



Designation: D 2321 – 00

An American National Standard

Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications¹

This standard is issued under the fixed designation D 2321; 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 Department of Defense.

1. Scope

1.1 This practice provides recommendations for the installation of buried thermoplastic pipe used in sewers and other gravity-flow applications. These recommendations are intended to ensure a stable underground environment for thermoplastic pipe under a wide range of service conditions. However, because of the numerous flexible plastic pipe products available and the inherent variability of natural ground conditions, achieving satisfactory performance of any one product may require modification to provisions contained herein to meet specific project requirements.

1.2 The scope of this practice necessarily excludes product performance criteria such as minimum pipe stiffness, maximum service deflection, or long term strength. Thus, it is incumbent upon the product manufacturer, specifier, or project engineer to verify and assure that the pipe specified for an intended application, when installed according to procedures outlined in this practice, will provide a long term, satisfactory performance according to criteria established for that application. A commentary on factors important in achieving a satisfactory installation is included in Appendix X1.

NOTE 1—Specific paragraphs in the appendix are referenced in the body of this practice for informational purposes.

NOTE 2—The following ASTM standards may be found useful in connection with this practice: Practice D 420, Test Method D 1556, Method D 2216, Specification D 2235, Test Method D 2412, Specification D 2564, Practice D 2657, Practice D 2855, Test Methods D 2922, Test Method D 3017, Practice F 402, Specification F 477, Specification F 545, and Specification F 913.

NOTE 3—Most Plumbing Codes and some Building Codes have provisions for the installation of underground “building drains and building sewers.” See them for plumbing piping applications.

1.3 *This standard does not purport to address all of the safety problems, 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.*

¹ This practice is under the jurisdiction of ASTM Committee F-17 on Plastic Piping Systems and is the direct responsibility of Subcommittee F17.62 on Sewer Pipe.

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2. Referenced Documents

2.1 ASTM Standards:

- D 8 Terminology Relating to Materials for Roads and Pavements²
- D 653 Terminology Relating to Soil, Rock, and Contained Fluids³
- D 698 Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m³))
- D 2487 Test Method for Classification of Soils for Engineering Purposes^{3,4}
- D 2488 Practice for Description and Identification of Soils (Visual-Manual Procedure)^{3,4}
- D 3839 Practice for Underground Installation of “Fiberglass” (Glass-Fiber Reinforced Thermosetting Resin) Pipe⁴
- D 4318 Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils³
- F 412 Terminology Relating to Plastic Piping Systems⁴

3. Terminology

3.1 *General*—Definitions used in this practice are in accordance with Terminologies F 412 and D 8 and Terminology D 653 unless otherwise indicated.

3.2 Definitions of Terms Specific to This Standard:

3.2.1 *foundation, bedding, haunching, initial backfill, final backfill, pipe zone, excavated trench width*—See Fig. 1 for meaning and limits, and trench terminology.

3.2.2 *aggregate*—a granular material of mineral composition such as sand, gravel, shell, slag or crushed stone (see Terminology D 8).

3.2.3 *deflection*—any change in the inside diameter of the pipe resulting from installation and imposed loads. Deflection may be either vertical or horizontal and is usually reported as a percentage of the base (undeflected) inside pipe diameter.

3.2.4 *dense-graded aggregate*—an aggregate that has a particle size distribution such that, when it is compacted, the

² Annual Book of ASTM Standards, Vol 04.03.

³ Annual Book of ASTM Standards, Vol 04.08.

⁴ Annual Book of ASTM Standards, Vol 08.04.

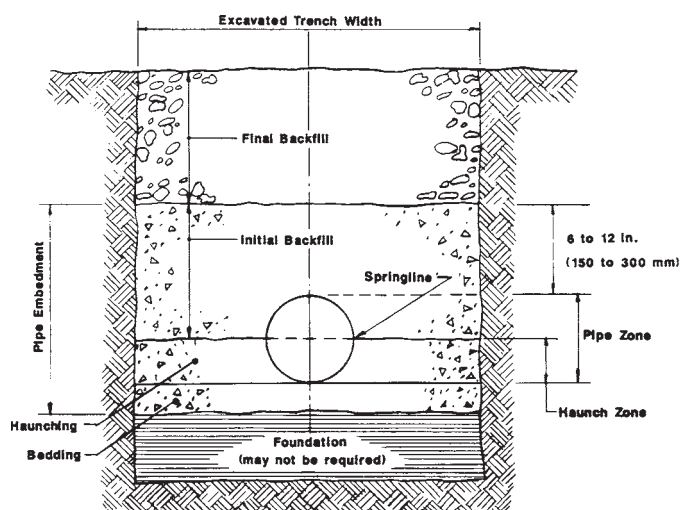


FIG. 1 Trench Cross Section Showing Terminology

resulting voids between the aggregate particles, expressed as a percentage of the total space occupied by the material, are relatively small.

3.2.5 *engineer*—the engineer in responsible charge of the work or his duly recognized or authorized representative.

3.2.6 *manufactured aggregates*—aggregates such as slag that are products or byproducts of a manufacturing process, or natural aggregates that are reduced to their final form by a manufacturing process such as crushing.

3.2.7 *open-graded aggregate*—an aggregate that has a particle size distribution such that, when it is compacted, the voids between the aggregate particles, expressed as a percentage of the total space occupied by the material, are relatively large.

3.2.8 *optimum moisture content*—The moisture content of soil at which its maximum density is obtained (see Test Methods D 698).

3.2.9 *processed aggregates*—aggregates that are screened, washed, mixed, or blended to produce a specific particle size distribution.

3.2.10 *standard proctor density*—the maximum dry unit weight of soil compacted at optimum moisture content, as obtained by laboratory test in accordance with Test Methods D 698.

4. Significance and Use

4.1 This practice is for use by designers and specifiers, installation contractors, regulatory agencies, owners, and inspection organizations who are involved in the construction of sewers and other gravity-flow applications that utilize flexible thermoplastic pipe. As with any standard practice, modifications may be required for specific job conditions or for special local or regional conditions. Recommendations for inclusion of this practice in contract documents for a specific project are given in Appendix X2.

5. Materials

5.1 *Classification*—Materials for use as foundation, embedment, and backfill are classified in Table 1. They include natural, manufactured, and processed aggregates and the soil types classified according to Test Method D 2487.

NOTE 4—See Practice D 2488 for a visual-manual procedure for field identification of soils.

NOTE 5—Processed materials produced for highway construction, including coarse aggregate, base, subbase, and surface course materials, when used for foundation, embedment, and backfill, should be classified in accordance with this section and Table 1 according to particle size, shape and gradation.

5.2 *Installation and Use*—Table 2 provides recommendations on installation and use based on class of soil or aggregates and location in the trench.

5.2.1 *Use of Class I to Class IVA Soils and Aggregates*—These materials may be used as recommended in Table 2, unless otherwise specified.

5.2.2 *Use of Class IV-B and Class V Soils and Frozen Materials*—These materials are not recommended for embedment, and should be excluded from the final backfill except where allowed by project specifications.

5.3 *Description of Embedment Material*—Sections 5.3.1 through 5.3.5 describe characteristics of materials recommended for embedment.

5.3.1 *Class IA Materials*—Class IA materials provide maximum stability and pipe support for a given density due to angular interlock of particles. With minimum effort these materials can be installed at relatively high densities over a wide range of moisture contents. In addition, the high permeability of Class IA materials may aid in the control of water, and these materials are often desirable for embedment in rock cuts where water is frequently encountered. However, when ground water flow is anticipated, consideration should be given to the potential for migration of fines from adjacent materials into the open-graded Class IA materials (see X1.8).

5.3.2 *Class IB Materials*—Class IB materials are processed by mixing Class IA and natural or processed sands to produce a particle size distribution that minimizes migration from adjacent materials that contain fines (see X1.8). They are more densely graded than Class IA materials and thus require more compactive effort to achieve the minimum density specified. When properly compacted, Class IB materials offer high stiffness and strength and, depending on the amount of fines, may be relatively free draining.

5.3.3 *Class II Materials*—Class II materials, when compacted, provide a relatively high level of pipe support. In most respects, they have all the desirable characteristics of Class IB materials when densely graded. However, open graded groups may allow migration and the sizes should be checked for compatibility with adjacent material (see X1.8). Typically, Class II materials consist of rounded particles and are less stable than angular materials unless they are confined and compacted.

5.3.4 *Class III Materials*—Class III materials provide less support for a given density than Class I or Class II materials. High levels of compactive effort may be required unless moisture content is controlled. These materials provide reasonable levels of pipe support once proper density is achieved.

5.3.5 *Class IV-A Materials*—Class IV-A materials require a geotechnical evaluation prior to use. Moisture content must be near optimum to minimize compactive effort and achieve the required density. Properly placed and compacted, Class IV-A materials can provide reasonable level of pipe support.



TABLE 1 Classes of Embedment and Backfill Materials

Class	Type	Soil Group Symbol D 2487	Description	Percentage Passing Sieve Sizes			Atterberg Limits		Coefficients	
				1½in. (40 mm)	No. 4 (4.75 mm)	No. 200 (0.075 mm)	LL	PI	Uni- formity C _u	Curva- ture C _c
IA	Manufactured Aggregates: open-graded, clean.	None	Angular, crushed stone or rock, crushed gravel, broken coral, crushed slag, cinders or shells; large void content, contain little or no fines.	100 %	≤10 %	<5 %	Non Plastic			
IB	Manufactured, Processed Aggregates; dense- graded, clean.	None	Angular, crushed stone (or other Class 1A materials) and stone/sand mixtures with gradations selected to minimize migration of adja- cent soils; contain little or no fines (see X1.8).	100 %	≤50 %	<5 %	Non Plastic			
II	Coarse-Grained Soils, clean	GW	Well-graded gravels and gravel-sand mixtures; little or no fines.	100 %	<50 % of “Coarse Fraction”	<5 %	Non Plastic		>4	1 to 3
		GP	Poorly-graded gravels and gravel-sand mixtures; little or no fines.						<4	<1 or >3
		SW	Well-graded sands and grav- elly sands; little or no fines.		>50 % of “Coarse Fraction”				>6	1 to 3
		SP	Poorly-graded sands and gravelly sands; little or no fines.						<6	<1 or >3
	Coarse-Grained Soils, bor- derline clean to w/fines	e.g. GW-GC, SP-SM.	Sands and gravels which are borderline between clean and with fines.	100 %	Varies	5 % to 12 %	Non Plastic		Same as for GW, GP, SW and SP	
III	Coarse-Grained Soils With Fines	GM	Silty gravels, gravel-sand-silt mixtures.	100 %	<50 % of “Coarse Fraction”	12 % to 50 %		<4 or <“A” Line		
		GC	Clayey gravels, gravel-sand- clay mixtures.					<7 and >“A” Line		
		SM	Silty sands, sand-silt mixtures.		>50 % of “Coarse Fraction”			>4 or <“A” Line		
		SC	Clayey sands, sand-clay mix- tures.					>7 and >“A” Line		
IVA ^A	Fine-Grained Soils (inor- ganic)	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands, silts with slight plasticity.	100 %	100 %	>50 %	<50	<4 or <“A” Line		
		CL	Inorganic clays of low to me- dium plasticity, gravelly clays, sandy clays, silty clays, lean clays.					>7 and >“A” Line		
IVB	Fine-Grained Soils (inor- ganic)	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts.	100 %	100 %	>50 %	>50	<“A” Line		
		CH	Inorganic clays of high plas- ticity, fat clays.					>“A” Line		
V	Organic Soils	OL	Organic silts and organic silty clays of low plasticity.	100 %	100 %	>50 %	<50	<4 or <“A” Line		
	Highly Organic	OH	Organic clays of medium to high plasticity, organic silts.				>50	<“A” Line		
		PT	Peat and other high organic soils.							

⁴Includes Test Method D 2487 borderline classifications and dual symbols depending on plasticity index and liquid limits.

Note—"Coarse Fraction" as used in this table is defined as material retained on a No. 200 sieve.