



Standard Test Method for Strength of Individual Stone Anchorages in Dimension Stone¹

This standard is issued under the fixed designation C 1354; 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 provides procedures for determining the ultimate strength of an assembly consisting of stone with mechanical anchor (anchorage). Load is applied, separately, perpendicular to the surface of the panel and parallel to the surface of the panel. This test is intended to represent the interaction of the anchor with the stone panel. However, influence of the backup structure on the strength of the assemblies is not included.

1.2 This method is applicable to stone panels supported by mechanical anchors.

1.3 The values stated in SI units are to be regarded as the standard.

1.4 *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 1242 Guide for Design, Selection, and Installation of Exterior Dimension Stone Anchors and Anchoring Systems

E 4 Practices for Force Verification of Testing Machines

E 575 Practice for Reporting Data from Structural Tests of Building Constructions, Elements, Connections, and Assemblies

3. Terminology

3.1 Definitions:

3.1.1 *anchor, n—in general*, a metal shape inserted into a slot or hole in the stone panel that provides for the transfer of

loads from the stone to the building structure, either directly or through an intermediate structure.

3.1.2 *anchorage, n*—assembly consisting of a stone panel with a mechanical anchor.

3.1.3 *panel, n*—cut stone with large face dimensions in relation to its thickness, for placement in a building structure or frame assembly.

4. Summary of Test Method

4.1 Test specimens consisting of a stone panel sample and a mechanical anchor are fabricated in the same manner and of the same materials as their intended construction uses. The mechanical anchor is connected to a test support. A test load is applied perpendicular or parallel to the face of the stone panel. The test load is applied gradually using a calibrated test machine; load is increased until the stone or the mechanical anchor fails.

4.2 The load at failure and mode of failure of each test specimen is observed and recorded. The test as described above is repeated five times for each combination of stone and anchor to be tested and for each direction of load to be tested.

5. Significance and Use

5.1 This test method is intended to provide information from which applicable design data can be determined for a given anchor used to support a dimension stone panel. The strength of a limited length of anchor may be related to a longer length of support when the flexibility of the support is properly considered by the designer. Refer to Guide C 1242.

6. Testing Machine

6.1 The testing machine shall conform to the requirements of Practices E 4.

6.2 The load from the testing machine shall be applied through appropriate devices (a lubricated ball-and-socket or a lubricated universal joint) to apply direct tension to the test specimen without bending.

7. Support Frame and Loading Device

7.1 The support frame (excluding the anchor to be tested) shall have sufficient strength to not yield while supporting maximum applied load. In addition, the support frame shall be

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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.

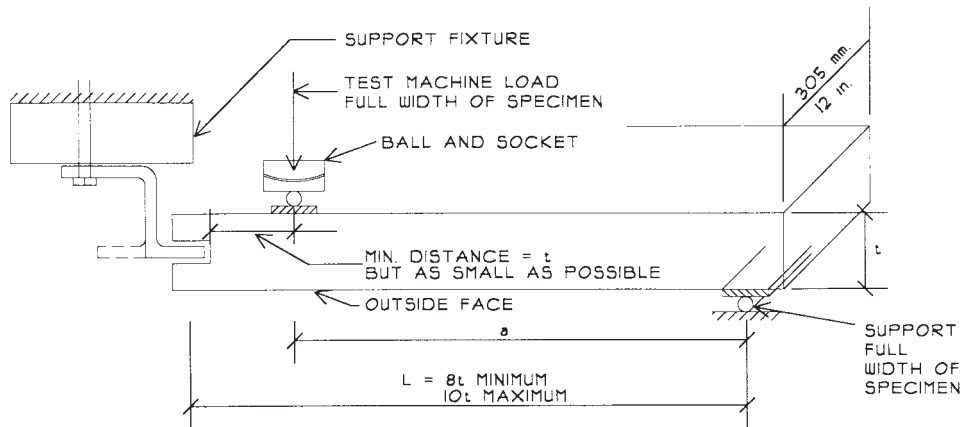


FIG. 1A Edge of Panel Supported by Tab Inserted into Kerf in Edge of Panel

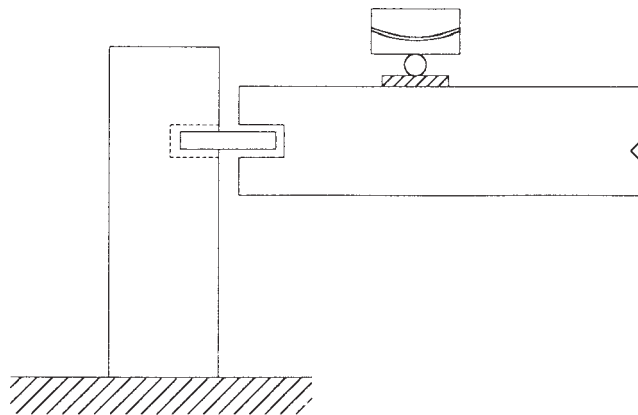


FIG. 1B Edge of Panel Supported by Pin Installed into Hole Drilled into Edge of Panel

FIG. 1 Setup for Testing Connection in Edge of Sample—Test Procedure A

sufficiently stiff to limit deflection to less than 1 mm (0.04 in.) at maximum test load and to limit rotation to less than 2°.

7.2 For load perpendicular to the surface of the stone panel:

7.2.1 A rubber pad or a setting gypsum bed shall be used between the stone and the loading or restraint surface to avoid concentration of stress in the surface of the stone sample.

7.2.2 A frame to support a stone sample with anchor in the side edge of the stone is shown in Fig. 1. Fig. 1 represents outward loading on a single stone panel. At the designer's option, two stone panels can be tested on a single split anchor.

7.2.2.1 The test specimen is supported at one end by the anchor. The anchor shall be attached to the support frame in the same way it will be attached to the backup structure in construction. The sample of stone is supported at the opposite end by a 25 mm (1 in.) diameter rod.

7.2.2.2 The load from the testing machine is applied to the stone sample through a 25 mm (1 in.) diameter rod, located as close as possible to the anchor that supports the stone but at a distance not less than the thickness of the panel.

7.2.3 A frame to test a stone sample with anchor in back of the stone and the load applied in a direction perpendicular to the panel are shown in Figs. 2 and 3. The sample of stone panel is held down while the upward load is applied through a single

sample of anchor. The stone sample may be held down by independent anchors as shown in Fig. 2 or by the device used to apply load as shown in Fig. 3.

7.3 For load parallel to the surface of the stone panel:

7.3.1 The stone panel sample is restrained in the plane of the panel while a test load is applied parallel to the plane of the panel as shown in Fig. 4. The area beneath the anchor shall be kept unsupported to prevent restraint of spalls that may artificially increase the strength. The surface between the loading plate and the stone panel sample shall be lubricated.

8. Test Specimens

8.1 *Anchorage System*—The anchorage system shall be representative of the type to be used in field construction and shall include the anchor to be used and all accessories normally required to attach the anchor to the backup structure. If sealant, epoxy, or other form of kerf filler is specified to be used in field construction, the bond between the sealant, epoxy, or other form of kerf filler shall be intentionally prevented in the test assembly. Alternatively, provisions may be made to distribute the load from the anchor to the stone with a soft bearing material. At the designer's option, the sealant or epoxy may be allowed to bond.

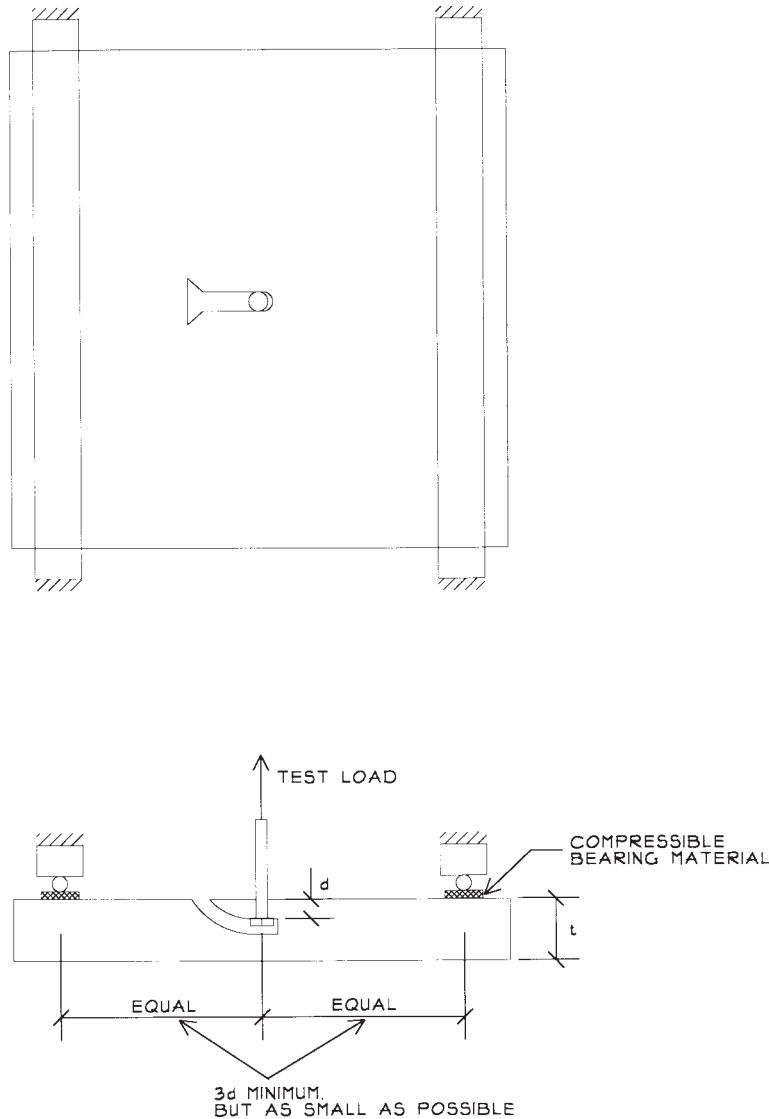


FIG. 2 Setup for Load Testing of Stone Panel with Connection in Back of Sample and Sample Held Down Independently—Load Applied Perpendicular to Surface

8.2 *Anchor Installation*—Install the anchor and accessories in accordance with the specified design.

8.3 *Number of Specimens*—For each combination of stone and anchor to be tested, test at least five specimens.³ Where edge connections are used, a set of five specimens shall be tested with connection made in each of the two perpendicular edges.

8.4 *Stone Panel Samples*—Select representative samples of dimension stone. Stone samples shall be taken from slabs oriented relative to rift as will be used in construction. Stone suppliers shall provide the following information: name of stone used for tests, stone type, quarry source, rift orientation, and stone finish.

8.5 *Anchor Samples*—Use anchor and accessories representative of that specified for the intended construction. If it is desired to measure fracture strength of stone when it exceeds the strength of the metal anchor, an additional set of tests shall be performed using a stiffer anchor or an anchor with a higher yield strength.

8.6 *Preconditioning*—Stone panel samples shall be preconditioned by immersing in water for 48 h at $22 \pm 2^\circ\text{C}$ ($72 \pm 4^\circ\text{F}$). Test specimens immediately upon removing from the bath, wiping the specimen free of surface water. At the designer's option, stone may be tested in a dry condition.

9. Procedure

9.1 For a load applied perpendicular to the panel, one set of five specimens shall be tested with the load applied outward, and one set of five specimens shall be tested with the load applied inward. At the designer's option, only one direction

³ More specimens may be needed depending on the variability of the test results. If necessary, determine suitable statistical parameters to evaluate the composite variability and to select the number of specimens needed for obtaining a given minimum precision in determining the capacity of the anchorage system.

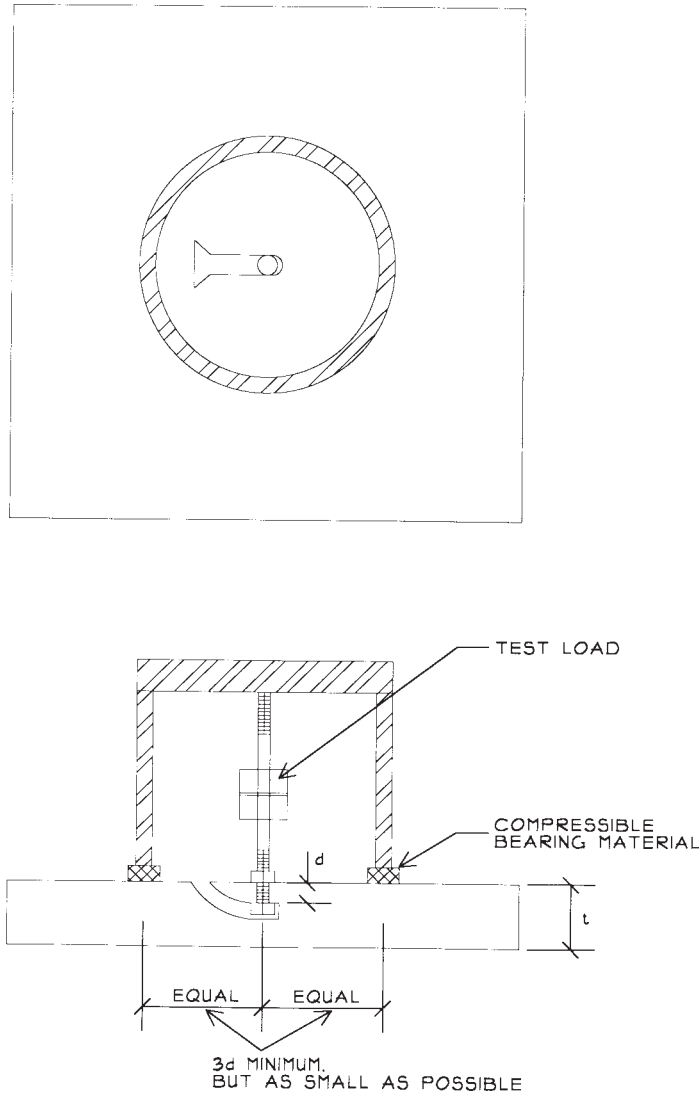


FIG. 3 Setup for Testing of Stone Panel with Connection in Back of Sample and Sample Held Down by Fixture—Load Applied Perpendicular to Surface

may be tested when it is apparent that a direction is the most critical based on the combination of greater load and lower strength.

9.2 For a load applied parallel to the panel, one set of five specimens shall be tested with the load applied in each direction the anchor is being tested.

9.3 Apply the load smoothly and at a rate of one-half the anticipated ultimate strength of the anchor assembly per minute.

9.4 Load each specimen until the anchor fails. Observe and record the failure of the load applied to each specimen.

9.5 Observe and record the mode of failure. If restraint devices have interfered with the fracture plane, note it and adjust the locations of the restraint devices.

9.6 If desired, deflection at the anchorage may be measured. Deflection shall be measured to an accuracy of 0.02 mm (0.001 in.) and in the loading direction. The designer specifying the test shall state what deflection is measured.

10. Calculation

10.1 For the specimens loaded using the test frame shown in Fig. 1, report the load in the anchorage system as (see Fig. 1):

$$\text{anchorage system load} = \frac{(\text{test machine load}) \times a}{L} \quad (1)$$

10.2 For specimens loaded using the test frames shown in Fig. 2, Fig. 3, or Fig. 4, report the load in the anchorage system as:

$$\text{anchorage system load} = \text{test machine load} \quad (2)$$

11. Report

11.1 Report the following information in accordance with Practice E 575:

11.1.1 Test and report dates,

11.1.2 Test sponsor agency,

11.1.3 Identification of anchorage tested: manufacturer, type, material, finish, shape, dimensions, and other pertinent information,

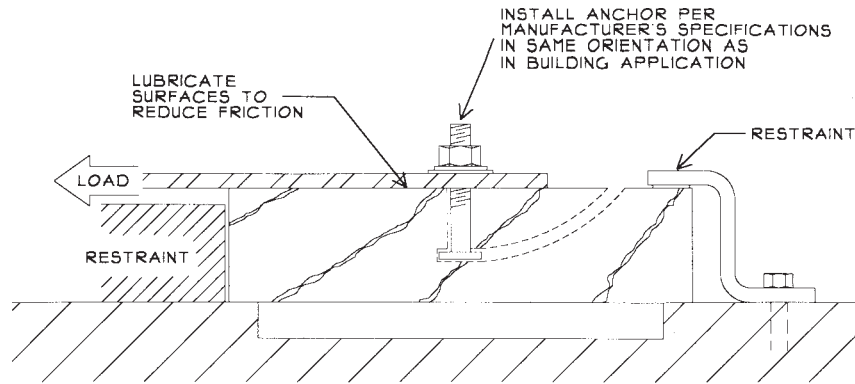


FIG. 4 Setup for Load Testing of Stone Panel with Connection in Back of Panel—Load Applied Parallel to Surface

11.1.4 Description of the anchorage tested,

11.1.5 Detailed drawings or photographs of test specimens before and after testing, if not described, including stone thickness, kerf dimensions or hole diameter, location of hole or kerf, and engagement of anchor into hole or kerf. Actual dimensions of each sample tested (rather than nominal dimensions) shall be measured and reported,

11.1.6 Stone name, stone type, quarry source, rift orientation, and stone finish,

11.1.7 Test method description, load procedures, and actual loading rate,

11.1.8 Number of specimens tested,

11.1.9 Individual and average failure test loads and individual failure modes, and

11.1.10 Names, signatures, and, if required, the professional certificate or seal of responsible persons.

12. Precision and Bias

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

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