



Standard Test Methods of Flexure Testing of Slate (Breaking Load, Modulus of Rupture, Modulus of Elasticity)¹

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INTRODUCTION

Due to the unique properties of slate, the flexure test is better adapted to use for strength and elasticity determinations than either compression or tension tests. Furthermore, several uses of slates are such that these determinations are of special interest and value, besides furnishing comparative data.

The property of slate termed “grain” causes a slab of the material to break transversely in one direction somewhat more readily than at right angles to this direction. For this reason it is desirable to test the strength and elasticity both parallel and perpendicular to the grain.

Breaking load test results for samples of roofing slate are only valid for the commercial supply of slates of that thickness or greater. For the commercial supply of thinner roofings slates, testing on samples of the minimum specified thickness must be conducted.

When comparing slates of equal thickness, but from various sources, slates which meet the required breaking load at the lowest specimen thickness will yield the best performance on the roof in terms of resistance to impact damage.

1. Scope

1.1 These test methods cover determination of the breaking load, modulus of rupture and modulus of elasticity of slate by means of flexure tests.

1.2 The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard.

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.*

¹ These test methods are under the jurisdiction of ASTM Committee C18 on Dimension Stone and are the direct responsibility of Subcommittee C18.01 on Test Methods.

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2. Referenced Documents

2.1 ASTM Standards:²

C119 Terminology Relating to Dimension Stone
C1799 Guide to Dimension Stone Test Specimen Sampling
and Preparation

3. Terminology

3.1 *Definitions*—All definitions are in accordance with Terminology C119.

4. Significance and Use

4.1 These test methods are useful in indicating the differences in flexure (breaking load, modulus of rupture, modulus of elasticity) between various slates. These test methods also provide one element in the comparison of slates.

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.

5. Apparatus

5.1 *Testing Machine*—The accuracy of the testing machine shall be within 1 % for the range from 10 to 1000 lbf [50 to 5000 N].

5.2 *Load Application and Support Blocks*—The supports for the specimen shall be of the rocker type (Fig. 1) with the edges at least as long as the width of the specimen. The load application block may be of either the rocker or rigid type. The portions of the load application and support blocks contacting the stone shall be rounded, with a nominal radius of ½ in. [13 mm].

6. Sampling

6.1 Select the sample to represent a true average of the type or grade of stone under consideration and of the quality supplied to the market under the type designation to be tested. The sample may be selected by the purchaser or his authorized representative from the quarried stone or taken from the natural ledge and shall be of adequate size to permit the preparation of

the desired number of test specimens. When perceptible variations occur, the purchaser may select as many samples as are necessary for determining the variations in flexure (breaking load, modulus of rupture, modulus of elasticity).

NOTE 1—Refer to Guide C1799 for additional information on selecting, preparing, and conditioning test specimens.

BREAKING LOAD AND MODULUS OF RUPTURE

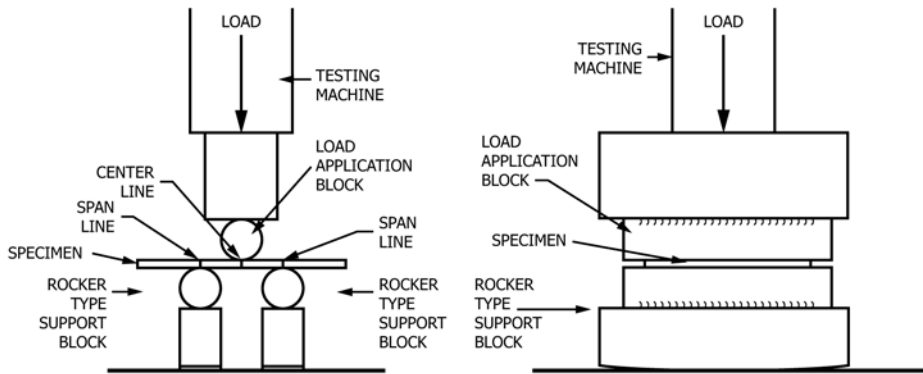
7. Test Specimens

7.1 *Structural or Electrical Slate*—Six representative specimens, 12 by 1½ by 1 in. [300 by 40 by 25 mm] in size, of the particular slate under consideration shall be tested.

7.2 *Roofing Slate*—At least ten specimens 4 in. [100 mm] in width, 5 in. [125 mm] or greater in length and minimum ⅜ in. [5 mm] thick.

8. Preparation of Specimens

8.1 *Structural or Electrical Slate*—Split the slate for the test to a thickness of approximately 1¼ in. [30 mm] and then saw



Specimen in Position for Testing

The test apparatus shown is one example of an acceptable configuration. Other configurations meeting the requirements of Section 5 are also acceptable.

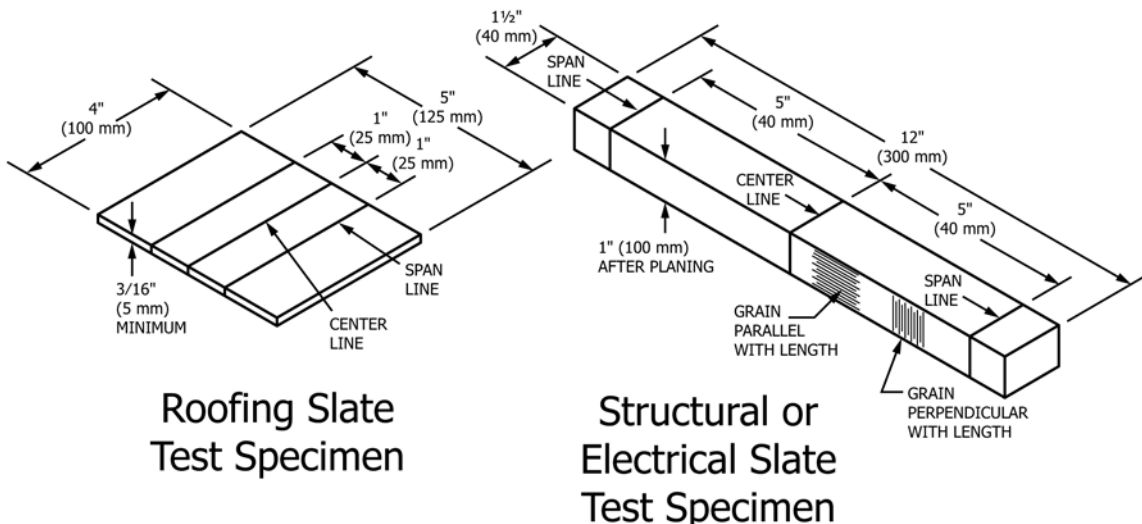


FIG. 1 Specimens and Preferred Type of Loading Application and Support Blocks for Determining the Breaking Load, Modulus of Rupture and Modulus of Elasticity of Slate

into strips 12 in. [300 mm] in length by 1½ in. [40 mm] in width. Cut half of these with the length parallel to the grain and half with the length perpendicular to the grain. Plane or rub down the 12 by 1½-in. [300 by 40-mm] faces to a thickness of approximately 1 in. [25 mm], taking care to have the finished surfaces as nearly parallel as practicable.

8.2 Roofing Slate—Cut one 4 by 5-in. [100 by 125-mm] specimen from each of a minimum 10 shingles. The saw blade shall be a continuous rim, diamond impregnated type, mounted to a water-cooled sliding bed saw capable of making a clean cut with no lacerated edges. Cut no part of the specimen nearer than 1 in. [25 mm] to a sheared edge or nail hole. The 5 in. [125 mm] or longer dimension is to be measured and cut parallel with the long dimension of the slate shingle. Do not resurface the split faces.

9. Conditioning

9.1 Dry the specimens for 48 h in a ventilated oven at a temperature of 140 ± 4°F [60 ± 2°C]. At the 46th, 47th and 48th hour, weigh the specimens to ensure that the weight is the same. If the weight continues to drop, continue to dry the specimens until there are three successive hourly readings with the same weight.

10. Marking and Measuring

10.1 On structural or electrical slate, rule the center lines with a try-square perpendicular to the edges of the specimens. Likewise, rule the span lines, parallel to, and 5 in. [125 mm] from, the center lines. On specimens of roofing slate rule the center lines perpendicular to an edge that is parallel to the length of the shingle. Rule span lines parallel to, and 1 in. [25 mm] from, the center lines. Measure the specimen thickness at three points along the center line to the nearest 0.01 in. [0.1 mm] and record the average as the specimen thickness.

11. Procedure

11.1 The testing machine shall be accurate to 1 % within the range from 100 to 2000 lbf [500 to 10 000 N]. Lay the specimens flatwise on the rocker type support blocks as shown in Fig. 1. Apply the load at the center span through a rocker or fixed type load application block. When a load of 10 lbf [50 N] has been applied, stop the loading and make all the blocks coincide with the marks on the specimen by centering the specimen under the load application block and moving the support blocks under the span marks. Apply loads at rates not exceeding 1000 lbf/min [5000 N/min] until failure, and record the breaking load to the nearest 5 lbf [20 N].

NOTE 2—When all three load application and support blocks are of the rocker type, care must be taken to adjust all three until the top face of the specimen is horizontal when loaded.

12. Calculation—Structural or Electrical Slate

12.1 Calculate the modulus of rupture as follows:

$$R = (3Wl/2bd^2) \quad (1)$$

where:

R = modulus of rupture, psi [MPa],

W = breaking load, lbf [N],

l = span length between support blocks, in. [mm],

b = width of specimen at the center, in. [mm], and

d = thickness of specimen at the center, in. [mm].

13. Report

13.1 *Structural or Electrical Slate*—Report all modulus of rupture values and the average of all modulus of rupture values for specimens cut parallel to the grain as the modulus of rupture “across the grain.” Report all modulus of rupture values and the average of all modulus of rupture values for specimens cut perpendicular to the grain as the modulus of rupture “with the grain.” All determinations shall be reported as information.

13.2 *Roofing Slate*—Report the span length, width of specimen, average thickness of specimen along the center line and at the edges and breaking load of each specimen. The average of the breaking loads shall be reported as the breaking load across the length of the slate shingle. All determinations, conditioning time and weight data for each specimen shall be reported as information.

13.3 The following additional information shall also be reported: Identification of the sample, including name and location of the quarry, name and position of the ledge, date when sample was taken, and trade name or grade of the slate.

MODULUS OF ELASTICITY

14. Test Specimens and Preparation of Specimens

14.1 The modulus of elasticity may be determined in conjunction with the modulus of rupture test. For this test on roofing slate it will be desirable to use a specimen 8 in. [200 mm] long.

15. Conditioning

15.1 Dry the specimens for 48 h in a ventilated oven at a temperature of 140 ± 4°F [60 ± 2°C]. At the 46th, 47th and 48th hour, weigh the specimens to ensure that the weight is the same. If the weight continues to drop, continue to dry the specimens until there are three successive hourly readings with the same weight.

16. Procedure

16.1 Support and load the test specimen in the same way as for the breaking load and flexural strength determination, except that the roofing slate specimen shall be supported on a 6-in. [150-mm] span. Set any type of deflectometer, capable of reading to 0.001 in. [0.02 mm], to measure deflections at mid-span (Note 3). Stop the loading at each 50-lbf [200-N] increment, and record the corresponding deflections.

NOTE 3—It is not ordinarily feasible to set the deflectometer to read zero when there is no load on the specimen. The best practice is to put a small initial load on the specimen, such as 10 lbf [50 N] and set the deflectometer to read zero for this load. Since it is only the slope of the stress-strain curve that is desired, this initial load does not affect the final result.

17. Calculation

17.1 Plot the load-deflection readings on cross-section paper to a convenient scale, and draw a straight line to represent, as

nearly as possible, the average of the plotted points (Note 4). If the line does not pass through the zero point, draw a corrected line through this point parallel to the stress-strain line. Calculate the modulus of elasticity, E , from the coordinates of some convenient point on the corrected line, as follows:

$$E = (W'l^3/4\Delta bd^3) \quad (2)$$

where:

- E = modulus of elasticity, psi [MPa],
- W' = load coordinate of the point, lbf [N],
- Δ = deformation coordinate of the point, in. [mm],
- l = length of span, in. [mm],
- b = width of specimen at the center, in. [mm], and
- d = thickness of specimen at the center, in. [mm].

NOTE 4—Slate does not show a definite yield point in the stress-strain curve.

18. Report

18.1 Report the average of the results obtained for specimens prepared with the length parallel to the grain as the

modulus of elasticity across the grain. Likewise, report the average of the results obtained on specimens cut with the length perpendicular to the grain as the modulus of elasticity with the grain. All determinations shall be reported as information.

18.2 The following additional information shall also be reported: Identification of the sample, including name and location of the quarry, name and position of the ledge, date when sample was taken, and trade name or grade of the slate.

19. Precision and Bias

19.1 Individual variations in a natural product may result in deviation from accepted values. A precision section will be added when sufficient data are available to indicate acceptable tolerances in repeatability and reproducibility.

20. Keywords

20.1 breaking load; dimension stone; flexure; modulus of elasticity; modulus of rupture; slate; test

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