



Standard Test Method for Slake Durability of Shales and Similar Weak Rocks¹

This standard is issued under the fixed designation D 4644; 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 slake durability index of a shale or other similar rock after two drying and wetting cycles with abrasion.

1.2 The values stated in SI units are to be regarded as the standard. The values given in parentheses are provided for information only.

1.3 *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:

E 11 Specification for Wire-Cloth Sieves for Testing Purposes²

3. Terminology

3.1 Definitions of Terms Specific to This Standard:

3.1.1 *slake durability index*—the percentage by dry mass retained of a collection of shale pieces on a 2.00 mm (No. 10) sieve after two cycles of oven drying and 10 min of soaking in water with a standard tumbling and abrasion action.

4. Significance and Use

4.1 The test method is used to estimate qualitatively the durability of weak rocks in the service environment.

4.2 This test method is used to assign quantitative durability values to weak rocks. A primary example is the Franklin Rating System (1).³

5. Apparatus

5.1 *Slake Durability Device*—The drum (Fig. 1) shall be made of 2.00 mm (No. 10) square-mesh, woven-wire cloth, conforming to the requirements of Specification E 11. It shall be cylindrical in shape, with a diameter of 140 mm (5.5 in.) and a length of 100 mm (3.9 in.). The ends shall be rigid plates,

with one removable end. It must be sufficiently strong to retain its shape during use, but neither the exterior of the mesh nor the interior of the drum shall be obstructed by a support. The drum shall be able to withstand a temperature of $110 \pm 5^\circ\text{C}$ ($230 \pm 9^\circ\text{F}$). A trough shall support the drum in a horizontal manner such that the drum is free to rotate about its axis. The trough shall be capable of being filled with slaking fluid to 20 mm (0.8 in.) below the drum axis, and shall allow at least 40 mm (1.6 in.) unobstructed clearance between the trough and the bottom of the mesh. The drum shall be rotated by a motor capable of maintaining a speed of 20 rpm, constant to within 5 %, for a period of 10 min. Devices conforming to these requirements are commercially available.

5.2 *Drying Oven*, thermostatically controlled, capable of maintaining a temperature of $110 \pm 5^\circ\text{C}$ ($230 \pm 9^\circ\text{F}$).

5.3 *Balance*, sensitive to 1 g and having a 2000-g capacity.

5.4 *Miscellaneous Apparatus*, including a brush.

5.5 *Distilled Water*.

6. Test Specimen

6.1 The specimen shall consist of ten representative, intact, roughly equidimensional shale fragments weighing 40 g to 60 g each. These fragments may be naturally occurring or may be produced by breaking with a hammer. Such fragments may be obtained from rock cores or from test pits, and their sizes will vary with the method of sampling. Break off any sharp corners, if possible, and remove any dust by brushing the sample just prior to weighing. The total sample shall weigh 450 to 550 g.

6.2 Transport and store the sample in such a manner as to retain the natural water content.

7. Procedure

7.1 Place the shale fragments in the drum. Weigh, and dry in the oven for 16 h or to constant mass. Allow the shale and drum to cool at room temperature for 20 min and weigh again. Calculate the natural water content as follows:

$$w = [(A - B)/(B - C)] \times 100 \quad (1)$$

where:

w = percentage water content,

A = mass of drum plus sample at natural moisture content, g,

B = mass of drum plus oven-dried sample before the first cycle, g, and

C = mass of drum, g.

¹ This test method is under the jurisdiction of ASTM Committee D-18 on Soil and Rock and is the direct responsibility of Subcommittee D18.12 on Rock Mechanics.

Current edition approved Feb. 2, 1987. Published April 1987.

² *Annual Book of ASTM Standards*, Vol 14.02.

³ The boldface numbers in parentheses refer to the list of references at the end of this standard.

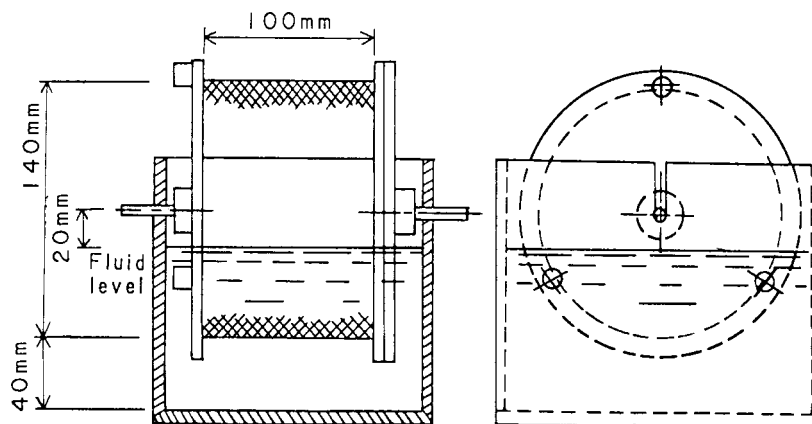


FIG. 1 Critical Dimensions of Slake Durability Equipment

7.2 Mount the drum in the trough and couple to the motor. Fill the trough with distilled water at room temperature to 20 mm (0.8 in.) below the drum axis. Rotate the drum at 20 rpm for a period of 10 min. Record the water temperature at the beginning and end of the run.

7.3 Remove the drum from the trough immediately after the rotation period is complete and dry the drum and the sample retained in the oven for 16 h, or to constant mass.

7.4 Weigh the drum and sample to obtain the oven-dried mass for the second cycle. Repeat 7.2 and 7.3. Again weigh the drum and sample to obtain a final mass.

7.5 Photograph materials retained and file a copy of the photo with the laboratory report, or record standard verbal descriptions, as follows:

7.5.1 *Type I*—Retained pieces remain virtually unchanged.

7.5.2 *Type II*—Retained materials consist of large and small pieces.

7.5.3 *Type III*—Retained material is exclusively small fragments.

7.6 See Fig. 2 for representative photographs of the three types.

8. Calculations

8.1 Calculate the slake durability index (second cycle), as follows:

$$I_d(2) = [(W_F - C)/(B - C)] \times 100 \quad (2)$$

where:

$I_d(2)$ = slake durability index (second cycle),

B = mass of drum plus oven-dried sample before the first cycle, g,

W_F = mass of drum plus oven-dried sample retained after the second cycle, g, and

C = mass of drum, g.

9. Report

9.1 The report shall include the following:

9.1.1 Description of the material and where it was obtained.

9.1.2 Slake durability index (second cycle) to the nearest 0.1 %.

9.1.3 Range and average value of the water temperature.

9.1.4 Natural water content.

9.1.5 Description of the appearance of the fragments retained in the drum (see 7.5).



FIG. 2 Illustration of Fragment Types Retained

10. Precision and Bias

10.1 Due to the nature of shale and other similar rock tested by this test method it is either not feasible or too costly at this time to produce multiple specimens which have uniform physical properties. Any variation observed on the data is just as likely to be due to specimen variation as to operator or

laboratory testing variation: Subcommittee D18.12 welcomes proposals that would allow for development of a valid precision statement. There is no accepted reference value of shale or weak rock for this test method; therefore, bias cannot be determined.

11. Keywords

11.1 abrasion resistance; shale; slake durability; weak rocks

REFERENCES

- (1) Franklin Trow Associates, "Field Evaluation of Shales for Construction Projects," Research and Development Project No. 1404, Ministry of Transportation and Communications, Research and Development Branch, Downsview, Ontario, March 1979.
- (2) Chapman, D. R., "Shale Classification Tests and Systems: A Comparative Study," MSCE Thesis and Joint Highway Research Project No. 75-11, Purdue University, West Lafayette, IN, June 1975, 90 pp.
- (3) Deo, P., "Shales as Embankment Materials," Ph.D. Thesis and Joint Highway Research Project No. 45, Purdue University, West Lafayette, IN, December 1972, 202 pp.
- (4) International Society for Rock Mechanics, "Suggested Methods for Determining Slake-Durability Index Properties," Commission on Standardization of Laboratory and Field Tests, November 1972.
- (5) Lutton, R. J., "Design and Construction of Compacted Shale Embankments, Volume 3, Slaking Indexes for Design," Report No. FHWA-RD-77-1, Federal Highway Administration, Washington, DC, February 1977.
- (6) Surendra, M., "Additives to Control Slaking in Compacted Shales," Ph.D. Thesis and Joint Highway Research Project No. 80-6, Purdue University, West Lafayette, IN, May 1980, 277 pp.
- (7) Oakland, M. W., and Lovell, C. W., "Classification and Other Standard Tests for Shale Embankment," Joint Highway Research Project No. 82-4, Purdue University, West Lafayette, IN, February 1982, 171 pp.

The American Society for Testing and Materials takes no position respecting the validity of any patent rights asserted in connection with any item mentioned in this standard. Users of this standard are expressly advised that determination of the validity of any such patent rights, and the risk of infringement of such rights, are entirely their own responsibility.

This standard is subject to revision at any time by the responsible technical committee and must be reviewed every five years and if not revised, either reapproved or withdrawn. Your comments are invited either for revision of this standard or for additional standards and should be addressed to ASTM Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee, which you may attend. If you feel that your comments have not received a fair hearing you should make your views known to the ASTM Committee on Standards, at the address shown below.

This standard is copyrighted by ASTM, 100 Barr Harbor Drive, PO Box C700, West Conshohocken, PA 19428-2959, United States. Individual reprints (single or multiple copies) of this standard may be obtained by contacting ASTM at the above address or at 610-832-9585 (phone), 610-832-9555 (fax), or service@astm.org (e-mail); or through the ASTM website (www.astm.org).