Standard Guide to Dimension Stone Test Specimen Sampling and Preparation[1]

This standard is issued under the fixed designation C1799/C1799M; 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.

INTRODUCTION

Dimension stones are products of nature, and as such, are subject to the variability and unpredictability that is associated with all products harvested in nature. Testing of dimension stones to generate reliable data on which engineering decisions can be based has been a standard procedure in the industry for decades. The reliability of the data produced is largely influenced by the care and protocol used in obtaining and preparing the stone test specimens.

1. Scope

1.1 This guide covers sampling, selection, preparation, and conditioning of specimens that will be used to test material properties of dimension stone.

1.2 This guide sets forth basic recommendations for sampling and preparation of dimension stone test specimens and provides information regarding variables that should be considered.

1.3 This guide is intended to be used by architects, engineers, contractors and material suppliers who design, select, specify, install, purchase, fabricate, finish, or test natural stone products for construction applications.

1.4 The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard.

1.5 *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:*

C97 Test Methods for Absorption and Bulk Specific Gravity of Dimension Stone
C99 Test Method for Modulus of Rupture of Dimension Stone
C119 Terminology Relating to Dimension Stone
C120 Test Methods of Flexure Testing of Slate (Breaking Load, Modulus of Rupture, Modulus of Elasticity)
C121 Test Method for Water Absorption of Slate
C170 Test Method for Compressive Strength of Dimension Stone
C217 Test Method for Weather Resistance of Slate
C241 Test Method for Abrasion Resistance of Stone Subjected to Foot Traffic
C880 Test Method for Flexural Strength of Dimension Stone
C1352 Test Method for Flexural Modulus of Elasticity of Dimension Stone
C1353 Test Method for Abrasion Resistance of Dimension Stone Subjected to Foot Traffic Using a Rotary Platform Abraser

3. Terminology

3.1 Refer to Terminology C119.

3.2 *Definitions:*

3.2.1 *sample*—a small part or quantity of stone, usually a slab, panel, or ashlar, that is cut from a larger block of stone.

3.2.2 *specifying authority*—party requiring testing of dimension stone material.

3.2.3 *specimen*—an individual piece of stone that is cut from a sample to be used for physical or mechanical testing.

4. Significance and Use

4.1 The purpose of testing dimension stone is to quantify the various material properties of the stone. The test should consistently predict performance of the stone in a specific application. Many of the test methods that have been developed are specific and attempt to approximate the anticipated behavior of the stone in the manner that is intended to be used,

[1] This test method is under the jurisdiction of ASTM Committee C18 on Dimension Stone and is the direct responsibility of Subcommittee C18.08 on Selection of Dimension Stone.

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such as flexural strength, compressive strength, and anchor strength. Other test methods provide general information about the stone, such as absorption and density. Test data provides the designer with information required to produce rational designs and assess if the stone will perform adequately for its intended use.

5. Selection Considerations

5.1 Natural stone test specimen selection is complicated by the anisotropic structure of most dimension stone. The term "rift" is used to describe the direction along which a dimension stone is most easily split. In some stone species, specifically the sedimentary stones such as limestone, sandstone and travertine, the rift direction and associated behavior can be pronounced, and is typically coincident with the natural bedding planes visible in the stone deposit.

5.2 Within the stone quarry, the in-situ orientation of these bedding planes may follow horizontal, mountain slope, or random directional trends. In other stone species of metamorphic or igneous origin, the presence of rift and, therefore, the anisotropy of the stone, tends to be milder. Exceptions to this rule are common, and stones of any formation type can be extremely anisotropic to nearly isotropic in both visual and mechanical properties.

5.3 Historically, all stones were considered to have a weak and a strong direction relative to their rift or bedding plane direction, or both. Commercially, the terms "fleuri" and "vein" are used to describe slabs that are cut parallel or perpendicular, respectively, to the bedding planes (Fig. 1). Test procedures were written to address this directional specificity and required test specimens to be cut for parallel loading or perpendicular loading, relative to the rift of the stone. Specific to bending strength specimens, a perpendicularly loaded test specimen is one that has the rift planes roughly parallel to the largest face of the sample, while a parallel loaded test specimen is one that has the rift planes roughly parallel to the end planes of the test specimen (see Fig. 2). Generally, a stone will demonstrate its greatest strength in a perpendicularly loaded test specimen and its lowest strength in a parallel loaded test specimen. It may be possible to identify a third orientation, but since its strength would logically fall between the true parallel and true perpendicular orientations, it is not normally sampled.

5.4 The historic sampling procedures are obtainable when the fabricator of the stone has access to cubic blocks of the material. Slabs must be cut from two perpendicular faces of the block to establish the proper rift plane orientation in the test specimens. Two practical problems exist with this practice.

5.4.1 For visual or aesthetic reasons, or both, many different types of stone are only sawn in one direction. If the slabs are only to be supplied in one direction relative to the rift, then testing in the other direction may produce data of no practical value and simply add unnecessary expense to the project.

5.4.2 Many materials are imported in slab form only, in which case the fabricator does not have access to cubic form quarry blocks from which the correct orientations can be obtained.

5.4.2.1 In such cases, the common practice is to prepare the test specimens from the slabs as provided from the fabricator, rotating the primary axis of the test specimen 90 degrees in the layout of the slabs so half of the test specimens are in an orthogonal relationship to the other half of the test specimens (Fig. 3).

5.4.2.2 Such specimens should not be referenced as "parallel" and "perpendicular" because they are not of true parallel and perpendicular rift orientation. The correct nomenclature to describe this sampling protocol would be "North-South" and "East-West", or "Major Axis" and "Minor Axis" specimens.

5.4.2.3 For slabs that are exclusively vein cut, flexural strength testing may produce results that demonstrate the effect of directionality on specimens oriented orthogonally to each other.

6. Sampling

6.1 Samples should be selected to represent a true average of the 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. Samples should be of adequate size to permit preparation of the desired number of test specimens. Samples taken

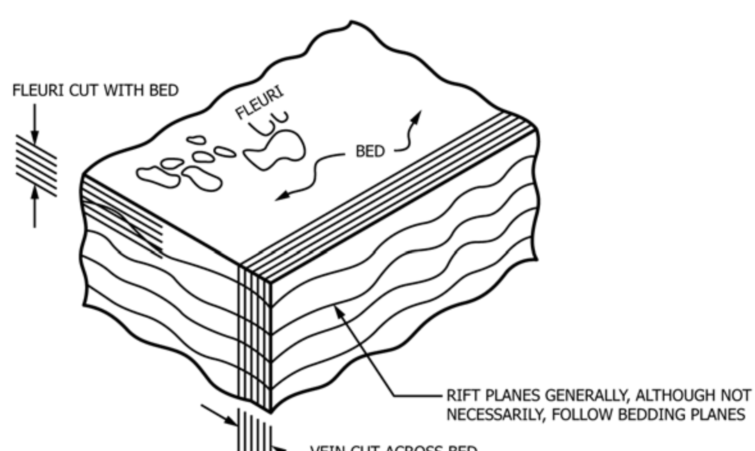

FIG. 1 Fleuri and Vein Cut Slabs

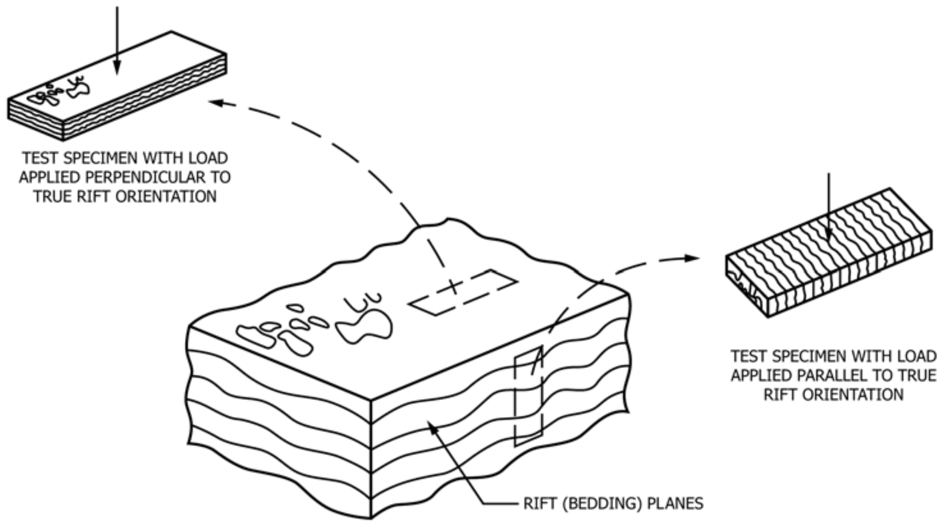

FIG. 2 True Parallel and Perpendicular Rift Orientation

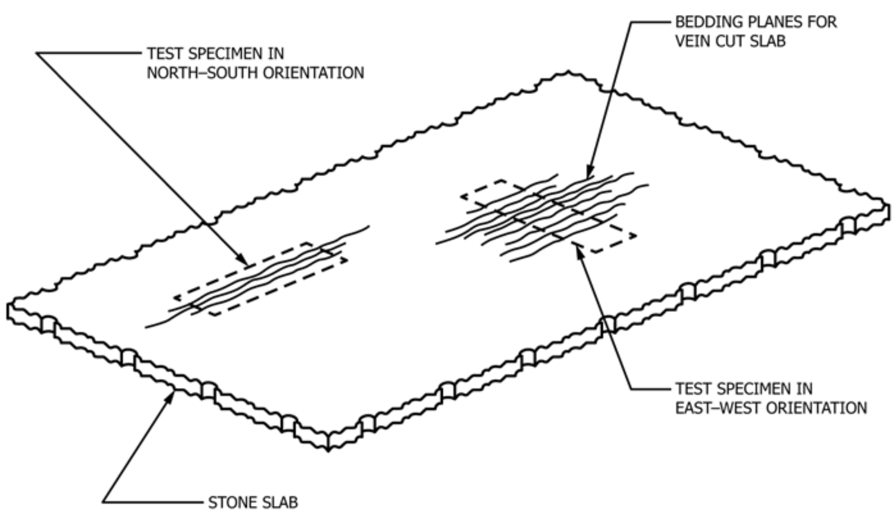

FIG. 3 Orthogonal Layout of Test Specimens

from a single slab should be discouraged. When perceptible variations occur, the purchaser may select as many samples as are necessary to determine the variation in the property to be tested.

7. Specimen Preparation

7.1 Unless noted otherwise by the test standard, each specimen should be sawn from a sample.

7.2 The sides of the specimen should be at right angles with respect to the top and bottom surfaces.

7.3 The planes of the specimen perpendicular to the load should have a fine abrasive finish and the sides of the specimen should have sawn finishes. Unless noted otherwise by the test standard, rough surfaces perpendicular to the load should be lapped with a No. 80 abrasive.

7.4 The load-bearing surfaces and the direction of bedding (or rift) should be marked on each specimen after preparation.

8. Conditioning

8.1 Conditioning of test specimens is standardized throughout the dimension stone test standards. As is the case with directionality, performing tests on specimens in both the wet and dry condition will establish an expected performance range for each tested property.

8.1.1 Based on anticipated service conditions, performing tests on specimens for both wet and dry conditions may not be necessary. The specifying authority should establish appropriate test specimen conditioning requirements.

8.1.2 For applications where it is unnecessary to establish the expected performance range, specimens may be tested "as received" without conditioning. Results obtained without conditioning test specimens should be identified as "unconditioned" when reporting test results.

8.2 *Dry Condition*—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 prior to testing.

8.3 *Wet Condition*—Before testing the specimens in a wet condition, immerse them in water for 48 h at 22 ± 2°C [72 ± 4°F]. Test immediately upon removal from the bath, wiping the specimens free of surface water.

9. Test Specimens

9.1 To establish material properties for the purposes of structural design or analysis, a minimum of five specimens should be tested for each condition (wet and dry) and each direction (parallel and perpendicular to the rift, or north-south and east-west with respect to the loading plane) of the test. The average value of the test results for each condition and direction is reported.

9.1.1 The specifying authority should evaluate and determine if additional specimens for each condition and each direction are necessary to establish material properties to be used as the basis for structural design.

9.2 The requirements for designing and supplying material for low-rise buildings are generally less complex than the requirements for a mid-rise or high-rise building. On large projects, production testing should be performed to verify that the material supplied throughout the project meets or exceeds the material properties upon which the design is based.

9.2.1 For projects where less than 10 000 ft^2 [900 m^2] of material is required, test data obtained from a single block, or results from testing within the previous three years submitted by the stone supplier, may be sufficient.

9.2.2 For projects where more than 10 000 ft^2 [900 m^2] of material is required, one additional block per every 10 000 ft^2 [900 m^2] that is quarried to supply material for the project should be tested. The number of specimens tested for each block should conform to the guidelines of Section 9.1.

9.2.2.1 Block sizes, panel thicknesses, and therefore, material yields, will vary among dimension stone types, manufacturers, and quarries. Variability within the stone and variability of past test data may warrant modifying production testing requirements.

9.2.2.2 Production testing should be performed on projects where there is very little performance history or previous test data are unavailable. Materials without exemplars require an extensive testing program in an attempt to establish performance reliability.

9.2.2.3 Production testing may be unnecessary for proposed systems that have stone materials in thickness, modules, panel sizes, anchors, and backups very similar to well-performing exemplars in the same climate.

9.2.3 The stone supplier or quarry representative should be consulted to determine the number of blocks required to supply a sufficient amount of material for the project. Based on the number of anticipated blocks, the number of required test specimens can be determined from the number of test methods specified for each project.

9.3 In some instances, material for fabricating test specimens may not be available in dimensions that conform to the requirements of the test methods used to determine whether a particular stone complies with the strength properties (compressive, flexural, modulus of rupture) prescribed in a material specification. This is often the case for thin stone tile material where representative thicker samples are not available.

9.3.1 Performing tests on specimens that are significantly smaller than the prescribed dimensions is likely to produce results that are significantly higher in variability than would be obtained when following each standard test method. When the area of the test specimen is small, extremely high or low individual test values may be obtained due to sampling very small weak or strong areas of stone.

9.3.2 Small imperfections in fabrication of the specimens, (that is, surface flatness and out-of square) will have a much greater reducing effect on the strength of the specimen than if the specimen were standard size. Therefore, testing reduced sized specimens, based on the number of test specimens prescribed in the test standards, is very likely to yield inaccurate results, the degree to which is dependent on specimen fabrication quality and stone variability. Even testing a large number of specimens may not be sufficient to overcome these inherent problems from testing small specimens.

9.3.3 Judgments made on the applicability and results of testing reduced-sized specimens should be made by a person with significant experience in testing and evaluating dimension stone.

10. Report

10.1 The requirements for reporting test results are provided within each test standard and should generally include the stone type, specimen size, preconditioning procedure used, individual test results for each specimen, and average value of the test results for each group of test specimens.

10.2 Suppliers frequently publish expected ranges of test results for materials that they supply or produce. If previous test results from the stone supplier are sufficient to meet project needs, the testing agency should be identified on the report submitted to the specifying authority and the test results should not be more than three years old. The quarry or supplier, or both, should also confirm in writing that the material supplied for a specific project is representative of the source material listed in the submitted test data.

11. Keywords

11.1 bedding plane; conditioning; design; preparation; rift; sampling; specimen; stone testing