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

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1. Scope

1.1 This guide covers guidance for obtaining cores of 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 meter (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 in self cementing fly ash materials which may also stabilize soil.

1.2 This guide does not cover material of less than 2070 kPa (300 psi) compressive strength such as cement-soil-bentonite mixtures or some controlled low strength materials (CLSM).

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

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.* Specific precautionary statements are given in Section 8.

1.5 *This guide offers an organized collection of information or a series of options and does not recommend a specific course of action. This document 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 ASTM standard 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 document 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.*

2. Referenced Documents

2.1 *ASTM Standards:*

C 51 Definitions of Terms Relating to Lime and Limestone[2]

C 219 Terminology Relating to Hydraulic Cement[2]

D 559 Test Methods for Wetting-and-Drying Compacted Soil-Cement Mixtures[3]

D 560 Test Methods for Freezing-and-Thawing Tests of Compacted Soil-Cement Mixtures[3]

D 653 Terminology Relating to Soil, Rock, and Contained Fluids[3]

D 1633 Test Method for Compressive Strength of Molded Soil-Cement Cylinders[3]

D 2113 Practice for Diamond Core Drilling for Site Investigation[3]

D 4220 Practices for Preserving and Transporting Soil Samples[3]

D 4452 Methods for X-Ray Radiography of Soil Samples[3]

D 5079 Practices for Preserving and Transporting Rock Core Samples[3]

D 5102 Test Method for Unconfined Compressive Strength of Compacted Soil-Lime Mixtures[3]

D 5434 Guide for Field Logging of Subsurface Explorations of Soil and Rock[3]

3. Terminology

3.1 *Definitions*:

3.1.1 Refer to Terminology C 51 for terms relating to *lime*.

3.1.2 Refer to Terminology C 219 for terms relating to *hydraulic cement*.

3.1.3 Refer to Terminology D 653 for terms relating to *soil*.

4. Summary of Guide

4.1 Core samples of cement or lime stabilized soil with a core diameter of 76- or 102-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 2070 kPa (300 psi) prior to coring, cores are retrieved, labeled, and logged. Coring may be repeated at other times if specified by the engineer. Retrieved core is tested as specified by the engineer. Tests commonly requested include unconfined compressive strength in accordance with Test Methods D 1633 and D 5102, durability in accordance with Test Methods D 559 and D 560, bond strength in accordance with the pending

[1] This test method is under the jurisdiction of ASTM Committee D-18 on Soil and Rock and is the direct responsibility of Subcommittee D 18.15 on Stabilization and Admixtures.

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[2] *Annual Book of ASTM Standards*, Vol 04.01.

[3] *Annual Book of ASTM Standards*, Vol 04.08.

ASTM standard for direct shear testing of rock, and uniformity and possible voids in accordance with Test Method D 4452.

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 curved to at least 2070 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 time intervals are 7, 28, 60 and/or 90 days, after placement. Twenty–eight (28) days after placement is the most common time interval for first drilling cores.

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 102-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, 76- or 102-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 76- or 102-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 conform to Practices D 5079 or D 4220.

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 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 2070 kPa (300 psi).

9. Sampling, Test Specimens and Test Units

9.1 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 start of construction. Cores should also be obtained in any area of questionable stabilized soil quality.

10. Conditioning

10.1 Identify, place core samples in shipping boxes and cover immediately after retrieval to minimize moisture loss in accordance with Practices D 4220 and Practice D 5079 .

11. Procedure

11.1 Record all data on an appropriate log form. Examples of soil-cement and soil-lime logs are shown in Figs. 2 and 3.

11.2 *Coring*—Coring is done when the strength of the stabilized soil has reached approximately 2070 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 specified by an engineer. Common time intervals are 7, 28, 60 and/or 90 days. If coring is repeated, subsequent holes should be immediately adjacent to the previous holes.

11.2.1 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 2—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.

11.2.2 As required, install a 76- or 102-mm (3- or 4-in.) inside diameter core barrel of sufficient length to penetrate the full vertical depth of the stabilized material facing.

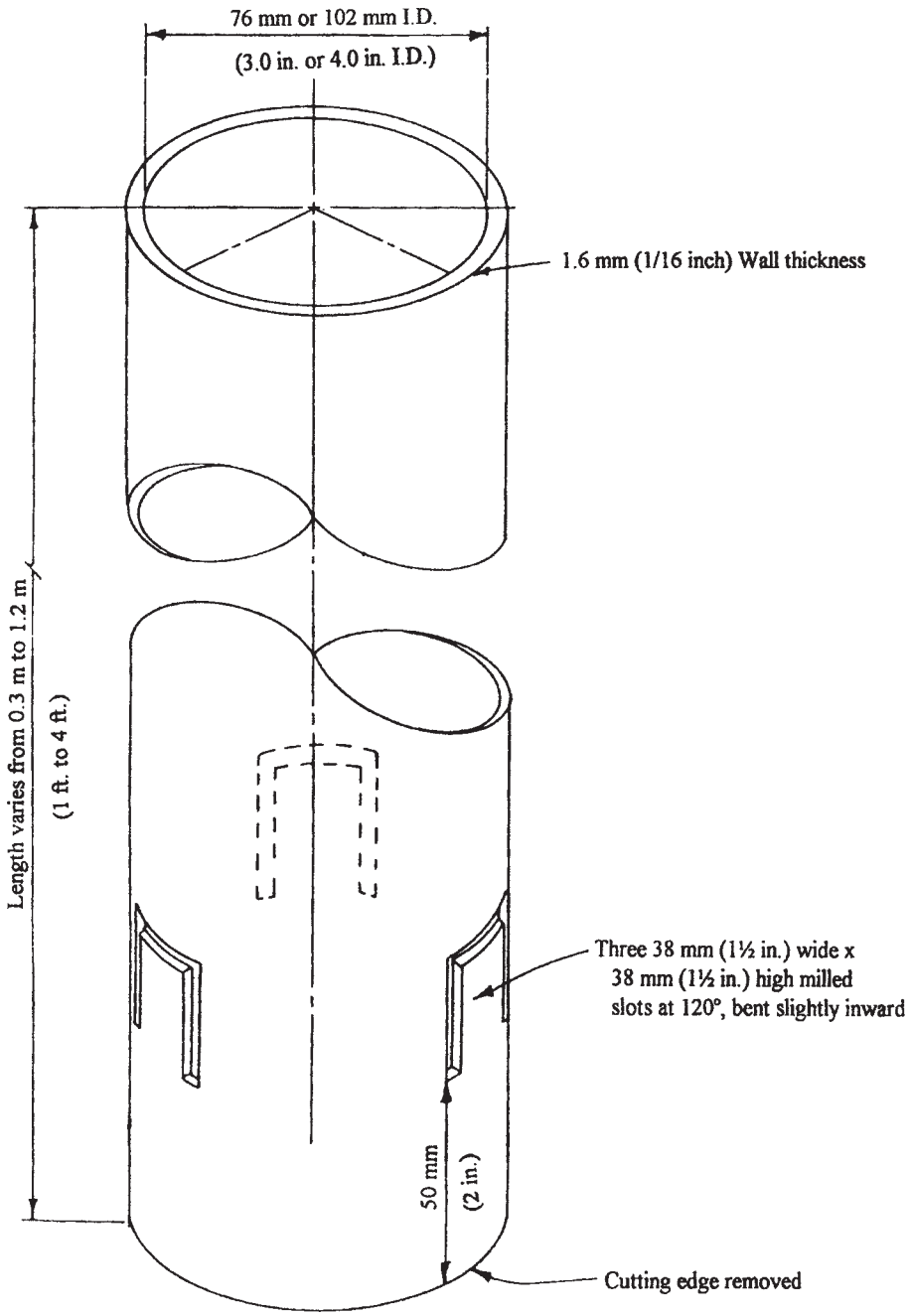

FIG. 1 Core Retrieval Barrel Made From Worn Diamond Studded Core Barrel

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

NOTE 3—Drilling should be performed at a slow rational 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 rational speed or feed rate can be specified. However, note that the material may be fragile and can easily be damaged in drilling.

11.2.3.1 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.

11.2.3.2 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.

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

11.2.5 Retrieve the core in one operation by inserting the core retrieval barrel over the full length of core and extracting

LOG OF SOIL-LIME DRILL HOLE

Project F.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
	12.1 6.2%	-- --		Lime particles visible throughout spun core
Used 19-mm electric drill with stand anchored to soil-lime, diamond tipped core barrel, 102 mm inside diameter.		-- 0.2 --	----------	--- Break, possible lift line
	12.2 6.3%	-- --		Solid
Hole drilled perpendicular to lift placement.		-- 0.4 --	----------	--- Break
Drill hole back filled with premix concrete.	12.3	-- 0.5 --		Top Crumbly
	6.3%	-- --		Solid
Specimens 12.1 through 12.5 selected for percent lime testing.		-- 0.7 --	----------	--- Break
	12.4	-- --		Solid
Specimens 12.2 and 12.4 selected for unconfined compressive strength testing.	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)

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.

NOTE 4—**Caution:** Take care when handling recovered samples to minimize disturbance which can affect test results strength and permeability.

11.2.6 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.

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

11.3.1 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.

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

11.3.3 On an appropriate form or by electric means, note the drilling method, drill run intervals, depth at which breaks occur in the core, lift contacts, embarkment or foundation contact, and bonding agent used (if any), and condition of bond. Include any other pertinent information such as spun core, loose material, surface appearance, poor compaction, clayballs, unhydrated lime concentrations, fractures, lack of bonding, etc.

LOG OF SOIL-CEMENT DRILL HOLE

Project F.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)

An example of appropriate forms for soil-lime and soil-center are shown in Figs. 2 and 3.

11.3.4 *Immediately After Logging,* carefully and securely pack each section of core in the shipping box in accordance with Practice D 5079 to prevent moisture loss and damage during transport to laboratory for testing.

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

12. Report

12.1 Report the following information:

12.1.1 A log for each hole drilled and completed as specified in 11.3.2,

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

12.1.3 Disposition of core samples

13. Precision and Bias

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

14. Keywords

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