



Standard Practice for Installing Vitrified Clay Pipe Lines¹

This standard is issued under the fixed designation C12; 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.

This standard has been approved for use by agencies of the U.S. Department of Defense.

1. Scope

1.1 This practice covers the proper methods of installing vitrified clay pipe lines in order to fully utilize the structural properties of such pipe.

1.2 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.3 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 ASTM Standards:²

C301 Test Methods for Vitrified Clay Pipe

C403/C403M Test Method for Time of Setting of Concrete Mixtures by Penetration Resistance

C425 Specification for Compression Joints for Vitrified Clay Pipe and Fittings

C700 Specification for Vitrified Clay Pipe, Extra Strength, Standard Strength, and Perforated

C828 Test Method for Low-Pressure Air Test of Vitrified Clay Pipe Lines

C896 Terminology Relating to Clay Products

C1091 Test Method for Hydrostatic Infiltration Testing of Vitrified Clay Pipe Lines

D2487 Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)

D2488 Practice for Description and Identification of Soils (Visual-Manual Procedure)

¹ This practice is under the jurisdiction of ASTM Committee C04 on Vitrified Clay Pipe and is the direct responsibility of Subcommittee C04.20 on Methods of Test and Specifications.

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² For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

D4832 Test Method for Preparation and Testing of Controlled Low Strength Material (CLSM) Test Cylinders

D5821 Test Method for Determining the Percentage of Fractured Particles in Coarse Aggregate

D6103 Test Method for Flow Consistency of Controlled Low Strength Material (CLSM) (Withdrawn 2013)³

3. Terminology

3.1 *General*—Terminology C896 can be used for clarification of terminology in this specification.

3.2 See Fig. 1.

DESIGN CONSIDERATIONS

4. Supporting Strength

4.1 The field supporting strength of vitrified clay pipe is materially affected by the methods of installation. The field supporting strength of a pipe is defined as its capacity to support dead and live loads under actual field conditions. It is dependent upon two factors: (1) the inherent strength of the pipe and (2) the bedding of the pipe.

4.2 The minimum bearing strength requirement in accordance with Specification C700, as determined by the 3-edge-bearing test of Test Methods C301, is a measure of the inherent strength of the pipe.

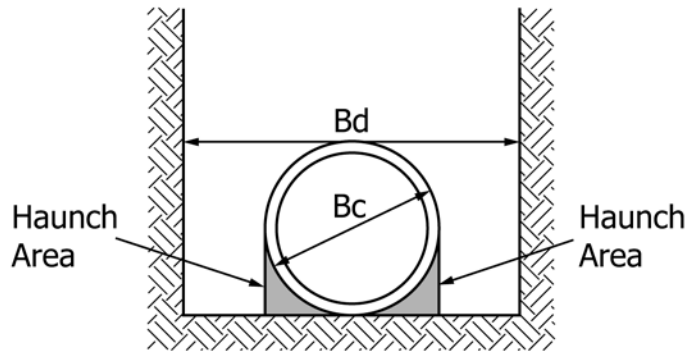
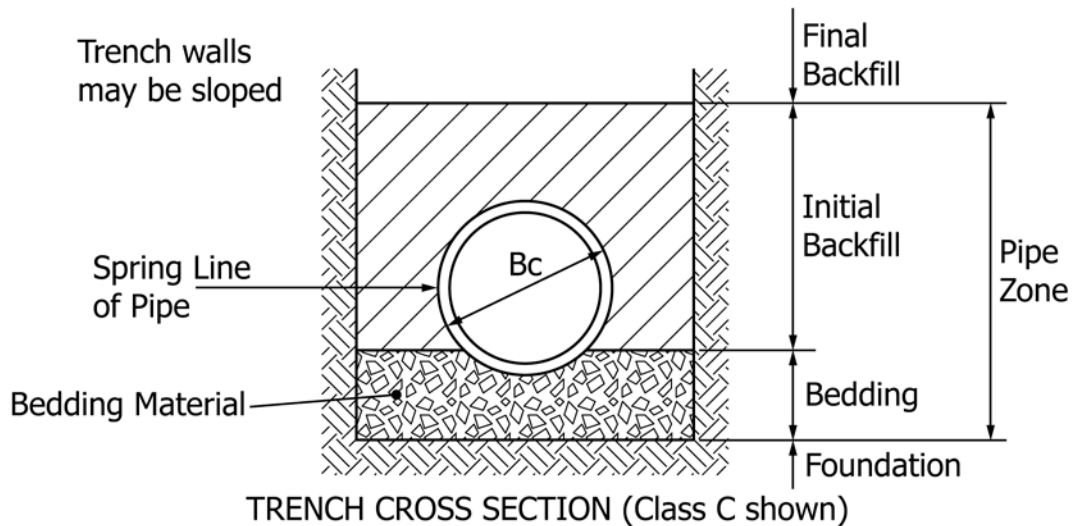
4.3 The tests used to measure bearing strength determine relative pipe strengths but do not represent actual field conditions. Therefore, an adjustment called a load factor is introduced to convert minimum bearing strength to field supporting strength. The magnitude of the load factor depends on how the pipe is bedded. The relationship is:

$$\text{Field supporting strength} = \text{minimum bearing strength} \times \text{load factor}$$

4.4 A factor of safety >1.0 and ≤1.5 shall be applied to the field supporting strength to calculate a safe supporting strength. The relationship is:

$$\text{Safe supporting strength} = \frac{\text{Field supporting strength}}{\text{Factor of safety}}$$

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



B_c = the outside diameter of the pipe barrel.
 B_d = the design trench width measured at the horizontal plane at the top of the pipe barrel.

FIG. 1 Terminology

5. External Loads

5.1 The external loads on installed vitrified clay pipe are of two general types: (1) dead loads and (2) live loads.

5.2 For pipes installed in trenches at a given depth, the dead load increases as the trench width, measured at the top of the pipe, increases. Pipe failure may result if the design trench width is exceeded. If the trench width exceeds the design width, a higher class of bedding, stronger pipe, or both, must be investigated.

5.3 Live loads that act at the ground surface are partially transmitted to the pipe. Live loads may be produced by wheel loading, construction equipment or by compactive effort. Compaction of embedment and backfill materials, beside and above the sewer pipe, produces a temporary live load on the pipe. The magnitude of the live load from compactive effort varies with soil type, degree of saturation, degree of compac-

tion and depth of cover over the pipe. Care must be used in selection of compaction methods so that the combined dead load and live load does not exceed the field supporting strength of the pipe, or cause a change in its line or grade.

NOTE 1—For generally accepted criteria and methods for determining loads and supporting strengths, see *Gravity Sanitary Sewer Design and Construction*, *Water Pollution Control Federation Manual of Practice No. FD-5*, *American Society of Civil Engineers—Manuals and Report on Engineering Practice—No. 60*.⁴

6. Bedding and Encasement

6.1 Classes of bedding and encasements for pipe in trenches are defined herein. The load factors indicated are for conversion of minimum bearing strength to field supporting strength.

⁴ Available from American Society of Civil Engineers (ASCE), 1801 Alexander Bell Dr., Reston, VA 20191, <http://www.asce.org>.

6.1.1 The soil groups used in each bedding class are defined in [Table 1](#).

6.1.2 The gradation for Class I and Class II soil for Class C bedding ([Fig. 3](#)) shall have a maximum particle size of 1 in. (25 mm).

6.1.3 The gradation for Class I and Class II bedding material for Class B ([Fig. 4](#)), Crushed Stone Encasement ([Fig. 5](#)), and CLSM installation ([Fig. 6](#)) shall be as follows:

- 100 % passing a 1 in. (25 mm) sieve
- 40-60 % passing a ¾ in. (19 mm) sieve
- 0-25 % passing a ⅜ in. (9.5 mm) sieve

6.1.4 For Class I, all particle faces shall be fractured.

6.1.5 Class II soils shall have a minimum of one fractured face. For Class B ([Fig. 4](#)), Crushed Stone Encasement ([Fig. 5](#)), and CLSM installations ([Fig. 6](#)) where high, or changing water tables, or both, are present; Class II material shall have a minimum percentage by particle count of one fractured face-100 %, two fractured faces-85 %, and three fractured faces-65 % in accordance with Test Method [D5821](#).

6.1.6 Class I material is considered to be more stable and provide better support than Class II material that have some rounded edges.

6.1.7 All bedding material shall be shovel-sliced so the material fills and supports the haunch area and encases the pipe to the limits shown in the trench diagrams.

6.2 *Class D* ([Fig. 2](#)):

6.2.1 The pipe shall be placed on a firm and unyielding trench bottom with bell holes provided ([Fig. 7](#)).

6.2.2 The initial backfill shall be either Class I, II, III, or IV having a maximum particle size of 1 in. (25 mm).

6.2.3 The load factor for Class D bedding is 1.1.

6.3 *Class C* ([Fig. 3](#)):

6.3.1 The pipe shall be bedded in Class I or Class II soil. Refer to [6.1.2](#) and [Table 2](#) for requirements. Sand is suitable as a bedding material in a total sand environment, but may be unsuitable where high and rapidly changing water tables are present in the pipe zone. Sand may also be undesirable in a trench cut by blasting or in trenches through clay type soil. Regardless of the trench condition or bedding class, the maximum load factor for sand bedding is 1.5. The bedding shall have a minimum thickness beneath the pipe of 4 in. (100 mm) or one sixth of the outside diameter of the pipe, whichever is greater, and shall extend up the haunches of the pipe one sixth of the outside diameter of the pipe.

6.3.2 The initial backfill shall be either Class I, II, III, or IV having maximum particle size of 1-½ in. (38 mm) (see [Table 2](#)).

6.3.3 The load factor for Class C bedding is 1.5.

6.4 *Class B* ([Fig. 4](#)):

6.4.1 The pipe shall be bedded in Class I or Class II soil. Refer to [6.1.3](#), [6.1.5](#), and [Table 2](#) for requirements. The bedding shall have a minimum thickness beneath the pipe of 4 in. (100 mm) or one sixth of the outside diameter of the pipe, whichever is greater, and shall extend up the haunches of the pipe to the springline.

6.4.2 The initial backfill shall be either Class I, II, III, or IV having a maximum particle size of 1-½ in. (38 mm).

6.4.3 The load factor for Class B bedding is 1.9.

6.5 *Crushed Stone Encasement* ([Fig. 5](#)):

6.5.1 The pipe shall be bedded in Class I or Class II soil. Refer to [6.1.3](#), [6.1.5](#), and [Table 2](#) for requirements. The bedding shall have a minimum thickness beneath the pipe of 4 in. (100 mm) or one sixth of the outside diameter of the pipe, whichever is greater, and shall extend upward to a horizontal

TABLE 1 Uniform Soil Groups for Pipe Installation

NOTE 1—Soil Classification descriptions and symbols are in accordance with Practice [D2487](#) and Practice [D2488](#).

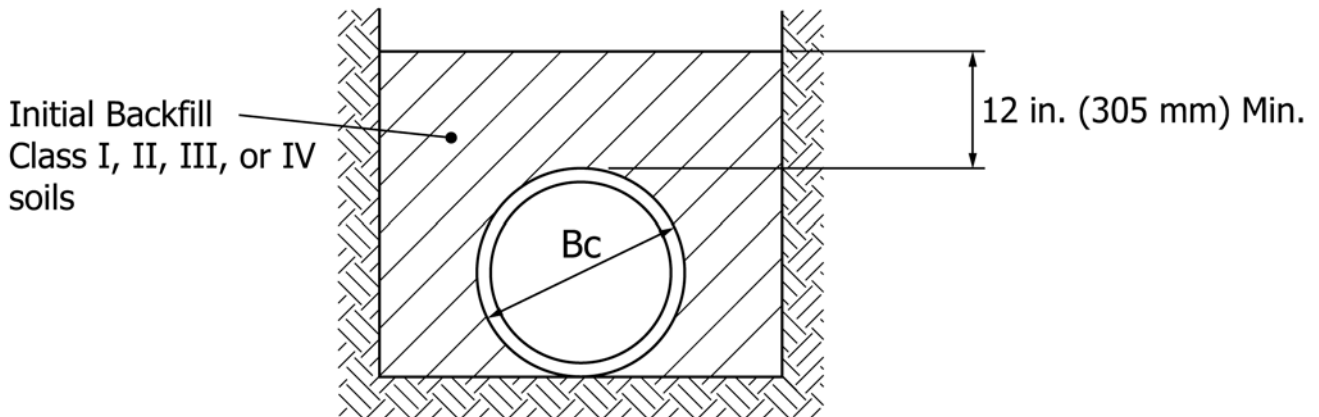
NOTE 2—For Class I, all particle faces shall be fractured.

NOTE 3—Materials such as broken coral, shells, slag, and recycled concrete (with less than 12 % passing a #200 sieve) should be treated as Class II soils.

NOTE 4—Class V soil is not suitable for use as a bedding or initial backfill material.

Class I	crushed rock 100 % passing 1-½ in. (38 mm) sieve, <= 15 % passing #4 sieve, <= 25 % passing ⅝ in. (9.5 mm) sieve, <= 12 % passing #200 sieve	
Class II	clean, coarse grained soils or any soil beginning with one of these symbols (can contain fines up to 12 %) uniform fine sands (SP) with more than 50 % passing a #100 sieve should be treated as Class III material	GW, GP, SW, SP
	coarse grained soils with fines or any soil beginning with one of these symbols	GM, GC, SM, SC
Class III	sandy or gravelly fine grained soils or any soil beginning with one of these symbols with >= 30 % retained on #200 sieve	ML, CL
Class IV	fine-grained soils or any soil beginning with one of these symbols with <30 % retained on #200 sieve	ML, CL
Class V	fine-grained soils, organic soils high compressibility silts and clays, organic soil	MH, CH, OL, OH, Pt

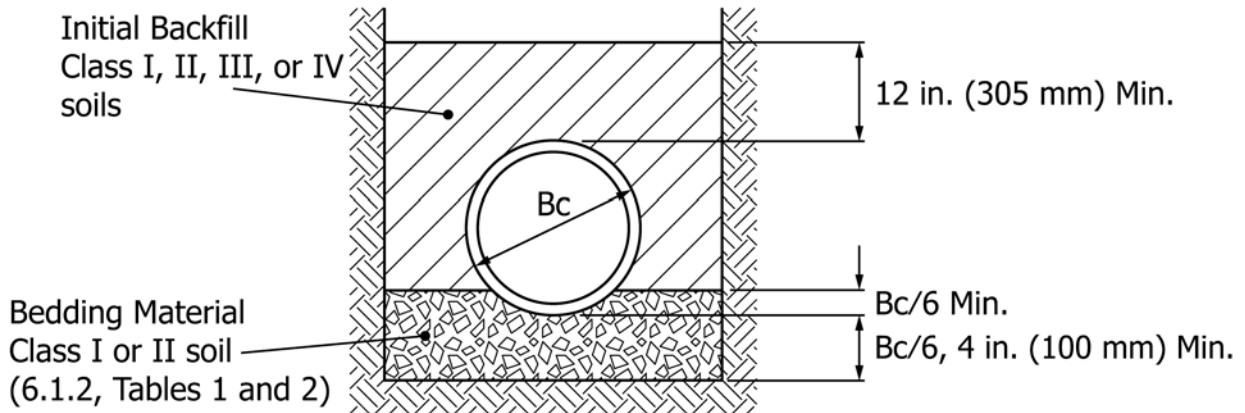
Trench Walls
may be sloped



Load Factor 1.1

FIG. 2 Class D

Trench walls
may be sloped



Load Factor 1.5

FIG. 3 Class C

plane at the top of the pipe barrel. Material shall be carefully placed into the pipe haunches.

6.5.2 Sufficient material shall be placed so that the bedding extends to a horizontal plane at the top of the pipe barrel following removal of any trench sheeting or boxes.

6.5.3 The initial backfill shall be either Class I, II, III, or IV having a maximum particle size of 1-½ in. (38 mm).

6.5.4 The load factor for crushed stone encasement is 2.2.

6.6 *Controlled Low Strength Material* (Fig. 6)—Controlled low strength material (CLSM) is used as an effective material for the bedding of vitrified clay pipe.

6.6.1 The pipe shall be bedded on Class I or Class II soil. Refer to 6.1.3, 6.1.5, and Table 2 for requirements. The

bedding shall have a minimum thickness beneath the pipe of 4 in. (100 mm) or one sixth of the outside diameter of the pipe, whichever is greater.

6.6.2 For pipe diameters 8 to 21 in. (205 to 535 mm), CLSM shall extend a minimum of 9 in. (230 mm) on each side of the pipe barrel. For pipe diameters 24 in. (610 mm) and larger, CLSM shall extend a minimum of 12 in. (305 mm) on each side of the pipe barrel (Fig. 6).

6.6.3 When placed, CLSM shall have a measured flowability of 8 ± 1 in. (205 ± 25 mm) spread diameter as determined by Test Method D6103.

6.6.4 28-day compressive strength shall be 100 to 300 psi (0.69 to 2.07 MPa) as determined by Test Method D4832.

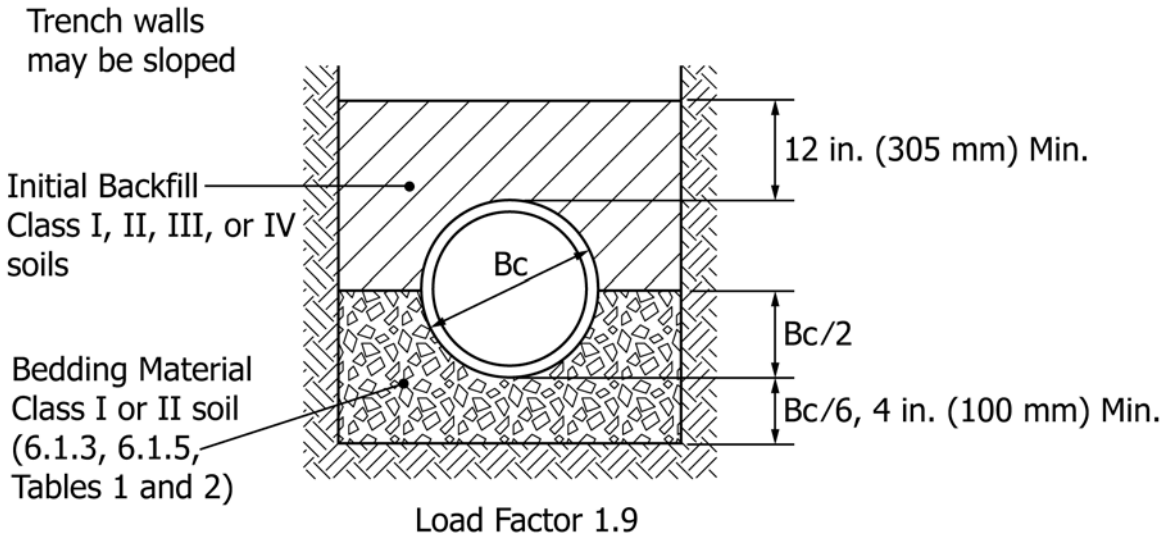


FIG. 4 Class B

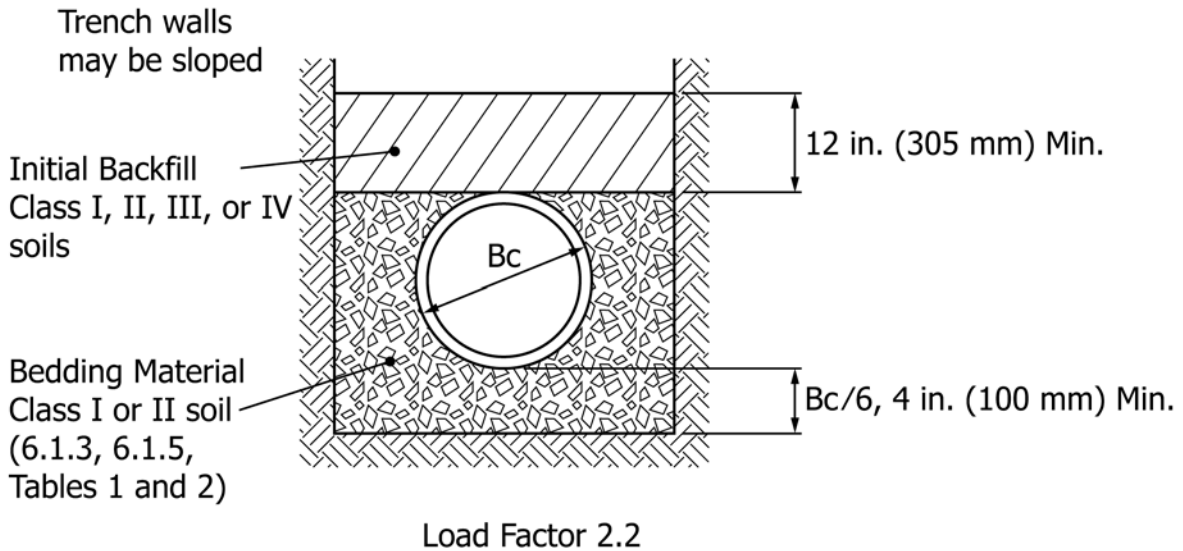


FIG. 5 Crushed Stone Encasement

6.6.5 CLSM shall be directed to the top of the pipe to flow down equally on both sides to prevent misalignment. Place CLSM to the top of the pipe barrel.

6.6.6 The initial backfill shall be either Class I, II, III, or IV having a maximum particle size of 1-½ in. (38 mm).

6.6.7 Initial backfill shall only commence after a 500 psi (3.45 MPa) minimum penetrometer reading is achieved as determined by Test Method C403/C403M. The penetrometer shall have a maximum load capability of 700 psi (4.83 MPa) and have a 1 in.² × 1 in. (645 mm² × 25 mm) long cylinder foot attached to a ¼ in. (6 mm) diameter pin.

6.6.8 The load factor for controlled low strength material is 2.8.

6.7 Concrete Cradle (Fig. 8)—

6.7.1 The pipe shall be bedded in a cradle of reinforced concrete having a thickness under the barrel of at least 6 in. (150 mm) or one fourth of the outside diameter of the pipe,

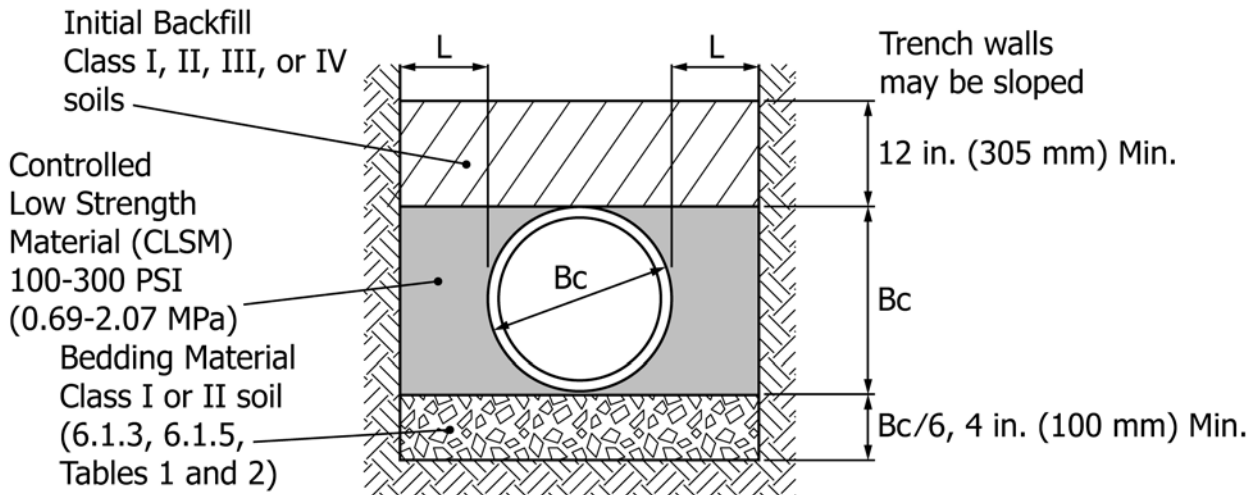
whichever is greater, and extending up the haunches to a height of at least one half the outside diameter of the pipe. The cradle width shall be at least equal to the outside diameter of the pipe plus 4 in. (100 mm) on each side or one and one fourth times the outside diameter of the pipe, whichever is greater. If the trench width is greater than either of these dimensions, concrete may be placed to full trench width.

6.7.2 The initial backfill shall be either Class I, II, III, or IV having a maximum particle size of 1-½ in. (38 mm).

6.7.3 The load factor for Class A concrete cradle bedding is 3.4 for reinforced concrete with $p = 0.4\%$, where p is the percentage of the area of transverse steel to the area of concrete at the bottom of the pipe barrel as shown in Fig. 8.

6.8 Concrete Encasement:

6.8.1 There are specific sites where concrete encasement may be desirable. Concrete encasement shall completely surround the pipe and shall have a minimum thickness, at any



$L = 9 \text{ in. (229 mm) Min. for Pipe Dia. 8-21 in.}$
 $L = 12 \text{ in. (305 mm) Min. for Pipe Dia. 24 in. and greater}$

Load Factor 2.8

This type of construction requires the fill to extend from the pipe to the trench wall, not to extend above the top of the pipe or below the bottom of the pipe. Where native soils are expansive, further investigation may be necessary.

FIG. 6 Controlled Low Strength Material (CLSM)

Provide uniform and continuous support of the pipe barrel between bell or coupling holes

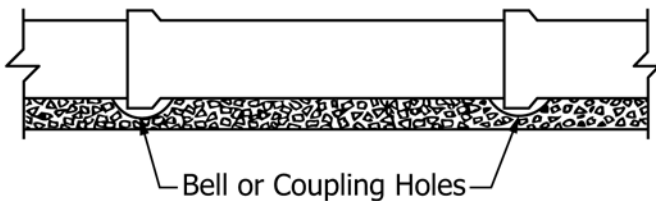


FIG. 7 Uniform Pipe Support

point, of one fourth of the outside diameter of the pipe or 4 in. (100 mm), whichever is greater.

6.8.2 The encasement shall be designed by the engineer to suit the specific use.

6.9 Construction joints shall be installed in concrete cradle or concrete encasement construction. These joints shall be aligned with the face of the socket.

CONSTRUCTION TECHNIQUES

7. Trench Excavation

7.1 Trenches shall be excavated to a width that will provide adequate working space, but not more than the maximum design width. Trench walls shall not be undercut.

7.2 The trench walls can be sloped to reduce trench wall failure. This sloping will not increase the load on the pipe provided the measured trench width at top of pipe does not exceed the design trench width.

7.3 Trenches, other than for Class D bedding, shall be excavated to provide space for the pipe bedding.

7.4 Sheet, shore, and brace trenches, as necessary, to prevent caving or sliding of trench walls, to provide protection for workmen and the pipe, and to protect adjacent structures and facilities.

7.5 Sheet piling shall not be removed below the top of the pipe if the resulting slope of native soil increases the trench width to such an extent that the load on the pipe exceeds the safe field supporting strength of the pipe and bedding system.

7.6 When a movable box is used in place of sheeting or shoring, secure the installed pipe to prevent it from moving when the box is moved.

7.7 Maintain the water level in the trench to an elevation below the bell of the pipe being laid. Exercise caution when terminating the dewatering procedure to avoid disturbing the pipe installation.

NOTE 2—The purpose of controlling the water in the trench is to maintain the lubricant on the joint surfaces, the integrity of the bell hole, and the ability to visually observe the cleanliness of the joint surfaces.

8. Trench Foundation

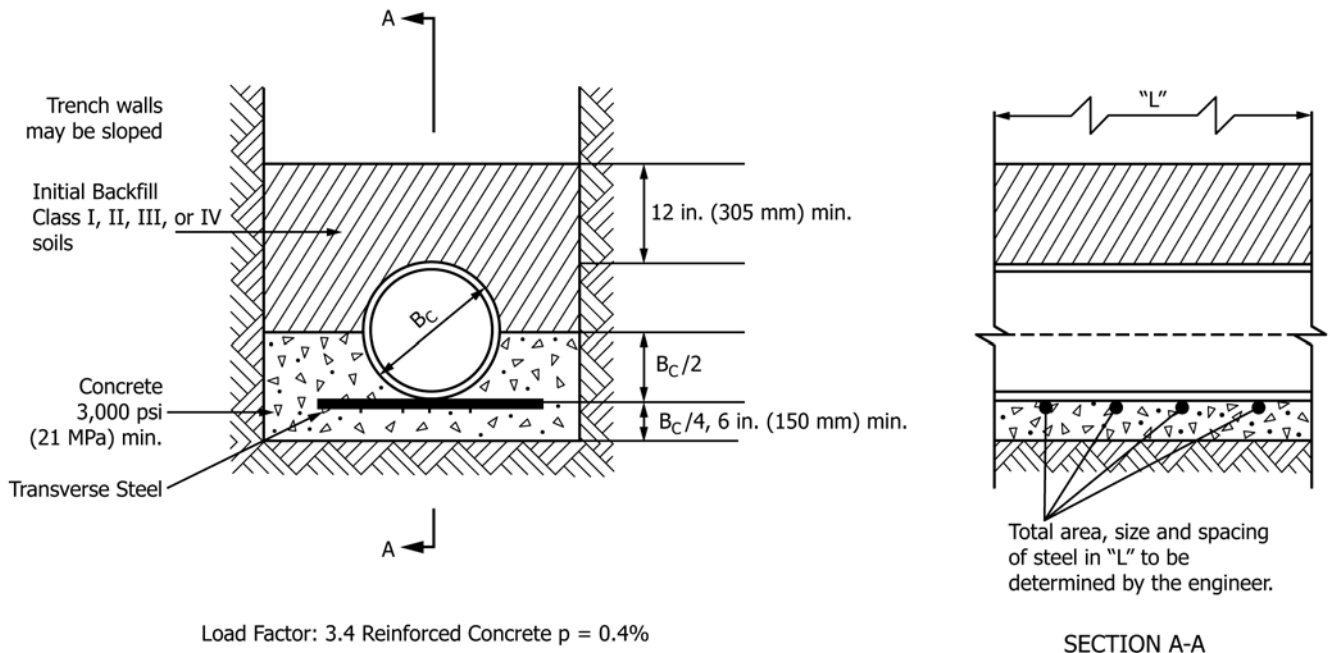
8.1 The trench foundation is the area below the pipe and bedding which supports the pipe bedding structure.

8.2 The trench foundation shall be firm and unyielding.

8.2.1 In cases where the trench foundation is soft or unsuitable to support the pipe, bedding and backfill; foundation improvement is necessary.

TABLE 2 Allowable Bedding Material and Initial Backfill Per Bedding Class

Bedding Class	Allowable Bedding Material			Allowable Initial Backfill	
	Class Table 1	Gradation	Maximum Particle Size	Class Table 1	Maximum Particle Size
Class D	N/A	N/A	N/A	I, II, III, or IV	1 in. (25 mm)
Class C	I or II	100 % passing a 1 in. (25 mm) sieve	1 in. (25 mm)	I, II, III, or IV	1-½ in. (38 mm)
Class B	I or II	40-60 % passing a ¾ in. (19 mm) sieve	1 in. (25 mm)	I, II, III, or IV	1-½ in. (38 mm)
		0-25 % passing a ⅝ in. (9.5 mm) sieve			
Crushed Stone Encasement	I or II	100 % passing a 1 in. (25 mm) sieve	1 in. (25 mm)	I, II, III, or IV	1-½ in. (38 mm)
		40-60% passing a ¾ in. (19 mm) sieve			
CLSM	I or II	0-25% passing a ⅝ in. (9.5 mm) sieve	1 in. (25 mm)	I, II, III, or IV	1-½ in. (38 mm)
		100 % passing a 1 in. (25 mm) sieve			
Concrete Cradle	N/A	N/A	N/A	I, II, III, or IV	1-½ in. (38 mm)



Minimum width of concrete cradle: $B_c + 8$ in. (205 mm) or $1\frac{1}{4} B_c$.
 p is the ratio of the area of steel to the area of concrete. (It is recommended that wire mesh reinforcement or uniformly distributed small diameter rebar be used in all concrete design.)

FIG. 8 Concrete Cradle

9. Pipe Bedding

9.1 Bell holes shall be excavated to prevent point loading of the bells or couplings of laid pipe, and to establish full-length support of the pipe barrel (Fig. 7).

9.2 The portion of the bedding directly beneath the pipe and above the foundation should not be compacted for Class B and Crushed Stone Encasement.

9.3 Bedding shall be placed so that the pipe is true to line and grade and to provide uniform and continuous support of the pipe barrel.

10. Pipe Handling

10.1 Pipe and fittings shall be handled carefully to protect from damage.

10.2 Carefully examine each pipe and fitting before installation, for soundness and specification compliance. Pipe accepted may be plainly marked by the inspector. Rejected pipe shall not be defaced, but shall be replaced with pipe that meets specification.

10.3 Handle pipe so that premolded jointing surfaces or attached couplings do not support the weight of the pipe. Do

not damage the jointing surfaces or couplings by dragging, contact with hard materials, or by use of hooks.

11. Pipe Laying

11.1 Clean joint contact surfaces immediately prior to joining. Use joint lubricants and joining methods, as recommended by the pipe manufacturer.

11.2 Unless otherwise required, lay all pipe straight between changes in alignment and at uniform grade between changes in grade. Excavate bell holes for each pipe joint. When joined in the trench, the pipe shall form a true and smooth line.

11.3 Straight lengths of pipe may be used for horizontal or vertical curves by uniformly deflecting each joint. The joint deflection limits shall be as described in [Table 3](#).

11.4 Whenever practicable, start pipe laying at the lowest point and install the pipe so that the spigot ends point in the direction of flow to prevent bedding material from entering the joint.

11.5 After each pipe has been brought to grade, aligned, and placed in final position, deposit and shovel slice bedding material into the pipe haunches. Shovel slicing the bedding material into the haunches of the entire pipe barrel is essential to realize the total design load factor. Wyres and tees shall be bedded to prevent shear loading.

11.5.1 Initial shovel slicing should be performed before the bedding is no higher than the quarter point of the pipe diameter.

11.6 Place pipe that is to be bedded in concrete cradle or encased in concrete, in proper position on temporary supports. When necessary, rigidly anchor or weight the pipe to prevent flotation as concrete is placed.

11.7 Place concrete for cradles, arches, or encasement uniformly on each side of the pipe and deposit at approximately its final position. Concrete placed beneath the pipe shall be sufficiently workable so that the entire space beneath the pipe can be filled without excessive vibration.

11.8 Where the pipeline connects to a manhole or other structure, protection from differential settlement must be provided.

11.8.1 The installation shall result in a minimum of two points of flexibility at each pipe connection to the manhole or other structure.

11.8.1.1 Short pipe lengths, 24 in. (610 mm) maximum, shall be used within 36 in. (915 mm) of the connected manhole or other structure.

11.8.1.2 Acceptable points of flexibility shall be a factory applied joint, an elastomeric compression coupling, or a flexible manhole connection. Each connection shall be considered a single point of flexibility.

12. Backfilling Trenches

12.1 Initial backfill need not be compacted to develop field supporting strength of the pipe. Final backfill may require compaction to prevent settlement of the ground surface.

12.2 Unless otherwise directed, backfill trenches as soon as practicable after the pipe is laid. In the case of concrete bedding, delay backfilling until the concrete has set sufficiently to support the backfill load.

12.3 The initial backfill shall be either Class I, II, III, or IV (see [Table 2](#)).

12.4 Final backfill shall have no rock, stones, or other material having a dimension larger than 6 in. (150 mm) within 3 ft (0.92 m) of the top of the pipe.

12.5 Water flooding or jetting may be used for consolidating backfill material only when approved by the engineer.

13. Field Performance and Acceptance

13.1 After installation the sewer shall be tested for integrity by a method specified or approved by the engineer.

NOTE 3—It is recommended that the contractor perform testing when the first manhole-to-manhole pipeline is installed, backfilled, and compacted prior to paving and periodically as the installation progresses.

13.2 Where ground water exists above the top of the pipe, the line may be tested for infiltration by determining the quantity of water entering the system during a specified time period. Infiltration testing is recommended and shall conform to the test procedure described in Test Method [C1091](#).

13.3 Where ground water does not exist above the top of the pipe, Test Method [C828](#) is recommended.

NOTE 4—When water or air tests are specified and the acceptance of a line depends upon satisfactory results, it should be recognized that several factors have a bearing on these results. Manhole bases, walls, and seals must be watertight. Household and commercial building and roof drains

TABLE 3 Joint Deflection Limits

NOTE 1—For calculating the minimum radius of curvature use the following:
 pipe—3 in. (76 mm) to 12 in. (305 mm) Diameter radius = 24 × pipe length
 pipe—15 in. (380 mm) to 24 in. (610 mm) Diameter radius = 32 × pipe length
 pipe—27 in. (685 mm) to 36 in. (915 mm) Diameter radius = 48 × pipe length
 pipe—39 in. (990 mm) to 48 in. (1220 mm) Diameter radius = 64 × pipe length

NOTE 2—Material is applicable to compression joints for vitrified clay pipe and fittings in accordance with Specification [C425](#).

Nominal Diameter, in. (mm)	Maximum Angular Deflection per Joint, degrees	Maximum Deflection of Pipe, in./linear ft (mm/linear m)
3–12 (76–305)	2.4°	½ (42)
15–24 (380–610)	1.8°	¾ (31)
27–36 (685–915)	1.2°	¼ (21)
39–48 (990–1220)	0.9°	⅜ (16)

must be isolated. Stoppers must be sufficiently secured to be air or watertight.

13.4 In order for the performance of the line to be acceptable, all tests shall be made on pipe laid in accordance with the bedding provisions of Section 6. Joining procedures shall follow the recommendation of the pipe manufacturer.

14. Keywords

14.1 backfilling; bedding; clay pipe; compaction; construction; design; excavation; installation; load factors; perforated pipe; pipe; sewers; trench foundation; trenching; vitrified

APPENDIX

(Nonmandatory Information)

X1. INSTALLATION CRITERIA FOR PERFORATED VITRIFIED CLAY PIPE

X1.1 *Position of Perforations:*

X1.1.1 Perforations in a subdrain or leachate pipe shall normally be down.

X1.1.2 Under unique conditions it may be desirable to place the perforations up.

X1.2 *Method of Design:*

X1.2.1 Design in accordance with standard engineering practice, noting particularly, the bearing strength as listed in Specification C700.

X1.3 *Bedding and Backfill:*

X1.3.1 Bedding and backfill shall be in accordance with the engineer's design.

X1.3.2 It is desirable to contain the bedding with a filter fabric.

X1.3.3 In the pipe zone the material shall be free draining without migration.

X1.3.4 Extreme care should be exercised in placement and compaction of backfill.

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