Designation: D5333 – 03

Standard Test Method for Measurement of Collapse Potential of Soils[1]

This standard is issued under the fixed designation D5333; 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 test method covers the determination of the magnitude of one-dimensional collapse that occurs when unsaturated soils are inundated with fluid.

1.2 This test method may be used to determine the magnitude of potential collapse that may occur for a given vertical (axial) stress and an index for rating the potential for collapse.

1.3 This test method specifies the technique for specimen preparation, apparatus, and procedure for quantifying the amount of height change associated with collapse and procedures for reporting test results.

1.4 The procedures given in this test method are applicable to both undisturbed and remolded specimens.

1.5 The values stated in SI units are to be regarded as the standard. The inch-pound units given in parentheses are for information only.

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1.6.1

1.7 *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:*[2]

D653 Terminology Relating to Soil, Rock, and Contained Fluids

D2216 Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass

D2435 Test Methods for One-Dimensional Consolidation Properties of Soils Using Incremental Loading

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

D4829 Test Method for Expansion Index of Soils

D6026 Practice for Using Significant Digits in Geotechnical Data

3. Terminology

3.1 Refer to Terminology D653 for standard definitions of terms. Additional terms are as follows:

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *collapse*—decrease in height of a confined soil following wetting at a constant applied vertical stress. A collapsible soil may withstand relatively large applied vertical stress with small settlement while at a low water content, but this soil will exhibit settlement (that could be large) after wetting with no additional increase in stress. Large applied vertical stress is not necessary for collapse.

3.2.2 *collapse index (I_e), percent*—relative magnitude of collapse determined at 200 kPa (2 tsf) and calculated using (Eq 1).

3.2.3 *collapse potential (I_c), percent*—relative magnitude of soil collapse determined at any stress level as follows:

$$I_c = \left[\frac{d_f - d_o}{h_o} - \frac{d_i - d_o}{h_o}\right] 100 = \left[\frac{d_f - d_i}{h_o}\right] 100 \qquad (1)$$

where:

d = dial reading, mm (in.),
d_o = dial reading at seating stress, mm (in.),
h_o = initial specimen height, mm (in.),
d_f = dial reading at the appropriate stress level after wetting, mm (in.),
d_i = dial reading at the appropriate stress level before wetting, mm (in.),
$(d_f - d_o)/h_o$ = strain at the appropriate stress level after wetting, and
$(d_i - d_o)/h_o$ = strain at the appropriate stress level before wetting.

Eq 1 may be rewritten in terms of void ratio:

$$I_c = \frac{\Delta e}{1 + e_o} \cdot 100 \qquad (2)$$

[1] This test method is under the jurisdiction of ASTM Committee D18 on Soil and Rock and is the direct responsibility of Subcommittee D18.05 on Structural Properties of Soils.

Current edition approved Jan. 10, 2003. Published March 2003.

Originally approved in 1992. Last previous edition approved in 1996 as D5333–92(1996). DOI: 10.1520/D5333-03.

[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.

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

where:

Δe = change in void ratio resulting from wetting, and
e_o = initial void ratio.

or, since the test is conducted as a one-dimensional test:

$$I_c = \frac{\Delta h}{h_o} \cdot 100 \quad (3)$$

where:

Δh = change in specimen height resulting from wetting, mm (in.) and
h_o = initial specimen height, mm (in.).

4. Summary of Test Method

4.1 The test method consists of placing a soil specimen at natural water content in a consolidometer, applying a predetermined applied vertical stress to the specimen and inundating the specimen with fluid to induce the potential collapse in the soil specimen. The fluid shall be distilled-deionized water when evaluating the collapse index, I_e. The fluid may simulate pore water of the specimen or other field condition as necessary when evaluating collapse potential, I_c.

5. Significance and Use

5.1 Collapsible soils occur widely in the United States and worldwide. Collapsible soils are typified by low values of dry unit weight and natural water content. Engineering works founded on collapsible soils may be damaged by sudden and often large induced settlements when these soils are saturated after construction. Predicting collapse potential is important to the design of many engineering structures.

5.2 Collapse potential, I_c, is used to estimate settlement that may occur in a soil layer at a particular site. I_c is determined from (Eq 1) using a predetermined applied vertical stress and fluids applied to a soil specimen taken from the soil layer. Settlement of a soil layer for the applied vertical stress is obtained by multiplying I_c by H/100 where H is the thickness of the soil layer.

5.2.1 Procedures for estimating potential for collapse are uncertain because no single criterion can be applied to all collapsible soils. For example, some soils may swell after fluid is added to the specimen until sufficient vertical stress has been applied. Collapse may then occur after additional vertical stress is applied. This test method may be used to determine the collapse potential, I_c, of soil at a particular vertical stress or the collapse index, I_e, at an applied vertical stress of 200 kPa (2 tsf). I_c for smaller applied vertical stress may be estimated assuming that the soil does not swell after inundation at smaller applied vertical stress.

5.2.2 Amount of settlement depends on the extent of the wetting front and availability of water, which can rarely be predicted prior to collapse.

5.3 The collapse index, I_e, is used to measure a basic index property of soil.

5.3.1 I_e is comparable to the expansion index as measured in accordance with Test Method D4829, and is used to describe the degree of collapse that a particular soil will exhibit under specified conditions.

5.3.2 I_e is not intended to duplicate any particular field conditions such as loading, in-place soil structure, or soil water chemistry. The test procedure maintains constant test conditions allowing direct correlation of data between organizations and direct investigation of a particular aspect of soil behavior.

5.3.3 I_e is classified in Table 1.

NOTE 1—Notwithstanding the statement on precision and bias contained in this test method: The precision of this test method is dependent on the competence of the personnel performing it and the suitability of the equipment and facilities used. Agencies which meet the criteria of Practice D3740 are generally considered capable of competent testing. Users of this test method are cautioned that compliance with Practice D3740 does not ensure reliable testing. Reliable testing depends on several factors; Practice D3740 provides a means of evaluating some of those factors.

6. Apparatus

6.1 Apparatus shall conform to Test Method D2435.

6.2 Porous stones shall be air-dried to preclude increases in water content of the specimen through capillarity.

7. Specimen Preparation

7.1 Specimens may be remolded or compacted or taken from undisturbed soil samples. Prepare undisturbed specimens in accordance with guidelines of Test Method D2435.

7.2 Use relatively undisturbed specimens to determine collapse potential, I_c. Since collapsible soils are sensitive to sampling methods using fluids, samples shall be taken using dry methods. Successful dry sampling methods include the double tube auger and hand carved block samples.

8. Calibration

8.1 Assemble and calibrate the consolidometer in accordance with Test Method D2435.

9. Soil Parameters

9.1 Soil parameters such as natural water content, mass, volume, specific gravity, liquid and plastic limits, and particle size distribution may be determined following general guidance in Test Method D2435. The natural and final water content shall be determined in accordance with Test Method D2216.

10. Procedure

10.1 Conduct the test in accordance with Test Method D2435, except as follows:

10.1.1 Place the specimen in the loading device immediately after determining the initial wet mass and height of the specimen following compaction or trimming. Enclose the specimen ring, filter paper, if any, and porous stones as soon as possible with a loose fitting plastic membrane, moist paper

TABLE 1 Classification of Collapse Index, I_e

Degree of Specimen Collapse	Collapse Index I_e, %
None	0
Slight	0.1 to 2.0
Moderate	2.1 to 6.0
Moderately severe	6.1 to 10.0
Severe	>10