Designation: D 3839 – 94a

An American National Standard

Standard Practice for Underground Installation of "Fiberglass" (Glass-FiberReinforced Thermosetting-Resin) Pipe[1]

This standard is issued under the fixed designation D 3839; 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 establishes procedures for the burial of pressure and nonpressure "fiberglass" (glass-fiber-reinforced thermosetting-resin) pipe in many typically encountered soil conditions. Included are recommendations for trenching, placing pipe, joining pipe, placing and compacting backfill, and monitoring deflection levels. Guidance for installation of fiberglass pipe in subaqueous conditions is not included.

1.2 Product standards for fiberglass pipe encompass a wide range of product variables. Diameters range from 1 in. to 12 ft and pipe stiffness range from 9 to over 72 psi with internal pressure ratings up to several thousand pound-force per square inch. This standard does not purport to consider all of the possible combinations of pipe, soil types, and natural ground conditions that may occur. The recommendations in this practice may need to be modified or expanded to meet the needs of some installation conditions. In particular, fiberglass pipe with diameters of a few inches are generally so stiff that they are frequently installed in accordance with different guidelines. Consult with the pipe manufacturer for guidance on which practices are applicable to these particular pipes.

1.3 The scope of this practice excludes product-performance criteria such as a minimum pipe stiffness, maximum service deflection, or long-term strength. Such parameters may be contained in product standards or design specifications, or both, for fiberglass pipe. It is incumbent upon the specified product manufacturer or project engineer to verify and ensure that the pipe specified for an intended application, when installed in accordance with procedures outlined in this practice, will provide a long-term, satisfactory performance in accordance with criteria established for that application.

NOTE 1—There is no similar or equivalent ISO standard.

NOTE 2—A discussion of the importance of deflection and a presentation of a simplified method to approximate field deflections are given in AWWA C 950.

1.4 *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:*

D 8 Terminology Relating to Materials for Roads and Pavements[2]
D 653 Terminology Relating to Soil, Rock, and Contained Fluids[3]
D 698 Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft (600 kN-m/m))[3]
D 883 Terminology Relating to Plastics[4]
D 1556 Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method[3]
D 2167 Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method[3]
D 2216 Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock[3]
D 2321 Practice for Underground Installation of Flexible Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications[5]
D 2487 Classification of Soils for Engineering Purposes[5]
D 2488 Practice for Description of Soils (Visual-Manual Procedure)[3]
D 2922 Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)[3]
D 3017 Test Method for Moisture Content of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)[3]
D 4253 Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table[3]
D 4254 Test Method for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density[3]
D 4318 Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils[3]

[1] This practice is under the jurisdiction of ASTM Committee D-20 on Plastics and is the direct responsibility of Subcommittee D20.23 on Reinforced Plastic Piping Systems and Chemical Equipment.

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[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 08.01.
[5] *Annual Book of ASTM Standards*, Vol 08.04.

D 4564 Test Method for Density of Soil in Place by the Sleeve Method[3]

D 4643 Method for Determination of Water (Moisture) Content of Soil by the Microwave Oven Method[3]

D 4914 Test Method for Density of Soil and Rock in Place by the Sand Replacement Method in a Test Pit[3]

D 4944 Test Method for Field Determination of Water (Moisture) Content of Soil by the Calcium Carbide Gas Pressure Tester Method[6]

D 4959 Test Method for Determination of Water (Moisture) Content of Soil by Direct Heating Method[6]

D 5030 Test Methods for Density and Unit Weight of Soil and Rock in Place by the Water Replacement Method in a Test Pit[6]

D 5080 Test Method for Rapid Determination of Percent Compaction[6]

F 412 Terminology Relating to Plastic Piping Systems[5]

2.2 *Other Standards:*

AASHTO American Association of State Highway and Transportation Officials Standard Specifications for Highway Bridges[7]

AWWA C 950 American Water Works Association Standard Specification for Fiberglass Pressure Pipe[8]

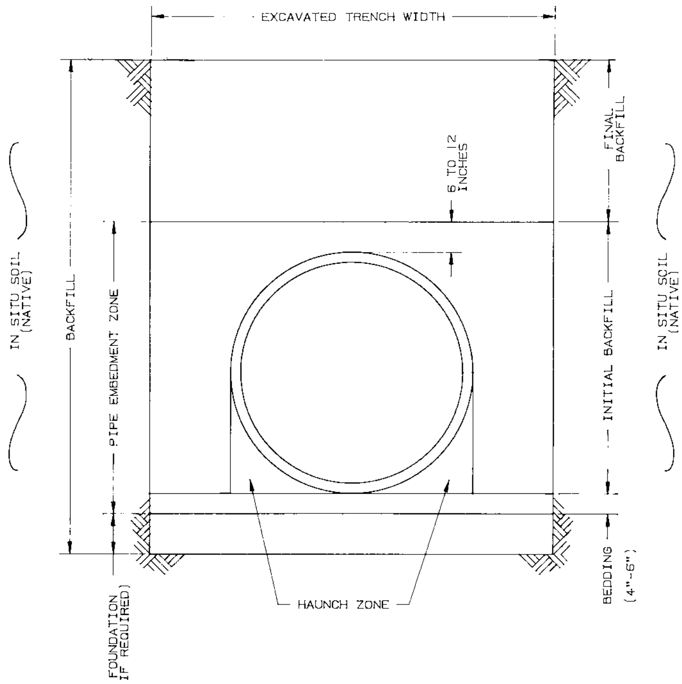

FIG. 1 Trench Cross-Section Terminology

3. Terminology

3.1 *Definitions:*

3.1.1 *General*—Unless otherwise indicated, definitions are in accordance with Terminologies D 8, D 653, D 883, and F 412.

3.2 *Definitions of Terms Specific to This Standard:* Descriptions of Terms Specific to This Standard:

3.2.1 *bedding*—backfill material placed and compacted in the bottom of the trench or on the foundation to provide a uniform material on which to lay the pipe.

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

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

3.2.4 *fiberglass pipe*—a tubular product containing glass-fiber reinforcements embedded in or surrounded by cured thermosetting resin; the composite structure may contain aggregate, granular, or platelet fillers, thixotropic agents, pigments, or dyes; thermoplastic or thermosetting liners or coatings may be included.

3.2.5 *final backfill*—backfill material placed from the top of the initial backfill to the ground surface.

3.2.6 *foundation*—backfill material placed and compacted in the bottom of the trench to replace over-excavated material or to stabilize the trench-bottom in case of unsuitable ground conditions, or both (see Fig. 1).

3.2.7 *geotextile*—any permeable textile material used with foundation, soil, earth, rock, or any other geotechnical engineering related material, as an integral part of a man-made product, structure, or system.

3.2.8 *haunching*—backfill material placed on top of the bedding and under the springline of the pipe; the term haunching only pertains to soil directly beneath the pipe (see Fig. 1).

3.2.9 *initial backfill*—backfill material placed at the sides of the pipe and up to 6 to 12 in. (150 to 300 mm) over the top of the pipe, including the haunching.

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

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

3.2.12 *native (in situ) soil*—natural soil in which a trench is excavated for pipe installation or on which a pipe and embankment are placed.

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

3.2.14 *optimum moisture content*—the moisture content of soil at which its maximum density is obtained. (See Test Method D 698.)

3.2.15 *pipe zone embedment*—all backfill around the pipe; this includes the bedding, haunching, and initial backfill.

3.2.16 *processed aggregates*—aggregates which are screened or washed or mixed or blended to produce a specific particle-size distribution.

3.2.17 *relative density*—a measure of the density of a

[6] *Annual Book of ASTM Standards*, Vol 04.09.
[7] Available from AASHTO, Denver, CO.
[8] Available from AWWA, Washington, DC.

granular soil based on the actual density of the soil "relative" to the soil in its loosest state and the soil in its densest state (see Terminology D 653 for a precise definition) as obtained by laboratory testing in accordance with Test Methods D 4253 and D 4254.

3.2.18 *soil stiffness*—a property of soil, generally represented numerically by a modulus of deformation that indicates the relative amount of deformation that will occur under a given load.

3.2.19 *split installation*—an installation in which the initial backfill consists of two different materials; the primary backfill must extend from the top of the bedding to a depth of at least 0.7 times the diameter and the secondary backfill extends from the top of the primary backfill to the top of the initial backfill.

4. Significance and Use

4.1 This practice is for use by designers and specifiers, manufacturers, installation contractors, regulatory agencies, owners, and inspection organizations involved in the construction of buried fiberglass pipelines. As with any 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 X1.

5. Materials

5.1 *Classification*—Soil types used or encountered in burying pipes include those classified in Table 1 and natural, manufactured, and processed aggregates. The soil classifications are grouped into soil-stiffness categories (SC) in Table 2 based on the typical soil stiffness when compacted. Soil-stiffness Category 1 indicates a soil that generally provides the highest soil stiffness at any given percentage of maximum Proctor density, and a soil that provides a given soil stiffness with the least compactive effort. Each higher-number soil-stiffness category provides successively less soil stiffness at a

TABLE 1 Soil Classification Chart (see Classification D 2487)

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests[A]				Soil Classification	
				Group Symbol	Group Name[B]
Coarse-Grained Soils More than 50 % retained on No. 200 sieve	gravels more than 50 % of coarse fraction retained on No. 4 sieve	clean gravels less than 5 % fines[E]	$Cu \geq 4$ and $1 \leq Cc \leq 3$[C]	GW	well-graded gravel[D]
			$Cu < 4$ and/or $1 > Cc > 3$[C]	GP	poorly graded gravel[D]
		gravels with fines more than 12 % fines[E]	Fines classify as ML or MH	GM	silty gravel[D,F,G]
			Fines classify as CL or CH	GC	clayey gravel[D,F,G]
	sands 50 % or more of coarse fraction passes No. 4 sieve	clean sands less than 5 % fines[I]	$Cu \geq 6$ and $1 \leq Cc \leq 3$[C]	SW	well-graded sand[H]
			$Cu < 6$ and/or $1 > Cc > 3$[C]	SP	poorly graded sand[H]
		sands with fines more than 12 % fines[I]	Fines classify as ML or MH	SM	silty sand[F,G,H]
			Fines classify as CL or CH	SC	clayey sand[F,G,H]
Fine-Grained Soils 50 % or more passes the No. 200 sieve	silts and clays liquid limit less than 50	inorganic	PI > 7 and plots on or above "A" line[J]	CL	lean clay[K,L,M]
			PI < 4 or plots below "A" line[J]	ML	silt[K,L,M]
		organic	$\frac{\text{liquid limit} - \text{oven dried}}{\text{liquid limit} - \text{not dried}} < 0.75$	OL	organic clay[K,L,M,N] organic silt[K,L,M,O]
	silts and clays liquid limit 50 or more	inorganic	PI plots on or above "A" line	CH	fat clay[K,L,M]
			PI plots below "A" line	MH	elastic silt[K,L,M]
		organic	$\frac{\text{liquid limit} - \text{oven dried}}{\text{liquid limit} - \text{not dried}} < 0.75$	OH	organic clay[K,L,M,P] organic silt[K,L,M,Q]
Highly organic soils	primarily organic matter, dark in color, and organic odor			PT	peat

[A] Based on the material passing the 3-in. (75-mm) sieve.
[B] If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.
[C] $Cu = D_{60}/D_{10}$ $\quad Cc = \frac{(D_{30})^2}{D_{10} \times D_{60}}$
[D] If soil contains ≥15 % sand, add "with sand" to group name.
[E] Gravels with 5 to 12 % fines require dual symbols:
GW-GM well-graded gravel with silt
GW-GC well-graded gravel with clay
GP-GM poorly graded gravel with silt
GP-GC poorly graded gravel with clay
[F] If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.
[G] If fines are organic, add "with organic fines" to group name.
[H] If soil contains ≥15 % gravel, add "with gravel" to group name.
[I] Sands with 5 to 12 % fines require dual symbols:
SW-SM well-graded sand with silt
SW-SC well-graded sand with clay
SP-SM poorly graded sand with silt
SP-SC poorly graded sand with clay
[J] If Atterberg limits plot in hatched area, soil is a CL-ML, silty clay (see Test Method D 4318).
[K] If soil contains 15 to 29 % plus No. 200, add "with sand" or "with gravel," whichever is predominant.
[L] If soil contains ≥30 % plus No. 200, predominantly sand, add "sandy" to group name.
[M] If soil contains ≥30 % plus No. 200, predominantly gravel, add "gravelly" to group name.
[N] PI ≥ 4 and plots on or above "A" line.
[O] PI < 4 or plots below "A" line.
[P] PI plots on or above "A" line.
[Q] PI plots below "A" line.

TABLE 2 Soil-Stiffness Categories

NOTE 1—Soil-stiffness categories group types together as a function of the relative level of soil stiffness developed when compacted to a given level. At any given level of compaction, SC1 soils provide the highest stiffness and SC5 soils the lowest.

NOTE 2—The soil-stiffness categories are similar but not identical to the soil classes in Practice D 2321.

Soil Group	Soil Stiffness Class
Crushed rock and gravel with <15 % sand and ≤5 % fines	SC1
GW, GP, SW, SP, and dual symbol soils beginning with one of these symbols such as GW-GC, SP-SM, etc. containing <12 % fines (passing the No. 200 sieve)	SC2
GM, GC, SM, SC, and ML, CL, CL-ML, or borderline soils beginning with one of these symbols such as CL/CH, SM/ML, etc. with ≥30 % retained on the No. 200 sieve	SC3
ML, CL, CL-ML, CL/ML, with <30 % retained on the No. 200 sieve with LL <50	SC4
CH, MH, OL, OH, PT, or borderline soils beginning with one of these symbols such as CH/MH, etc. and any frozen materials	SC5

given percentage of maximum Proctor density and requires greater compactive effort to provide a given level of soil stiffness.

NOTE 3—See Practice D 2488 for a visual-manual procedure for field identification of soils.

NOTE 4—Processed materials produced for highway construction, including coarse aggregate, base, subbase, and surface coarse materials, when used for foundation, embedment, and backfill, should be categorized in accordance with this section and Table 1 in accordance with particle size and gradation.

5.2 *Installation and Use*—Table 3 provides recommendations on installation and use based on soil-stiffness category and location in the trench. Soil-stiffness Categories 1 to 4 may be used as recommended in Table 3, unless otherwise specified. Soil-stiffness Category 5, including clays and silts with liquid limits greater than 50, organic soils, and frozen soils, should be excluded from the pipe-zone embedment.

5.2.1 *Soil-Stiffness Category 1 (SC1)*— SC1 materials provide maximum stability and pipe support for a given density due to the low content of sand and fines. With minimum effort these materials can be installed at relatively high-soil stiffnesses over a wide range of moisture contents. In addition, the high permeability of SC1 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 SC1 materials. (See 5.5.)

5.2.2 *Soil-Stiffness Category 2 (SC2)*— SC2 materials, when compacted, provide a relatively high level of pipe support; however, open-graded groups may allow migration and the sizes should be checked for compatibility with adjacent material; see 6.5.

5.2.3 *Soil-Stiffness Category 3 (SC3)*— SC3 materials provide less support for a given density than SC1 or SC2 materials. Higher levels of compactive effort are required and moisture content must be controlled. These materials provide reasonable levels of pipe support once proper density is achieved.

TABLE 3 Recommendations for Installation and Use of Soils and Aggregates for Foundation and Pipe-Zone Embedment

Soil Stiffness Category[A]	SC1	SC2	SC3	SC4
General Recommendations and Restrictions	Acceptable and common where no migration is probable or when combined with a geotextile filter media. Suitable for use as a drainage blanket and under drain where adjacent material is suitably graded or when used with a geotextile filter fabric (see 6.5).	Where hydraulic gradient exists check gradation to minimize migration. Clean groups suitable for use as a drainage blanket and underdrain (see Table 1).	Do not use where water conditions in trench prevent proper placement and compaction.	Difficult to achieve high-soil stiffness (see section 6.2.4). Do not use where water conditions in trench prevent proper placement and compaction.
Foundation	Suitable as foundation and for replacing over-excavated and unstable trench bottom as restricted above.	Suitable as foundation and for replacing over-excavated and unstable trench bottom as restricted above.	Suitable for replacing over-excavated trench bottom as restricted above.	Not suitable.
Pipe Zone Embedment	Suitable as restricted above. Work material under pipe to provide uniform haunch support.	Suitable as restricted above. Work material under pipe to provide uniform haunch support.	Suitable as restricted above. Difficult to place and compact in the haunch zone.	Suitable as restricted above. Difficult to place and compact in the haunch zone.
Embedment Compaction: MinSPD[B] Density (E′ = 1000 psi min)	[C]	85 %	90 %	95 %
Relative Compactive Effort Required to Achieve Minimum Density	low	moderate	high	very high
Compaction Methods	vibration or impact	vibration or impact	impact	impact
Required Moisture Control	none	none	maintain near optimum to minimize compactive effort	maintain near optimum to minimize compactive effort

[A]SC5 materials are unsuitable as embedment. They may be used as final backfill as permitted by the engineer.
[B]SPD is standard Proctor density as determined by Test Method D 698.
[C]Minimum density typically achieved by dumped placement.