250	1350	1425	1525	1600
66	875	775	700	750	800	875	950	1025	1100	1200	1275	1350	1450	1550	1625
72	850	800	700	750	825	900	975	1050	1125	1200	1300	1375	1475	1550	1650
78	800	775	750	775	825	900	975	1050	1125	1225	1300	1400	1475	1575	1650
84	750	750	775	775	850	900	975	1075	1150	1225	1325	1400	1500	1575	1675
90	725	750	775	800	850	925	1000	1075	1150	1250	1325	1425	1500	1600	1675
96	700	750	775	825	875	925	1000	1100	1175	1250	1350	1425	1525	1600	1700
102	725	750	775	825	875	950	1025	1100	1200	1275	1350	1450	1525	1625	1700
108	725	725	800	825	900	950	1050	1125	1200	1275	1375	1450	1550	1625	1725

**Fill Height Tables are based on:**

1.  $\gamma_s = 120$  pcf
2. AASHTO HL-93 live load
3. Positive Projecting Embankment Condition -  
this gives conservative results in comparison to trench conditions

**D-Load (lb/ft/ft) for Type 3 Bedding**

	Class I		Class IV
	Class II		Class V
	Class III		Special Design

Pipe i.d. (inches)	Fill Height (feet)																
	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
12	1675	1775	1850	1950	2050	2150	2225	2325	2425	2525	2625	2725	2825	2900	3000	3100	3200
15	1625	1725	1800	1900	2000	2075	2175	2275	2375	2450	2550	2650	2725	2825	2925	3025	3125
18	1600	1700	1775	1875	1975	2050	2150	2250	2325	2425	2500	2600	2700	2800	2875	2975	3075
21	1600	1675	1775	1875	1950	2050	2125	2225	2325	2400	2500	2575	2675	2775	2850	2950	3050
24	1600	1675	1775	1850	1950	2050	2125	2225	2300	2400	2500	2575	2675	2750	2850	2950	3025
27	1600	1700	1775	1875	1950	2050	2125	2225	2300	2400	2500	2575	2675	2775	2850	2950	3025
30	1600	1700	1775	1875	1950	2050	2150	2225	2325	2400	2500	2600	2675	2775	2875	2950	3050
33	1625	1700	1800	1875	1975	2075	2150	2250	2325	2425	2525	2600	2700	2800	2875	2975	3050
36	1625	1725	1800	1900	2000	2075	2175	2250	2350	2450	2525	2625	2725	2800	2900	3000	3075
42	1650	1725	1825	1900	2000	2100	2175	2275	2350	2450	2550	2625	2725	2825	2900	3000	3100
48	1650	1750	1825	1925	2025	2100	2200	2275	2375	2475	2550	2650	2725	2825	2925	3000	3100
54	1675	1775	1850	1950	2025	2125	2200	2300	2400	2475	2575	2675	2750	2850	2950	3025	3125
60	1700	1775	1875	1950	2050	2150	2225	2325	2425	2500	2600	2700	2775	2875	2950	3050	3150
66	1725	1800	1900	1975	2075	2175	2250	2350	2450	2525	2625	2725	2800	2900	3000	3075	3175
72	1750	1825	1925	2000	2100	2200	2275	2375	2475	2550	2650	2750	2825	2925	3025	3100	3200
78	1750	1850	1925	2025	2100	2200	2300	2375	2475	2575	2650	2750	2850	2925	3025	3125	3200
84	1750	1850	1950	2025	2125	2225	2300	2400	2475	2575	2675	2750	2850	2950	3025	3125	3225
90	1775	1875	1950	2050	2125	2225	2325	2400	2500	2600	2675	2775	2850	2950	3050	3125	3225
96	1775	1875	1975	2050	2150	2225	2325	2425	2500	2600	2700	2775	2875	2975	3050	3150	3225
102	1800	1900	1975	2075	2150	2250	2350	2425	2525	2600	2700	2800	2875	2975	3075	3150	3250
108	1825	1900	2000	2075	2175	2275	2350	2450	2525	2625	2725	2800	2900	2975	3075	3175	3250



**Fill Height Tables are based on:**

1.  $\gamma_s = 120$  pcf
2. AASHTO HL-93 live load
3. Positive Projecting Embankment Condition -  
this gives conservative results in comparison to trench conditions

**D-Load (lb/ft/ft) for Type 4 Bedding**

	Class I		Class IV
	Class II		Class V
	Class III		Special Design

Fill Height (feet)															
Pipe i.d. (inches)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
12	2250	1465	1225	1150	1150	1225	1325	1450	1575	1700	1825	1975	2100	2250	2375
15	2100	1375	1150	1100	1125	1200	1275	1400	1525	1625	1775	1900	2025	2175	2300
18	1925	1325	1125	1075	1100	11775	1250	1375	1475	1600	1725	1850	1975	2125	2250
21	1625	1275	1075	1050	1075	1150	1250	1350	1450	1575	1700	1825	1950	2075	2200
24	1425	1250	1075	1025	1075	1125	1225	1325	1450	1575	1675	1800	1925	2050	2200
27	1275	1200	1050	1025	1050	1125	1225	1325	1450	1550	1675	1800	1925	2050	2175
30	1150	1175	1025	1025	1050	1125	1225	1325	1425	1550	1675	1800	1925	2050	2175
33	1050	1075	1025	1000	1050	1125	1225	1325	1425	1550	1675	1775	1900	2025	2150
36	975	1025	1025	1000	1050	1125	1225	1325	1425	1550	1675	1775	1900	2025	2150
42	925	925	1000	1000	1050	1125	1225	1325	1425	1550	1675	1775	1900	2025	2150
48	950	900	950	1000	1050	1125	1225	1325	1450	1550	1675	1800	1900	2025	2150
54	950	875	925	1000	1050	1150	1250	1350	1450	1575	1675	1800	1925	2050	2150
60	950	875	925	975	1075	1150	1250	1350	1475	1575	1700	1825	1925	2050	2175
66	975	900	925	1000	1075	1175	1275	1375	1475	1600	1700	1825	1950	2075	2175
72	950	925	925	1000	1075	1175	1275	1375	1500	1600	1725	1950	1950	2075	2200
78	900	925	950	1025	1100	1200	1300	1400	1500	1625	1750	1850	1975	2100	2225
84	875	900	950	1025	1100	1200	1300	1425	1525	1650	1750	1875	2000	2100	2225
90	850	900	950	1050	1125	1225	1325	1425	1550	1650	1775	1900	2000	2125	2250
96	825	900	950	1050	1150	1250	1350	1450	1550	1675	1800	1900	2025	2150	2250
102	850	900	975	1050	1150	1250	1350	1450	1575	1700	1800	1925	2050	2150	2275
108	850	900	975	1075	1175	1275	1375	1475	1600	1700	1825	1950	2050	2175	2300

**Fill Height Tables are based on:**

1.  $\gamma_s = 120$  pcf
2. AASHTO HL-93 live load
3. Positive Projecting Embankment Condition -  
this gives conservative results in comparison to trench conditions

**D-Load (lb/ft/ft) for Type 4 Bedding**

	Class I		Class IV
	Class II		Class V
	Class III		Special Design

<b>Fill Height (feet)</b>							
<b>Pipe i.d. (inches)</b>	<b>16</b>	<b>17</b>	<b>18</b>	<b>19</b>	<b>20</b>	<b>21</b>	<b>22</b>
12	2525	2675	2800	2950	3100	3250	3400
15	2425	2575	2700	2850	3000	3125	3275
18	2375	2525	2650	2775	2925	3052	3200
21	2350	2475	2600	2750	2875	3000	3125
24	2325	2450	2575	2700	2725	2975	3100
27	2300	2425	2550	2675	2725	2950	3075
30	2300	2425	2550	2675	2800	2925	3050
33	2275	2400	2525	2650	2775	2925	3050
36	2275	2400	2525	2650	2775	2900	3025
42	2275	2400	2525	2650	2775	2900	3025
48	2275	2400	2525	2650	2775	2900	3025
54	2275	2400	2525	2650	2775	2900	3025
60	2300	2425	2525	2650	2775	2900	3025
66	2300	2425	2550	2675	2800	2925	3025
72	2325	2450	2550	2675	2800	2925	3050
78	2325	2450	2575	2700	2825	2950	3050
84	2350	2475	2600	2700	2825	2950	3075
90	2375	2475	2600	2725	2850	2975	3100
96	2375	2500	2625	2750	2875	2975	3100
102	2400	2525	2650	2750	2875	3000	3125
108	2425	2525	2650	2775	2900	3025	3150

The preceding fill height tables are based on a concrete pipe installed in a positive projecting embankment installation with a soil unit weight of 120 lbs/ft<sup>3</sup> and HL-93 live load per the AASHTO LRFD Bridge Design specifications at the surface. Pipe outside diameters were based on a wall C thickness since the larger outside diameters would represent the highest soil overburden load on the pipe. The required classes of pipe do not account for construction loads or any other load induced on the pipe prior to its completed installation, or live load in excess of HS 20.

Dimensions of Circular Concrete Pipe - Imperial Units						
Internal Diameter inches	Wall A		Wall B		Wall C	
	Minimum Wall Thickness inches	Average Weight pounds per foot	Minimum Wall Thickness inches	Average Weight pounds per foot	Minimum Wall Thickness inches	Average Weight pounds per foot
12	1-3/4	79	2	93	2-3/4	133
15	1-7/8	103	2-1/4	127	3	177
18	2	131	2-1/2	168	3-1/4	226
21	2-1/4	171	2-3/4	214	3-1/2	281
24	2-1/2	217	3	264	3-3/4	341
27	2-5/8	255	3-1/4	322	4	406
30	2-3/4	295	3-1/2	384	4-1/4	476
33	2-7/8	336	3-3/4	451	4-1/2	552
36	3	383	4	524	4-3/4	633
42	3-1/2	520	4-1/2	686	5-1/4	811
48	4	683	5	867	5-3/4	1011
54	4-1/2	864	5-1/2	1068	6-1/4	1232
60	5	1064	6	1295	6-3/4	1473
66	5-1/2	1287	6-1/2	1542	7-1/4	1735
72	6	1532	7	1811	7-3/4	2023
78	6-1/2	1797	7-1/2	2100	8-1/4	2329
84	7	2085	8	2409	8-3/4	2656
90	7-1/2	2395	8-1/2	2740	9-1/4	3004
96	8	2710	9	3090	9-3/4	3374
102	8-1/2	3078	9-1/2	3480	10-1/4	3765
108	9	3446	10	3865	10-3/4	4178
114	9-1/2	3840	10-1/2	4278	11-1/4	4611
120	10	4263	11	4716	11-3/4	5066
126	10-1/2	4690	11-1/2	5175	12-1/4	5542
132	11	5148	12	5655	12-3/4	6040
138	11-1/2	5627	12-1/2	6156	13-1/4	6558
144	12	6126	13	6679	13-3/4	7098
150	12-1/2	6647	13-1/2	7223	14-1/4	7659
156	13	7190	14	7789	14-3/4	8242
162	13-1/2	7754	14-1/2	8375	15-1/4	8846
168	14	8339	15	8983	15-3/4	9471
174	14-1/2	8945	15-1/2	9612	16-1/4	10,117
180	15	9572	16	10,263	16-3/4	10,785

Dimensions of Circular Concrete Pipe - Metric Units					
Designated Internal Diameter mm	Actual Internal Diameter mm	Wall B		Wall C	
		Minimum Wall Thickness mm	Average Weight kg/m	Minimum Wall Thickness mm	Average Weight kg/m
300	305	50	162	69	197
375	381	57	216	75	262
450	457	63	253	82	335
525	533	69	327	88	417
600	610	75	430	94	505
675	686	82	500	100	602
750	762	88	598	107	708
825	838	94	695	113	821
900	914	100	832	119	940
975	991	113	923	125	1090
1050	1067	117	1057	132	1207
1200	1219	125	1324	144	1504
1350	1372	138	1589	157	1829
1500	1524	150	1927	169	2192
1650	1676	163	2295	182	2582
1800	1829	175	2695	194	2998
1950	1981	188	3125	207	3457
2100	2134	200	3585	219	3943
2250	2286	213	4078	232	4460
2400	2438	225	4598	244	5009
2550	2591	238	5179	257	5595
2700	2743	250	5752	269	6202
3000	3048	279	6344	298	7521
3600	3658	330	8104	349	10,540



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