Designation: C 99 – 87 (Reapproved 2000)

Standard Test Method for Modulus of Rupture of Dimension Stone[1]

This standard is issued under the fixed designation C 99; 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 modulus of rupture of all types of dimension stone except slate.

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 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 This test method is useful in indicating the differences in modulus of rupture between the various dimension stones. This test method also provides one element in comparing stones of the same type.

5. Apparatus

5.1 *Testing Machine*— The accuracy of the testing machine shall be within 1 % for the range from 10 to 1000 lbf (44 to 4450 N).

5.2 *Knife Edges*— The supports for the specimen shall be two knife edges of the rocker type (Fig. 1) with edges at least as long as the width of the specimen. The loading knife edge may be of either the rocker or rigid type.

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 modulus of rupture.

7. Test Specimens

7.1 The specimens shall be approximately 4 by 8 by 2¼ in. (101.6 by 203.2 by 57.2 mm) in size. They shall be sawed from the sample and finished by grinding to smooth surfaces. The 4 by 8-in. faces shall be as nearly plane and parallel as practicable. For loading perpendicular to the rift (Note 1) five specimens shall be prepared with the 4 by 8-in. faces parallel to the rift planes (see A_2 in Fig. 1), and for loading parallel to the rift, five specimens shall be prepared with the 4 by 2¼-in. (101.6 by 57.2 mm) faces parallel to the rift (Note 2). When tests are desired on the stone in both the wet and dry condition, ten specimens shall be prepared for each direction of loading; that is, five for tests dry, perpendicular to the rift, five for tests wet, perpendicular to the rift, etc.

NOTE 1—The term rift is used here to designate the direction in which the stone splits most easily. In stratified stones it is considered to coincide with the bedding or stratification. The rift direction should always be marked on the sample by the quarryman, since it often is not possible to determine it on a small block.

NOTE 2—Another condition of loading may occur in structures when the rift planes are vertical and parallel to the length of the beam. The strength of the stone may be obtained for such loading by cutting the specimens with the 2¼ by 8-in. (57.2 by 203.2-mm) face parallel to the rift. The meager data available for this condition of loading indicates that the strength is at least as high as when the load is applied perpendicular to the rift as shown by A_2 in Fig. 1.

8. Marking and Measuring Specimens

8.1 On the 4 by 8-in. (101.6 by 203.2-mm) face draw the center line perpendicular to one edge (8 by 2¼-in. (203.2 by 57.2-mm) face) and extend down both edges perpendicular to the 4 by 8-in. face. At a distance of 3.5 in. (88.9 mm) each way from the center line, draw two similar sets of lines (span lines, "*a*" in Fig. 1). Mark each specimen to indicate the direction of the rift and label with suitable numbers or letters for identification in measuring and testing.

8.2 Measure the dimensions of the cross section on the center line. Measure the width to the nearest 0.01 in. (0.25 mm) and take the thickness as the average of three measurements to

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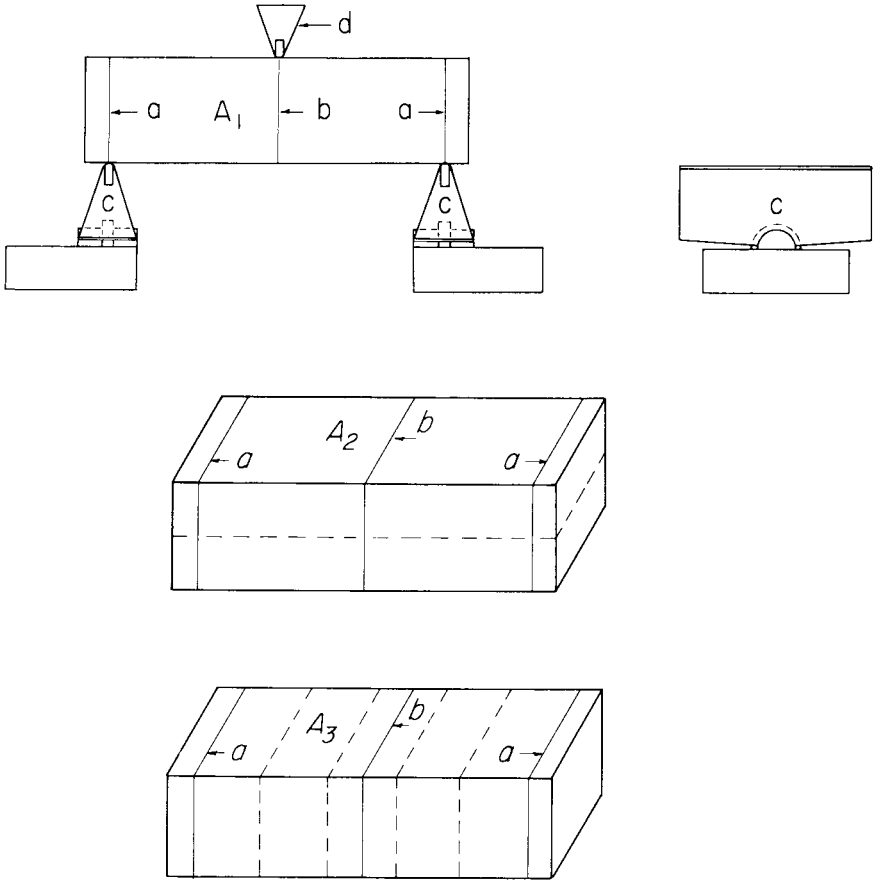
[2] *Annual Book of ASTM Standard*, Vol 04.07.



A_1—Specimen in position for testing.
A_2—Specimen for test perpendicular to the rift.
A_3—Specimen for test parallel to the rift.
(Dotted lines on A_2 and A_3 indicate the rift direction)

a—Span lines.
b—Center lines.
c—Supporting knife edges.
d—Loading knife edge.

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a—Span lines.
b—Center lines.
c—Supporting knife edges.
d—Loading knife edge.

FIG. 1 Specimens and Preferred Type of Knife Edges for Determining the Modulus of Rupture of Building Stone

the nearest 0.01 in., one taken at the center and one near each edge.

9. Conditioning

9.1 Before testing the specimens in a dry condition, dry them for 48 h at 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. After removing the specimens from the oven, cool them to room temperature in a desiccator before testing them.

9.2 Before testing the specimens in a wet condition, immerse them in water for 48 h at 22 ± 2°C (72 ± 4°F). Test them immediately upon removal from the bath, wiping the specimens free of surface water.

10. Procedure

10.1 Lay the specimen flatwise on the supporting knife edges, spaced 7 in. (177.8 mm) apart and equidistant from the loading knife edges (Note 3), with all three knife edges parallel. 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 the loading at a rate not exceeding 1000 lbf/min (4450 N/min) until failure of the specimen.

NOTE 3—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

11.1 Calculate the modulus of rupture of each specimen as follows:

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

where:
R = modulus of rupture, psi (or MPa),
W = breaking load, lbf (or N),

l = length of span, in. (or mm),
b = width of specimen, in. (or mm). and
d = thickness of specimen, in. (or mm),

12. Report

12.1 Report the average of all values of modulus of rupture for test specimens loaded perpendicular to the rift as the modulus of rupture perpendicular to the rift, and report the average for all test specimens loaded parallel to the rift as the modulus of rupture parallel to the rift. In case any specimen gives a value of as much as 20 % under the average it shall be examined for defects and, if the low value appears to be due to a flaw or faulty test piece, report the average of the remaining specimens of the group as the modulus of rupture of the sample for the condition of loading under consideration. Report all determinations as information.

12.2 Report the following additional information:

12.2.1 Identification of the sample, including the name and location of the quarry, name and position of the ledge, date when sample was taken, and trade name or grade of the stone,

12.2.2 Size and shape of specimens used in the test, and

12.2.3 A description of the way in which the specimens were prepared.

13. Precision and Bias

13.1 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.

14. Keywords

14.1 dimension stone; flexure; modulus of rupture; stone