Designation: C 120 – 06$^{\epsilon 1}$

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

This standard is issued under the fixed designation C 120; 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.

This standard has been approved for use by agencies of the Department of Defense.

ε[1] NOTE—To correct 10.1, the words "by centering the specimen" were added to the fourth sentence editorially in June 2006.

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 *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]

C 99 Test Method for Modulus of Rupture of Dimension Stone

C 119 Terminology Relating to Dimension Stone

3. Terminology

3.1 *Definitions*—All definitions are in accordance with Terminology C 119.

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.

5. Sampling

5.1 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

[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] 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.

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).

MODULUS OF RUPTURE

6. Test Specimens

6.1 *Structural or Electrical Slate*—Six representative specimens, 12 by 1½ by 1 in. (305 by 38.1 by 25.4 mm) in size, of the particular slate under consideration shall be tested.

6.2 *Roofing Slate*—At least ten specimens 4 in. (101.6 mm) in width, 5 in. (127.0 mm) or greater in length and minimum 3⁄16 in. (4.8 mm) thick.

7. Preparation of Specimens

7.1 *Structural or Electrical Slate*—Split the slate for the test to a thickness of approximately 1¼ in. (31.8 mm) and then saw into strips 12 in. (304.8 mm) in length by 1½ in. (38.1 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. (304.8 by 38.1-mm) faces to a thickness of approximately 1 in. (25.4 mm), taking care to have the finished surfaces as nearly parallel as practicable.

7.2 *Roofing Slate*—Cut one 4 by 5-in. (101.6 by 127.0-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. (25.4 mm) to a sheared edge or nail hole. The 5 in. (127.0 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.

8. Conditioning

8.1 Dry the specimens for 48 h in a ventilated oven at a temperature of 60 ± 2°C (140 ± 4°F). 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.

9. Marking and Measuring

9.1 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. (127 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. (25.4 mm) from, the center lines. Measure the specimen thickness at three points along the center line to the nearest 0.01 in. (0.254 mm) and record the average as the specimen thickness.

10. Procedure

10.1 The testing machine shall be accurate to 1 % within the range from 100 to 2000 lbf (444.8 to 8896 N). Place the specimens flat on the rocker type knife-edges as shown in Fig. 1 of Test Method C 99. Apply the load at the center span through a rocker or fixed type knife-edge. When a load of 10 lbf (44 N) has been applied, stop the loading and make all knife edges coincide with the marks on the specimen by centering the specimen under the loading edge and moving the supporting edges under the span marks. Apply loads at rates not exceeding 1000 lbf (4448 N)/min until failure, and record the breaking load to the nearest 5 lbf (22.2 N).

NOTE 1—When all three knife edges are of the rocker type, care must be taken to adjust all three until the top face of the specimen is horizontal when loaded.

11. Calculation - Structural or Electrical Slate

11.1 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 supporting knife-edges, in. (mm),
b = width of specimen at the center, in. (mm), and
d = thickness of specimen at the center, in. (mm).

12. Report

12.1 *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.

12.2 *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.

12.3 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

13. Test Specimens and Preparation of Specimens

13.1 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. (203.2 mm) long.

14. Conditioning

14.1 Dry the specimens for 48 h in a ventilated oven at a temperature of 60 ± 2°C (140 ± 4°F). 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.

15. Procedure

15.1 Support and load the test specimen in the same way as for the flexural strength determination, except that the roofing

slate specimen shall be supported on a 6-in. (152.4-mm) span. Set any type of deflectometer, capable of reading to 0.001 in. (0.025 mm), to measure deflections at mid-span (Note 2). Stop the loading at each 50-lbf (222-N) increment, and record the corresponding deflections.

NOTE 2—It is not ordinarily feasible to set the deflectomer 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 (44 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.

16. Calculation

16.1 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 3). 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:

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

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

17. Report

17.1 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.

17.2 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.

18. Precision and Bias

18.1 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.