Designation: C 120 – 00

Standard Test Methods of Flexure Testing of Slate (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.

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.

In the quarrying of slate, blasting is frequently resorted to, and for this reason certain portions of the material may have been unduly strained. Low or erratic strength results on some of the test specimens should be regarded in the light of defective material.

1. Scope

1.1 These test methods cover determination of the 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:*

C 99 Test Method for Modulus of Rupture of Dimension Stone[2]

C 119 Terminology Relating to Dimension Stone[2]

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 (modulus of rupture, modulus of elasticity) between various slates. These test methods also provide one element in the comparison of slates.

MODULUS OF RUPTURE

5. Test Specimens

5.1 *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.

5.2 *Roofing Slate*—At least six specimens 4 in. (101.6 mm) in width, 4 in. or more in length, and of thickness 3⁄16 to ¼ in. (4.8 to 6.4 mm).

6. Preparation of Specimens

6.1 *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 1½in. (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.

6.2 *Roofing Slate*—Cut one 4 by 4-in. (101.6 by 101.6-mm) specimen, of the thickness of the slate, from each of six shingles. Cut no part of the specimen nearer than 1 in. (25.4 mm) to a sheared edge or a nail hole. Mark the direction of the length of the shingle on each specimen, and do not resurface the split faces.

7. Conditioning

7.1 Dry the specimens for 48 h in a ventilated oven at a

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[1] These test methods are under the jurisdiction of ASTM Committee C-18 on Dimension Stone and are the direct responsibility of Subcommittee C18.01 on Test Methods.

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[2] *Annual Book of ASTM Standards*, Vol 04.07.

temperature of 60°C ± 2°C (140°F ± 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.

8. Marking and Measuring

8.1 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.

9. Procedure

9.1 The testing machine shall be accurate to 1 % within the range from 100 to 2000 lbf (444.8 to 8896 N). Place the specimens flatwise on knife-edges of the type shown in Fig. 1 of Test Method C 99. Apply the load at the center of span through a similar knife-edge, with the supporting knife-edges centered under the span lines. 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).

10. Calculation

10.1 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).

11. Report

11.1 Report all failure loads and the average of all modulus of rupture values for specimens cut parallel to the grain from structural or electrical slate, or parallel to the long dimension of the shingle in the case of roofing slate, as the modulus of rupture "across the grain." Report the average for specimens cut perpendicular to the grain as the modulus of rupture "with the grain." All determinations shall be reported as information.

MODULUS OF ELASTICITY

12. Test Specimens

12.1 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.

13. Procedure

13.1 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 1). Stop the loading at each 50-lbf (222-N) increment, and record the corresponding deflections.

NOTE 1—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.

14. Calculation

14.1 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 2). 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:
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 2—Slate does not show a definite yield point in the stress-strain curve.

15. Report

15.1 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.

15.2 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.

16. Precision and Bias

16.1 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.