Designation: D6236 – 11

Standard Guide for Coring and Logging Soil-Cement or Lime-Stabilized Soil[1]

This standard is issued under the fixed designation D6236; 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.

1. Scope*

1.1 This guide covers obtaining cores of soil-cement or lime-stabilized soil for use in determining compressive strength, lift thickness and bond strength, and other physical properties. This guide is primarily for use in coring through shallow (0.3 to 3 m (1 to 10 ft) thick) layers of cement or lime-stabilized soils containing particles < 50 mm (2 in.) in diameter to the underlying foundation.

NOTE 1—This guide could be used for some Class C self-cementing fly ash materials, which may also stabilize soil.

1.2 This guide does not cover material of less than 2100 kPa (300 psi) compressive strength such as cement-soil-bentonite mixtures or some controlled low strength materials (CLSM).

1.3 All observed and calculated values shall conform to the guidelines for significant digits and rounding established in Practice D6026.

1.4 The values stated in SI units are to be regarded as the standard. Other values are examples or for information only.

1.5 *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.* Specific precautionary statements are given in Section 8.

1.6 *This guide offers an organized collection of information or a series of options and does not recommend a specific course of action. This guide cannot replace education or experience and should be used in conjunction with professional judgment. Not all aspects of this guide may be applicable in all circumstances. This guide is not intended to represent or replace the standard of care by which the adequacy of a given professional service must be judged, nor should this guide be applied without consideration of a project's many unique aspects. The word "Standard" in the title of this document means only that the document has been approved through the ASTM consensus process.*

1.7 The text of this standard references notes and footnotes which provide explanatory material. These notes and footnotes (excluding those in tables and figures) shall not be considered as requirements of the standard.

2. Referenced Documents

2.1 *ASTM Standards:*[2]

C51 Terminology Relating to Lime and Limestone (as used by the Industry)

C219 Terminology Relating to Hydraulic Cement

D559 Test Methods for Wetting and Drying Compacted Soil-Cement Mixtures (Withdrawn 2012)[3]

D560 Test Methods for Freezing and Thawing Compacted Soil-Cement Mixtures (Withdrawn 2012)[3]

D653 Terminology Relating to Soil, Rock, and Contained Fluids

D1633 Test Methods for Compressive Strength of Molded Soil-Cement Cylinders

D3740 Practice for Minimum Requirements for Agencies Engaged in Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction

D4220 Practices for Preserving and Transporting Soil Samples

D4452 Practice for X-Ray Radiography of Soil Samples

D5079 Practices for Preserving and Transporting Rock Core Samples

D5102 Test Methods for Unconfined Compressive Strength of Compacted Soil-Lime Mixtures

D5607 Test Method for Performing Laboratory Direct Shear Strength Tests of Rock Specimens Under Constant Normal Force

D6026 Practice for Using Significant Digits in Geotechnical Data

3. Terminology

3.1 *Definitions:*

3.1.1 Refer to Terminology C51 for terms relating to *lime*.

[1] This test method is under the jurisdiction of ASTM Committee D18 on Soil and Rock and is the direct responsibility of Subcommittee D18.15 on Stabilization With Admixtures.

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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.

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

***A Summary of Changes section appears at the end of this standard**

3.1.2 Refer to Terminology C219 for terms relating to *hydraulic cement*.

3.1.3 Refer to Terminology D653 for terms relating to *soil*.

4. Summary of Guide

4.1 Core samples of soil-cement or lime-stabilized soil with a core diameter of 75- or 100-mm (3- or 4-in.) are obtained through the entire thickness of a stabilized soil section or facing using a rotary drill equipped with a diamond coring bit. To minimize the possibility of breakage or other internal damage to the sample during coring operations, it is suggested that the stabilized soil have a minimum compressive strength of 2100 kPa (300 psi) prior to coring, cores are retrieved, labeled, and logged. Coring may be repeated at other times if specified by the engineer. Retrieve, label, and log the cores. Retrieved cores are tested as specified by the engineer. Tests commonly requested include unconfined compressive strength in accordance with Test Methods D1633 and D5102, durability in accordance with Test Methods D559 and D560, bond strength in accordance with Test Method D5607 and uniformity and possible voids in accordance with Test Methods D4452.

5. Significance and Use

5.1 Coring is performed to evaluate construction control and physical properties of stabilized soil.

5.2 Coring is conducted to determine the quality and the total thickness of the stabilized soil and to evaluate bonding between lifts.

5.3 Coring stabilized soil before it has cured to at least 2100 kPa (300 psi) compressive strength can cause excessive breakage in the core.

5.4 If lab-cured specimens are prepared, samples may be cored to correlate with specified break intervals of the lab-cured specimens. Typical curing time intervals are 7, 28, 60, or 90 days or combinations thereof after placement. Twenty-eight (28) days after placement is the most common time interval for first drilling cores.

NOTE 2—The quality of the result produced by this standard is dependent on the competence of the personnel performing it, and the suitability of the equipment and facilities used. Agencies that meet the criteria of Practice D3740 are generally considered capable of competent and objective testing/sampling/inspection/etc. Users of this standard are cautioned that compliance with Practice D3740 does not in itself assure reliable results. Reliable results depend on many factors; Practice D3740 provides a means of evaluating some of those factors.

6. Interferences

6.1 Failure to adequately stabilize the drill and drill stand during coring can cause excessive breakage in the core.

6.2 Failure to set up the drill and drill stand perpendicular to the surface of the stabilized soil will cause error in determining the thickness of the stabilized material.

7. Apparatus

7.1 *Drill and Drill Stand*—A rotary drill capable of drilling 100-mm (4-in.) diameter core samples to the required depth (generally 0.3 to 1.2 m (1 to 4 ft). The drill must be capable of drilling holes perpendicular to the face of the stabilized soil. The drill should be mounted and the drill stand anchored so that the drill and stand are stable during the drilling process.

7.2 *Core Barrels*—Diamond surface set or diamond impregnated core bits, 75- or 100-mm (3- or 4-in.) inside diameter, of sufficient length to penetrate the full vertical depth of the stabilized material.

7.3 *Adapters*—Removable extension adapters and extensions rods compatible with drill and core barrels.

7.4 *Water*—Water supply for drilling to remove cuttings and cool drill bits.

7.5 *Generator*—Portable electric generator suitable for supplying electric power to drill.

7.6 *Percussion Drill*—Rotary percussion drill or other suitable device holes for anchor bolts.

7.7 *Anchors*—Anchors and bolts adequate for securing the drill stand to the stabilized material.

7.8 *Core Retrieval Barrels*—Worn 75- or 100-mm (3- or 4-in.) diameter core bits with cutting edge removed and slotted on the drilling end for retrieving core samples (Fig. 1).

7.9 *Pry Bar*—Metal bar suitable for breaking core from the bottom of the hole.

7.10 *Containers*—Containers shall be in accordance with Practices D5079 or D4220.

7.11 *Grouting Materials*—Potable water, concrete premix, bagged cement, or grout premix for back filling drill holes.

7.12 *Miscellaneous Equipment*—Assorted tools necessary for drilling operations, chain tongs and pipe wrenches for installing and removing core barrels, and water proof markers for labeling core samples.

8. Hazards

8.1 *Safety Hazards:*

8.1.1 Safety hazards may be involved in the use of the rotary drill. Refer to the manufacturer's handbook before operating the drill.

8.1.2 Ensure that electrical supply lines are well insulated and connections kept dry to prevent electrical shock.

8.1.3 Use caution when refilling gasoline tanks on electrical generators.

8.1.4 Drilling equipment and core samples are heavy and awkward. Use care when lifting or transporting equipment or samples.

8.1.5 Drilling operations often take place on sloped surfaces. Adequate safety shoes or safety boots should be worn to prevent slipping into machinery or down the slope.

8.1.6 Wear safety glasses and hard hat.

8.1.7 Use of a respirator may be necessary.

8.2 *Technical Hazards:*

8.2.1 Because of low early compressive strength, it may be difficult to obtain representative intact core samples until the stabilized soil has reached a compressive strength of 2100 kPa (300 psi).

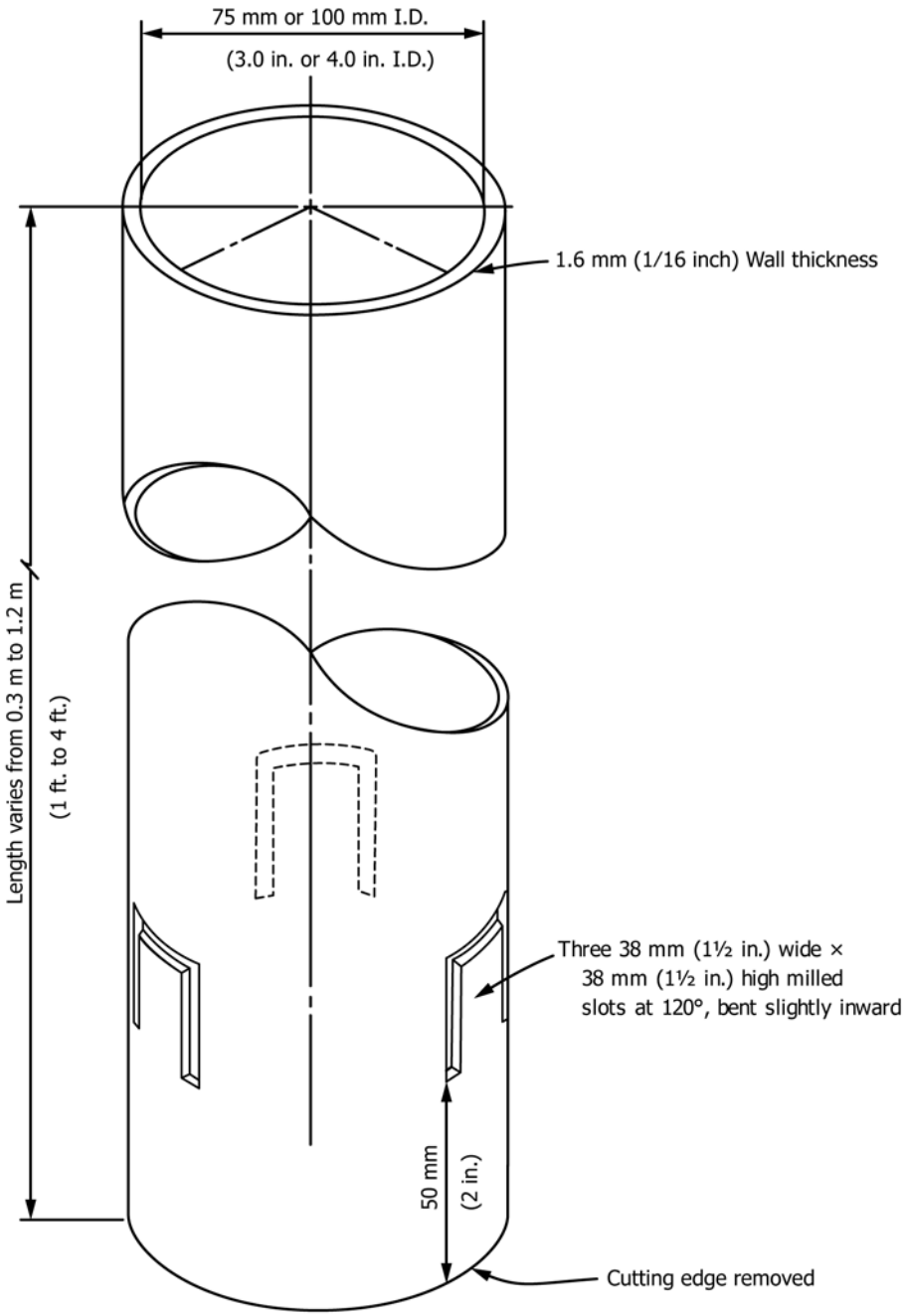

FIG. 1 Core Retrieval Barrel Made From Worn Diamond Studded Core Barrel

9. Procedure

9.1 Record all data on an appropriate log form.

9.2 *Coring*—Coring is done when the strength of the stabilized soil has reached an estimated minimum compressive strength of 2100 kPa (300 psi). Time to reach this strength will vary depending on mix design. Time interval after placement until sample is cored should be coordinated with specified break intervals of lab-cured specimens if such were prepared, or as specified by an engineer. Common curing time intervals are 7, 28, 60, and/or 90 days. If coring is repeated, subsequent holes should be immediately adjacent to the previous holes.

9.2.1 Core drill hole locations and depths are based on the design of the stabilized soil-lime or soil-cement structure. General hole locations and core diameters required for testing should be determined prior to the start of construction. Cores should also be obtained in any area of questionable stabilized soil quality.

9.2.2 Anchor the drill stand in a manner which effectively stabilizes the drill and drill stand during drilling and allows for coring and core retrieval to be perpendicular to the placement lifts.

NOTE 3—Core barrels should remain perpendicular to the face of the

stabilized soil, and the drill and stand should be stable while drilling to prevent core from binding in the barrel.

9.2.3 As required, install a 75- or 100-mm (3- or 4-in.) inside diameter core barrel of sufficient length to penetrate the full vertical depth of the stabilized material facing.

9.2.4 In one continuous operation, drill through the entire depth of the stabilized soil to the embankment or foundation contact.

NOTE 4—Drilling should be performed at a slow rotational speed, with constant feed pressure, such that the core is not damaged during the drilling operations. Because of the great variation in strength of the material, depending on mix design and time of sampling, no one rotational speed or feed rate can be specified. However, note that the material may be fragile and can easily be damaged in drilling.

9.2.4.1 If the core has broken and is binding in the core barrel, stop drilling, remove the core barrel, and retrieve any broken pieces of core remaining in the hole with the core retrieval barrel before continuing.

9.2.4.2 If the depth of the stabilized material exceeds the maximum length of the core barrel, remove the core barrel and retrieve the core with the core retrieval barrel. Add an extension rod and continue drilling to embankment or foundation contact.

9.2.5 Remove the core barrel, and install a core retrieval barrel of sufficient length to remove the core in one piece.

9.2.6 Retrieve the core in one operation by inserting the core retrieval barrel over the full length of core and extracting both from the hole. As soon as the core retrieval barrel and core are out of the hole, place a cover over the hole to prevent the core from falling back into the hole.

9.2.6.1 **Warning**—Take care when handling recovered samples to minimize disturbance, which can affect test results strength and permeability.

9.2.7 Remove the core retrieval barrel from the drill, and carefully remove the core from the barrel by pushing the core out the top. Immediately place the core in a shipping box in the exact order that it was retrieved.

9.3 *Logging Core*—Log each core as it comes from the retrieval barrel and is placed in the shipping box.

9.3.1 Immediately label the core by hole number and its position in the hole from top to bottom. Indicate the direction of top on each piece of core.

9.3.2 Identify, place core samples in shipping boxes, and cover immediately after retrieval to minimize moisture loss in accordance with Practices D4220 and D5079.

9.3.3 To prevent moisture loss, place the samples in airtight plastic bags prior to placing in shipping container. Keep samples out of direct sunlight.

9.3.4 *Immediately After Logging,* carefully and securely pack each section of core in the shipping box in accordance with Practice D5079 to prevent moisture loss and damage during transport to laboratory for testing.

9.4 *Refilling Holes*—Refill all core holes with grout, concrete premix slurry, or stabilized soil mixed to original placement specifications.

10. Report: Data Form

10.1 The methodology used to specify how data are recorded on the data forms is covered in 1.3.

10.2 Report the following information:

10.2.1 A log for each hole drilled and completed,

10.2.2 At a minimum note the following:

10.2.2.1 Drilling method

10.2.2.2 Drill run intervals

10.2.2.3 Depth at which breaks occur in the core

10.2.2.4 Lift contacts

10.2.2.5 Embarkment or foundation contact

10.2.2.6 Bonding agent used (if any), and

10.2.2.7 Condition of bond.

10.2.3 Include any other pertinent information, such as spun core, loose material, surface appearance, poor compaction, clayballs, unhydrated lime concentrations, fractures, lack of bonding, etc.

10.2.4 Location and condition (backfilled, capped, etc.) of drill hole, and

10.2.5 Disposition of core samples

NOTE 5—Examples of soil-cement and soil-lime logs are shown in Figs. 2 and 3.

11. Precision and Bias

11.1 This guide provides qualitative and general information only. Therefore, a precision and bias statement is not applicable.

12. Keywords

12.1 coring; logging; soil-cement; soil-lime; soil stabilization

LOG OF SOIL-LIME DRILL HOLE

Project E.M.	Feature Example Canal	Location Reach 1
Hole No. DH-1	Station 10 + 00 m	Offset 10.0 left cL m
Ground Elevation 150.0 m	Total Depth 1.2 m	Core Diameter 102 mm
Date Cored 10-24-96	Logged By Kunzer	Approved By Austin

Notes (a) Description of drilling method (b) Other pertinent information	Test Specimen and % Lime	Depth m	Graphic Log	Description of Core
Used 19-mm electric drill with stand anchored to soil-lime, diamond tipped core barrel, 102 mm inside diameter.	12.1 6.2%	-- --		Lime particles visible throughout spun core
		--0.2--	----------	--- Break, possible lift line
Hole drilled perpendicular to lift placement.	12.2 6.3%	-- --		Solid
		--0.4--	----------	--- Break
Drill hole back filled with premix concrete.	12.3	--0.5--		Top Crumbly
Specimens 12.1 through 12.5 selected for percent lime testing.	6.3%	-- --		Solid
		--0.7--	----------	--- Break
Specimens 12.2 and 12.4 selected for unconfined compressive strength testing.	12.4	-- --		Solid
	6.2%	-- --		
		--1.0--	----------	--- Break
	12.5 6.2%	-- --		
		--1.2--	----------	--- Soil, Foundation
		-- --		
		-- --		
		--1.5--		

FIG. 2 Log of Soil-Lime Drill Hole (SI Example)

LOG OF SOIL-CEMENT DRILL HOLE

Project E.M.	Feature Example	Location Outlet Works
Hole No. 16	Station 121 + 86 ft.	Offset 42.00 left cL ft.
Ground Elevation 150.0 ft.	Total Depth 3.40 ft.	Core Diameter 3.0 in.
Date Cored 10-24-96	Logged By Kunzer	Approved By Austin

Notes (a) Description of drilling method (b) Other pertinent information	Specimens for Testing	Depth (ft.)	Graphic Log Show lift lines	Description of Core Description of Bond Between Lifts (a) Bonding agent used (if any) (b) Condition of bond (c) Description of break
		--- ---		Cement slurry used as bonding agent between lifts
Used ¾-inch electric rotary drill with stand anchored to soil-cement. Core barrel diamond tipped, 3-inch inside diameter.	16.1	0.55		Lift Contact - Bonded
Drill hole backfilled with premix concrete.		--- 1.0 ---		
Specimens 16-1 and 16-3 selected for durability testing.		1.10		Lift Contact - No Bond
	16.2			Poor Compaction - Voids
		1.60		Lift Contact - No Bond <–0.1 ft. Clayball
		--- 2.0 ---		
	16.3	2.05		Lift Contact - Bonded
		2.45		Lift Contact - Bonded
		2.65		Fracture Within Lift
		2.90		Lift Contact - Bonded
	16.4	--- 3.0 ---		
		3.40		Embankment Contact

FIG. 3 Log of Soil-Cement Drill Hole (Ft/lb Example)

SUMMARY OF CHANGES

Committee D18 has identified the location of selected changes to this guide since the last issue, D6236–98(2004), that may impact the use of this guide. (Approved January 1, 2011)

(*1*) Revised title to reflect standard terminology for "soil-cement."
(*2*) Rationalized SI and inch-pound units throughout standard.
(*3*) Made minor changes to syntax and spelling where needed.
(*4*) Inserted 1.3 regarding Practice D6026 and renumbered subsequent paragraphs.
(*5*) Inserted 1.7 containing ASTM policy on notes and footnotes.
(*6*) Added reference to Test Method D5607 in 4.1 and deleted references in text that the standard was under development.
(*7*) Inserted Note 2, the quality of results caveat, including reference to Practice D3740, per D18 policy and renumbered subsequent notes.
(*8*) Deleted old Section 9 and renumbered subsequent sections. Relocated text to 9.2.1.
(*9*) Deleted old Section 10 and renumbered subsequent sections. Relocated text to 9.3.2.
(*10*) Deleted old 11.3.3 and renumbered subsequent paragraphs. Relocated text to 10.2.2 and 10.2.3.
(*11*) Moved the warning in old Note 4 into the text as 9.2.6.1 to comply with ASTM Form and Style and renumbered subsequent notes.
(*12*) Inserted 10.1 referencing significant digits and renumbered subsequent paragraphs.
(*13*) Add Note 5 referencing Figs. 2 and 3. Deleted prior reference in 11.1.