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Standard Recommended Practice for INSTALLING VITRIFIED CLAY PIPE LINES[1]

This Standard is issued under the fixed designation C 12; 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.

1. Scope

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

2. Applicable Documents

2.1 *ASTM Standards:*

C 425 Specification for Compression Joints for Vitrified Clay Pipe and Fittings[2]

C 700 Specification for Vitrified Clay Pipe, Extra Strength, Standard Strength, and Perforated[2]

C 828 Recommended Practice for Low-Pressure Air Test of Vitrified Clay Pipe Sewer Lines (4 to 12-in.)[2]

3. Pipe Strength

3.1 The field supporting strength of vitrified clay pipe is materially affected by the methods of installation. The field supporting strength of a pipe is its ability to support dead and live loads under actual field conditions and is dependent upon two factors: (*1*) the inherent strength of the pipe and (*2*) the manner in which the pipe is bedded.

3.2 The inherent strength of the pipe is fixed by the shape of the pipe, the materials used, and the method of manufacture. The applicable ASTM pipe specification stipulates the minimum crushing strength for each type and class of pipe.

3.3 The tests used to measure crushing strength determine relative pipe strengths but do not represent actual field conditions. Therefore, an adjustment called a load factor must be introduced to convert test crushing strength to field supporting strength. The load factor depends on how the pipe is bedded. The relationship is as follows:

Field supporting strength
= three-edge-bearing strength × load factor

3.4 An appropriate factor of safety should be applied to the field supporting strength to calculate a safe supporting strength as follows:

Safe supporting strength
= (three-edge-bearing strength × load factor)/factor of safety

4. External Loads

4.1 The external loads on vitrified clay pipe are of two general types: (*1*) earth loads and (*2*) live loads.

4.2 For pipes installed in trenches, the earth load increases with the trench width measured at the top of the pipe, regardless of pipe size. Consequently, the trench width at the top of the pipe should be kept as narrow as possible, consistent with providing adequate working space at the sides of the pipe. Pipe failure may result if the design trench width is exceeded. If the trench width exceeds the width used for design, a better class of bedding or stronger pipe, or both, should be provided.

4.3 Beginning at a plane 12 in. (300 mm) or more above the top of the pipe, the trench walls can be sloped back without increasing the load imposed on the pipe.

4.4 Pipes that are installed in or beneath embankments are called projecting conduits. The earth load on a projecting conduit is influenced by the pipe diameter, the weight and character of the embankment material, the foundation material, the method of installation,

[1] This recommended practice is under the jurisdiction of ASTM Committee C-4 on Vitrified Clay Pipe.
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[2] *Annual Book of ASTM Standards*, Part 16

and the height of the embankment above the top of the pipe.

4.5 Live loads consist of superimposed loads, such as wheel loads, which act at the ground surface and are partially transmitted to the pipe. An allowance for impact should be added to the live loads. The live load transmitted to the pipe diminishes as the depth of cover increases.

NOTE 1—For generally accepted criteria and methods for determining loads and supporting strengths see *Design and Construction of Sanitary and Storm Sewers, Water Pollution Control Federation Manual No. 9, American Society of Civil Engineers Manual No. 37.*

5. Types of Bedding

5.1 Four acceptable classes of bedding for pipe in trenches are defined herein. The load factors indicated are for conversion of three-edge-bearing strength to field supporting strength.

5.2 *Class A*—This class of bedding can be achieved with either of two construction methods:

5.2.1 *Concrete Cradle* (see Fig. 1)—The pipe shall be bedded in a monolithic cradle of plain or reinforced concrete having a thickness under the barrel of at least 4 in. (100 mm) or one fourth of the inside diameter of the pipe, whichever is greater, and extending up the sides to a height of at least one fourth of the pipe outside diameter. The cradle shall have a width at least equal to the outside diameter of the pipe plus 8 in. (200 mm) or one and one fourth of the outside diameter of the pipe, whichever is greater. Backfill above the cradle and extending 12 in. (300 mm) above the top of the pipe shall be carefully placed.

5.2.1.1 The load factor for Class A concrete cradle bedding is 2.2 for plain concrete with lightly tamped backfill; 2.8 for plain concrete with carefully tamped backfill; and up to 3.4 for reinforced concrete with p = 0.4 percent, where p is the percentage of the area of steel to the area of concrete at the pipe invert.

5.2.2 *Concrete Arch* (see Fig. 2)—The pipe shall be bedded in crushed stone or rounded gravel bedding material (Note 2). The bedding shall have a minimum thickness beneath the pipe of 4 in. (100 mm) or one fourth of the outside diameter of the pipe, whichever is greater, and shall extend up the sides of the pipe to the horizontal centerline. The top half of the pipe shall be covered with a monolithic plain or reinforced concrete arch having a thickness of at least 4 in. (100 mm) or one fourth of the inside diameter of the pipe, whichever is greater, at the pipe crown and a minimum width equal to the outside diameter of the pipe plus 8 in. (200 mm) or one and one fourth of the diameter of the pipe, whichever is greater.

5.2.2.1 The load factor for Class A-1 concrete arch bedding is 2.8 for plain concrete; up to 3.4 for reinforced concrete with p = 0.4 percent; and up to 4.8 for reinforced concrete with p = 1.0 percent, where p is the percentage of the area of steel to the area of concrete at the pipe crown.

NOTE 2—Because of the recent research and subsequent general acceptance of the advantages of interlocking bedding materials, this recommended practice calls special attention to the desirability of using ¾ to ¼-in. (19.0 to 6.3-mm) crushed stone bedding. Where crushed material is not readily available, rounded material is acceptable.

5.3 *Class B* (see Fig. 3)—The pipe shall be bedded in crushed stone or rounded gravel bedding material (Note 2) placed on the trench bottom. The bedding material shall have 95 percent passing a ¾-in. (19.0-mm) sieve and 95 percent retained on a No. 4 (4.75-mm) sieve. The bedding shall have a minimum thickness beneath the pipe of 4 in. (100 mm) or one eighth of the outside diameter of the pipe, whichever is greater, and shall extend up the sides of the pipe to the horizontal centerline. Backfill from pipe horizontal centerline to a level not less than 12 in. (300 mm) above the top of the pipe shall be of the bedding material or carefully placed earth. Hand placed backfill shall be finely divided materials free from debris, organic material, and stones.

5.3.1 The load factor for Class B bedding is 1.9.

5.4 *Class C* (see Fig. 4)—The pipe shall be bedded in crushed stone or rounded gravel bedding material (Note 2) placed on the trench bottom. The bedding material shall have 95 percent passing a ¾-in. (19.0-mm) sieve and 95 percent retained on a No. 4 (4.75-mm) sieve. Shells, pea gravel, sand, native soil, or other locally available and commonly used bedding materials may be specified by the engineer in place of the previously described bedding materials. The bedding shall have a minimum thickness beneath the pipe of 4 in. (100 mm) or one eighth of the outside diameter of the pipe, whichever is greater, and shall extend up the sides of the pipe one sixth of the outside diameter of the pipe. Backfill between the bedding and a plane 12 in. (300 mm) over the top of the pipe, shall be hand placed finely divided earth free from debris and stones.

5.4.1 The load factor for Class C bedding is 1.5.

5.5 *Class D* (see Fig. 5)—The pipe shall be bedded in suitable native material on an unshaped trench bottom.

5.5.1 The load factor for Class D bedding is 1.1.

6. Concrete Encasement

6.1 Concrete encasement shall completely surround the pipe and shall have a minimum thickness at any point of one fourth of the inside diameter of the pipe or 4 in. (100 mm), whichever is greater.

6.2 In addition to providing bedding at least equivalent to Class A, concrete encasement provides additional field supporting strength. Whenever the strength of the pipe with Class A bedding is not sufficient to support the external loads, the encasement should be designed to provide the necessary additional strength.

7. Trench Excavation

7.1 Open no more trench in advance of pipe laying than is necessary to expedite the work.

7.2 Excavate trenches to a width that will provide adequate working space, but not more than the maximum design width. Do not undercut trench walls.

7.3 Excavate trenches below the pipe invert a sufficient distance to provide space for the pipe bedding. Carry trenches in ledge rock, compact rocky or gravelly soil, or other unyielding materials below the bottom of the pipe at least one fourth of the outside diameter of the pipe, or 4 in. (100 mm), whichever is greater. Refill the space beneath the pipe with bedding material as specified for Class B or Class C bedding.

7.4 Excavate bell holes at each joint to provide full-length barrel support of the pipe and to prevent point loading at the bells or couplings.

7.5 Unless trench banks above the top of the pipe are cut back on a stable slope, sheet and brace trenches as necessary to prevent caving or sliding, to provide protection for workmen and the pipe, and to protect adjacent structures and facilities. Do not remove trench sheeting unless the pipe strength is sufficient to support the external loads, including the weight of a prism of earth above the top of the pipe with trench width measured to the back of the sheeting. Do not brace sheeting against the pipe, but brace it so that no concentrated loads or horizontal thrusts are transmitted to the pipe.

8. Pipe Bedding

8.1 Carefully prepare bedding so that the pipe after installation will be true to line and grade.

8.2 Surface grade fill material or trench subgrade beneath the pipe to provide a uniform and continuous support beneath the pipe at all points between bell holes or pipe joints (see Fig. 6). Densify fill material beneath the pipe.

8.3 After each pipe has been brought to grade, aligned, and placed in final position, deposit and densify sufficient bedding material under the pipe haunches and on each side of the pipe to hold the pipe in proper position during subsequent pipe jointing, bedding, and backfilling operations. Deposit bedding material uniformly and simultaneously on each side of the pipe to prevent lateral displacement.

8.4 Place pipe that is to be bedded in a concrete cradle or encased in concrete in proper position on temporary supports consisting of preshaped wood blocks or bricks with wood wedges. When necessary, rigidly anchor or weight the pipe to prevent flotation when the concrete is placed.

8.5 Place concrete for cradles, arches, or encasement uniformly on each side of the pipe and deposit at approximately its final position. Do not move concrete more than 5 ft (1.5 m) from its point of deposit. Concrete placed beneath the pipe shall be sufficiently workable so that the entire space beneath the pipe can be filled without excessive vibration.

9. Pipe Laying

9.1 Protect pipe during handling against impact shocks and free fall. Do not permit hooks to come in contact with premolded joint surfaces.

9.2 Handle pipe having premolded joint rings or attached couplings so that no weight, including the weight of the pipe itself, will bear on or be supported by the jointing material. Take care to avoid dragging the spigot ring on the ground or allowing it to be damaged by contact with gravel, crushed stone, or other hard objects.

9.3 After delivery alongside the trench, carefully examine each piece of vitrified clay pipe for soundness and specification compliance. Acceptable pipe may be marked with paint or other permanent marking material so that the marks are plainly visible after installation in the trench and before the pipe is covered.

9.4 Clean joint contact surfaces immediately prior to jointing. Use lubricants, primers, or adhesives as recommended by the pipe or joint manufacturer.

9.5 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 jointed in the trench, the pipe shall form a true and smooth line.

9.6 Keep trenches dry during pipe laying. Divert surface water from the trench area to the greatest extent practicable without causing damage to the adjacent property. Before pipe laying is started remove all water that may have entered the trench.

9.7 Whenever practicable, start pipe laying at the lowest point and install the pipe so that the spigot ends point in the direction of flow.

10. Backfilling Trenches

10.1 Unless other protection work is directed, backfill trenches immediately after the pipe is laid. In the case of concrete cradle bedding, delay backfilling until the concrete has set sufficiently to support the backfill load. Except for unusual circumstances (such as subaqueous installation) permit no water to rise in unbackfilled trenches after the pipe is in place.

10.2 Backfill material to be placed above pipe bedding shall be free of brush, debris, and junk. Unless specifically authorized, place no rock or rock excavation detritus in the upper 18 in. (460 mm) of the trench. Place no rock or stones having a dimension larger than 6 in. (150 mm) within 3 ft (0.9 m) of the top of the pipe. Large stones may be placed in the remainder of the trench backfill only if well separated and arranged so that no interference with backfill settlement will result.

10.3 Use puddling, jetting or water flooding for consolidating backfill material only when approved by the engineer. Particularly prone to water damage are sewers laid in heavy clay soils or during cold winter months. Water flooding or jetting in porous sand or gravel during warm periods may be recommended. In general, limit the addition of water during backfill to providing optimum moisture content for tamping procedures.

10.4 Unless otherwise required, the backfill beneath streets, pavement, drives, curbs, walks, and other surface construction shall be bedding material, sand, or tamped earth. Tamped backfill shall be placed in uniform layers and shall have a moisture content that will ensure that maximum density will be obtained with the placement method used.

11. Field Performance and Acceptance

11.1 After the pipe has been laid in the trench, the sewer shall be tested for tightness by a method specified or approved by the engineer. The test shall demonstrate tightness to the degree specified by the engineer before the line is accepted. To test an installed line for construction integrity, water or air testing is recommended depending on the conditions at the site.

11.2 Where ground water exists, the line may be tested by placing a weir in appropriate manholes and determining the quantity of water entering the system during a specified time period.

11.3 Where ground water does or does not exist either a water or low-pressure air test method is considered to be an appropriate test procedure. This will readily determine any construction deficiencies that may exist.

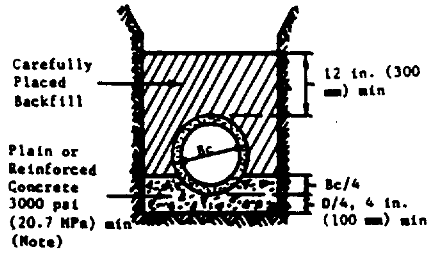
NOTE 3—When water or air tests are specified and the acceptance of a line depends upon satisfactory results, it should be recognized that several factors have a bearing on these results. Manhole bases, walls, and seals must be watertight. Household and commercial building and roof drains must be eliminated. Stoppers for wye and tee spur fittings must be secured sufficiently to be air or watertight, or both. Wyes and tees must be satisfactorily underbedded to prevent shear loading.

11.4 In order for the performance of the [illegible] to be acceptable, all tests shall be made on pipe laid in accordance with the bedding provisions of Section 5. Jointing procedures shall follow the recommendation of the pipe manufacturer.

12. General Recommendations

12.1 Whenever a movable steel box is used in place of sheeting, take care to prevent the pipe from moving when the steel box is moved. Pipe must be secured to prevent longitudinal movement.

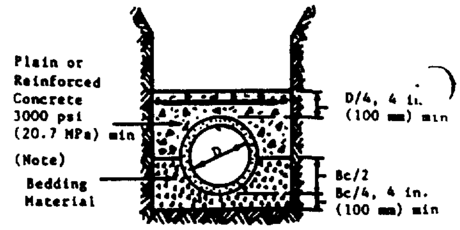
12.2 Where pipe connects with outside faces of manhole walls or the outside faces of the walls of other structures, provide a pipe joint such that slight flexibility or motion can take place in or near the plane of the wall face. It is recommended that a short pipe stub 12 to 18 in. (300 to 450 mm) be extended from manhole or other wall faces.



NOTE—Minimum width of concrete cradle or concrete arch = *Bc* + 8 in. (200 mm) or 1¼ *Bc*

Load factors
2.2 Lightly tamped
2.8 Carefully tamped
3.4 Reinforced concrete, p = 0.4 percent

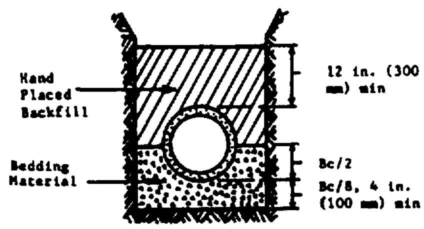
FIG. 1 Class A



NOTE—Minimum width of concrete cradle or concrete arch = *Bc* + 8 in. (200 mm) or 1¼ *Bc*

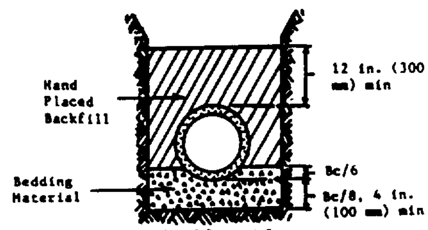
Load Factors
2.8 Plain concrete
3.4 Reinforced concrete, p = 0.4 percent
4.8 Reinforced concrete, p = 1.0 percent

FIG. 2 Class A-I



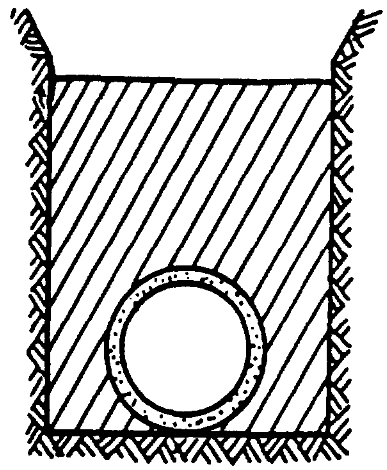
Load factor 1.9

FIG. 3 Class B



Load factor 1.5

FIG. 4 Class C



Load Factor 1.1

FIG. 5 Class D

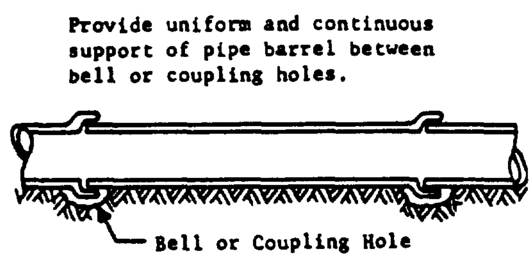


FIG. 6 Uniform Pipe Support

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