Designation: C 170 – 90 (Reapproved 1999)

Standard Test Method for Compressive Strength of Dimension Stone[1]

This standard is issued under the fixed designation C 170; 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.

1. Scope

1.1 This test method covers the sampling, preparation of specimens, and determination of the compressive strength of dimension stone.

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]

E 4 Practices for Force Verification of Testing Machines[3]

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 compressive strength between the various dimension stones. This test method also provides one element in comparing stones of the same type.

5. Apparatus

5.1 Any testing machine conforming to Practices E 4 and to the speed of testing requirements prescribed in Section 9 of this test method may be used.

5.2 In vertical testing machines, the spherical bearing block shall be suspended from the upper head of the machine in such a manner that the contact plate remains in a central position (spherical surfaces in full contact) when not loaded. The spherical surfaces shall be well lubricated, and the center of curvature shall lie in the surface of contact with the specimen.

6. Sampling

6.1 The sample shall be selected to represent a true average of the type or grade of stone under consideration and shall be of the quality supplied to the market in finished form under the type designation to be tested. The sample may be selected by the purchaser or his authorized representative from 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 variation in compressive strength.

7. Test Specimens

7.1 The test specimens may be cubes, square prisms, or cylinders and shall be cut from the sample with saws or core drills. The diameter or lateral dimension (distance between opposite vertical faces) shall be not less than 2 in. (50.8 mm) (Explanatory Note 1), and the ratio of height (Explanatory Note 2) to diameter or lateral dimension should be not less than 1:1. At least five specimens shall be prepared for each condition of the test; that is, when the compressive strength is desired for the wet and dry conditions but in only one direction, such as perpendicular to the bed (or rift) (see Fig. 1(*a*)), ten specimens will be required. For wet and dry strength tests both perpendicular and parallel to the bed (or rift) (see Fig. 1(*a*) and (*b*)), twenty specimens are required (Explanatory Note 3). The load-bearing faces shall be finished by grinding to as nearly true and parallel planes (Explanatory Note 4) as practicable.

7.2 The load-bearing surfaces and the direction of bedding (or rift) shall be marked on each specimen after finishing.

7.3 The load-bearing areas of the specimen shall be calculated from measurements taken midway between the load-bearing surfaces. The dimensions of the specimens shall be measured to the nearest 0.02 in. (0.5 mm) and the load-bearing areas calculated to the nearest 0.04 in. ^{2} (0.26 cm^2).

8. Conditioning

8.1 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 h, 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 3 successive hourly readings with the

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

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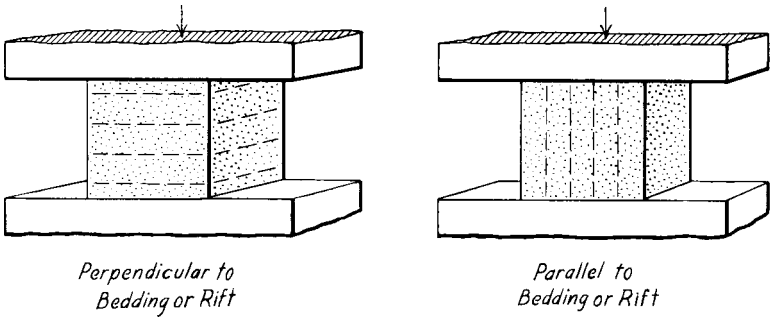
[2] *Annual Book of ASTM Standards*, Vol 04.07.

[3] *Annual Book of ASTM Standards*, Vol 03.01.



NOTE 1—Dashed lines indicate direction of bedding or rift. Arrows indicate direction of loading.
(*a*) Loading Perpendicular to Bedding or Rift (*b*) Loading Parallel to Bedding or Rift

FIG. 1 Methods of Applying Load with Reference to Bedding or Rift

same weight. After removing the specimens from the oven, cool them to room temperature in a desiccator before testing them.

8.2 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.

9. Procedure

9.1 Center the specimens in the testing machine and apply the initial load at a rate that will permit hand adjustment of the contact plate on the specimen. Rotate the plate back and forth through an angle of about 30° under a small load to properly seat the spherical block, but take care not to move the specimen out of the central position. Preferably, the rate of loading should not exceed 100 psi (690 kPa)/s, but this requirement may be considered as being met if the speed of the loading head is not more than 0.05 in. (1.3 mm)/min.

10. Calculation

10.1 Calculate the compressive strength of each specimen as follows:

$$C = W/A \quad (1)$$

where:

C = compressive strength of the specimen, psi (MPa)
W = total load, lbf (N), on the specimen at failure, and
A = calculated area of the bearing surface in in.^{2} (mm^2).

Round each individual result to the nearest 100 psi (1 MPa).

10.2 When the ratio of height to diameter (or lateral dimension) differs from unity by 25 % or more, calculate the result to that of the corresponding cube, as follows:

$$C_c = C_p/[0.778 + 0.222(b \div h)] \quad (2)$$

where:

C_c = compressive strength of an equivalent cubical specimen,
C_p = compressive strength of the specimen having a height greater than the diameter or lateral dimension,
b = diameter or lateral dimension, and
h = height.

11. Report

11.1 Report the average of all values of compressive strength of specimens loaded perpendicular to the bedding (or rift) as shown in Fig. 1(*a*) in a dry condition as the compressive strength perpendicular to the rift in a dry condition. Similarly report the values perpendicular/wet, parallel/dry as shown in Fig. 1(*b*) and parallel/wet. All determinations shall be reported as information.

11.2 The following additional information shall be reported:

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

11.2.2 Size and shape of specimens used in the tests, and

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

12. Precision and Bias

12.1 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.

EXPLANATORY NOTES

NOTE 1—For very coarse-grain materials like some of the granites, the diameter of the specimen should not be less than 2.5 in. (63.5 mm).

NOTE 2—The height of the specimen is considered as the distance between the load-bearing faces.

NOTE 3—In some materials, such as granite, three directions with respect to fissility are recognized, as follows: “rift” (the plane of easiest splitting), “grain” (the plane of next easiest splitting), and “head-grain” (the plane of hardest splitting). Occasionally, tests are required for determining the strength perpendicular to each of these directions. In such cases, the sample shall be marked at the quarry to show which faces are grain, rift, and head-grain, and the required number of specimens shall be prepared with load-bearing faces parallel to each of these planes and properly labeled for the various tests.

NOTE 4—Accuracy of test results depends largely on uniform distribution of the load over the bearing faces. In order to grind the surfaces to reasonably true planes, considerable care is necessary. The following procedure is suggested: Assuming that the specimen is a rectangular prism and the load is to be applied to the ends, mark two adjacent sides for reference, then grind the ends on a grinding wheel or lap until they are perpendicular to these reference sides as gaged by a try square. Complete the grinding by rubbing the ends on a smooth machine-planed surface of a cast iron plate with No. 80 emery and water. The specimen should be grasped as near the surface of the plate as possible to prevent rocking of the specimen. A suitable way to determine when the surfaces are reasonably plane is to dip the specimen in water and press the ends on a smooth machine-planed and polished surface of a 10-lb (4.5-kg) weight. If the weight can be lifted by raising the specimen, the surfaces may be

considered to be sufficiently accurate. A satisfactory mechanical means of finishing the bearing surfaces of the specimens is to place them in a chuck in a lathe and surface the ends with a tool post grinder. This grinder consists of a small motor and arbor carrying an abrasive wheel which turns at about 5000 rpm. A three-point chuck is used to permit the surfacing of cylindrical, square prism, or cubical specimens. When the square-type specimen is used it will be necessary to place a small piece of notched metal between the specimen and one chuck point. This causes the specimen to be placed somewhat off-center but does not interfere with the surfacing process. The surface can be tested for planeness by holding a straightedge on the surface and viewing it before a strong light. Specimens finished in this way commonly give considerably higher test results than specimens prepared by hand.