Standard Test Methods for Strength Properties of Prefabricated Architectural Acoustical Tile or Lay-In Ceiling Panels[1]

This standard is issued under the fixed designation C 367; 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

Materials used for absorbing sound generally have a porous, low-density structure. In comparison with many building materials they may be relatively fragile. Materials are available that possess adequate strength and stability and at the same time provide good sound absorption. The test methods described here cover procedures for evaluating those physical properties related to strength. The methods are of use in developing, manufacturing, and selecting acoustical tile or lay-in panels.

It should be kept in mind that a property related to strength is only one of several considerations important in judging the usefulness of an acoustical material. For example, a material judged to be quite weak by one of these tests may still be desired for other reasons, and with adequate precautions, may be shipped and installed successfully.

1. Scope

1.1 These test methods cover the determination of the strength properties of prefabricated architectual acoustical tile or lay-in ceiling panels as follows:

Tests	Sections
Hardness	2 to 7
Friability	8 to 13
Sag	14 to 20
Transverse strength	21 to 26

1.2 Not all of the tests described in these test methods may be necessary to evaluate any particular product for a specific use. In each instance, it will be necessary to determine which properties are required.

1.3 These test methods specify procedures that may be used in product development, manufacturing control, specification acceptance, and service evaluation.

1.4 Properties determined by these test methods reflect the performance of the materials under the specific conditions of the test, and do not necessarily indicate performance under conditions other than those specified herein.

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.*

HARDNESS

2. Significance and Use

2.1 Knowledge of hardness is useful in the development and the quality control of acoustical tile. Deviation from an established hardness range will assist in pointing out processing errors or defective raw materials, thereby aiding the maintenance of uniform product quality.

2.2 This property is also useful in comparing the relative abilities of materials to resist indentations on the panel surface caused by impacts.

2.3 Since the hardness varies with the thickness, only samples of the same thickness may be directly compared.

3. Apparatus

3.1 *Testing Machine*—Any standard mechanical or hydraulic testing machine capable of applying and measuring the required load within an accuracy of ±1 % may be used. It shall be equipped with a 50.8-mm (2.00-in.) diameter metal ball, or hemispherically shaped penetrator that bears upon the specimen surface.

4. Test Specimens

4.1 Cut five 100 by 100-mm (4 by 4-in.) specimens from a single tile or panel. Cut the five specimens from representative areas of the tile or ceiling panel.

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5. Conditioning

5.1 The strength properties of acoustical materials often depend on the moisture content at the time of the test. Therefore, condition materials for test under "room conditions" to constant weight (within ±1 %) in an atmosphere maintained at a relative humidity of 50 ± 2 %, and a temperature of 23 ± 1°C (73 ± 2°F). State in the test report any departure from this recommended condition.

6. Procedure

6.1 Place the specimen in the conditioning chamber and let it remain until equilibrium is obtained.

6.2 Place the specimen on a flat surface under the loading penetrator of the test machine. Force the penetrator into the specimen 6.4± 0.3 mm (0.25 ± 0.01 in.) below the original surface (Note 1) at a rate of 2.5 mm (0.10 in.)/min (Note 2).

NOTE 1—The original surface is defined as the point where the penetrator first contacts the specimen.

NOTE 2—When possible, the penetrator should bear between perforations or fissures when testing perforated or fissured material.

6.3 Record the load shown on the testing machine when the penetrator reaches the specified depression as the hardness of the specimen in newtons or pounds-force.

7. Report

7.1 The report shall include the following:

7.1.1 Identification of the test material,

7.1.2 Method of conditioning including time of conditioning, temperature, °C or °F, and relative humidity, %,

7.1.3 Statement describing whether the finished or unfinished surface was tested,

7.1.4 Average thickness for the five specimens, mm or in.,

7.1.5 Individual thicknesses for each of the five specimens, mm or in.,

7.1.6 Average hardness for the five specimens, N or lbf, and

7.1.7 Individual hardness for each of the five specimens, N or lbf.

FRIABILITY

8. Significance and Use

8.1 The friability test measures the susceptibility of an acoustical product to edge and corner damage that might be sustained during shipping, handling, and installing. Products that are friable and soft may erode considerably when subjected to rough treatment.

9. Apparatus

9.1 *Balance*, accurate to within 0.5 % of the weight of the smallest specimen tested.

9.2 *Testing Container*, consisting of a red oak box with inside dimensions of 200 mm (7¾ in.) square by 190 mm (7½ in.) deep and fitted with a cover on one end for inserting and removing the specimens. The box shall be mounted so that it may be rotated at 60 r/min on a horizontal axis that is perpendicular to its square dimension.

9.3 *Red Oak Cubes*, 24, 19 ± 0.8 mm (¾ ± 1⁄32 in.) on an edge, having a specific gravity of 0.65 ± 0.02.

9.4 *Timer*, consisting of a watch or clock capable of measuring intervals of 10 min within ± 5.0 s.

10. Test Specimens

10.1 Cut twelve 25 by 25-mm (1 by 1-in.) square specimens from a single tile or panel. The specimen thickness is equal to the tile or panel thickness.

NOTE 3—If the friability of original edges is of importance, separate tests should be run on 25 by 25-mm (1 by 1-in.) specimens having one or two original edges.

11. Conditioning

11.1 Maintain standard conditions as described in 5.1 during preparation and testing of specimens.

12. Procedure

12.1 Weigh the twelve specimens and record the combined weight to the nearest 0.1 g.

12.2 Place the 12 specimens and the 24 oak cubes in the testing container. Close the top of the testing container and rotate the container about its axis at a speed of 60 rpm for two 10-min periods. At the end of each 10-min period, remove the specimens from the box and determine the percentage of loss in weight, due to pulverization and breakage. In the case of badly abraded specimens, remove up to twelve of the largest pieces remaining and weigh these for the determination. In rare cases, no pieces may remain from an individual specimen. In this case, the weight loss shall be reported as 100 %.

13. Report

13.1 The report shall include the following:

13.1.1 Identification of the test material,

13.1.2 Method of conditioning including time of conditioning, temperature, °C or °F, and relative humidity, %, and

13.1.3 Percentage loss in weight for the 10- and 20-min periods.

SAG

14. Significance and Use

14.1 This test method is for the purpose of determining the sag properties of ceiling tile or panels under various conditions of humidity exposure. Tiles or panels of various sizes can be tested by using appropriately sized supporting frames.

14.2 The test method will provide both the initial sag below the plane of the grid system and the total moisture-induced sag.

14.3 This test method is not designed to establish the expected performance of the ceiling panels under field conditions of use, but only the sag properties for the specific temperature, humidity, exposure time, and mounting conditions used in the test.

15. Apparatus

15.1 *Controlled-Atmosphere Chamber*, capable of operating at a dry-bulb temperature of 23 to 32± 1.5°C (73 to 90 ± 3°F), and relative humidities of 50, 60, 70, 80, or 90 ± 2 %. The chamber should be equipped with suitable recording equipment to record wet- and dry-bulb temperatures (or dry bulb and relative humidity). This equipment shall be checked periodically and calibrated with a psychrometer that shall also be used to establish the test conditions.

15.2 *Sample Test Frames and Racks*, fabricated from nonferrous metal, such as aluminum, and of suitable linear dimensions as shown in Fig. 1. Frames shall be constructed of 6 by 38 by 38-mm (¼by 1½-in.) angle with miter-cut corners. Inside surfaces of corners shall be welded and ground smooth. Frames shall be fabricated so they are level and square. Overall inside dimensions of the frames shall be such that the panels do not touch the vertical edges of the frame if they expand under prolonged exposure to conditions of high humidity.

15.2.1 Racks may be constructed of a convenient design to hold one or more test frames in a horizontal plane; however, a sufficient distance shall be maintained between frames to permit adequate circulation of the test atmosphere and permit test measurements without moving panels.

15.3 *Zero-Plane Plate*—In the event that measurements are made using the zero-plane plate, means of zeroing the dial indicator (Note 4), a zero-plane plate fabricated of 6-mm (¼-in.) thick by 80-mm (3-in.) wide steel or aluminum stock, shall be provided. The length of the plate shall be 6 mm (¼ in.) less than the inside width of the test frame.

NOTE 4—In the case of panels with a width of 610 mm (24 in.) or less, an alternative means of zeroing the sag bar dial indicator may be used. This consists of placing a zero-plane plate in the test specimen frame parallel with the shortest member of the frame, and centered in the longest member of the frame. The sag bar is then placed beneath the frame and the dial gage is adjusted to read zero at the plane of the specimen surface.

15.4 *Sag Bar*, equipped with a dial indicator having a minimum movement of 25 mm (1 in.) calibrated in increments of 0.025 mm (0.001 in.) or less. The dial indicator shall be equipped with a 13-mm (0.50-in.) diameter pressure foot. The bar shall be equipped with individually adjustable feet having 20-mm (¾-in.) diameter bearing surfaces. The distance between centers of the bearing surfaces shall be equal to the nominal width of the test panel. Fig. 2 shows a suitable sag bar design including spacing between bearing surfaces.

16. Test Specimens

16.1 Test specimens shall be full-size tile or panels as shipped for installation in the field.

17. Conditioning

17.1 Condition specimens as described in 5.1 prior to placing in the controlled atmosphere chamber for sag testing.

18. Procedure

18.1 Adjust the environmental chamber controls to provide one of the temperature and humidity conditions selected from those listed in 15.1.

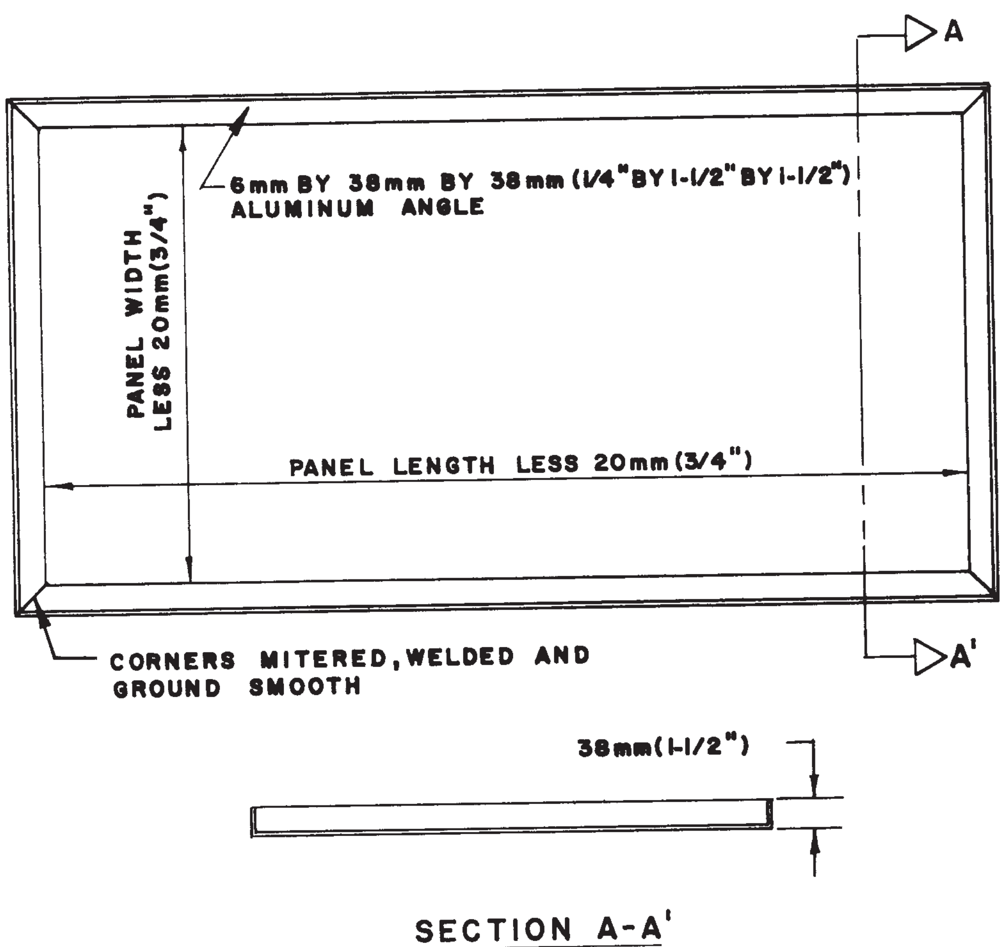
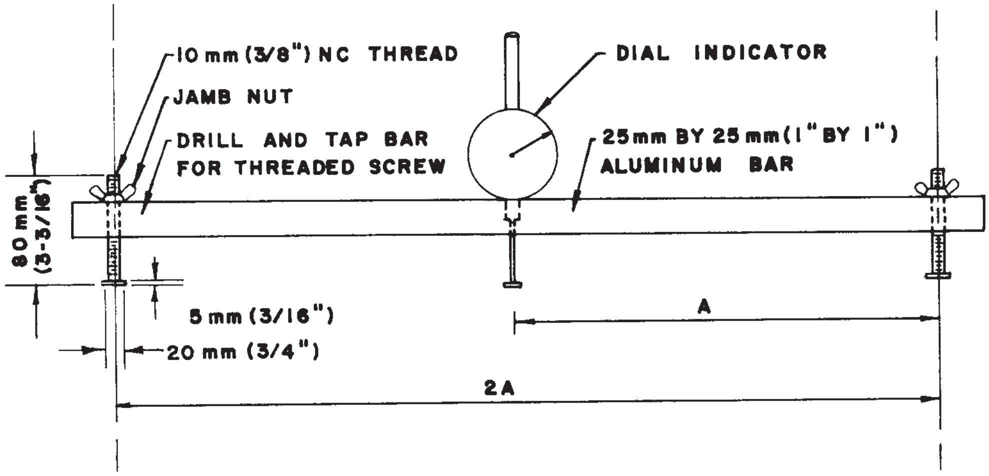


FIG. 1 Sag Test Frame



Panel Minimum Linear Dimension, mm (in.)	Dimension A, mm (in.)
305 (12)	150 (6)
610 (24)	305 (12)
1220 (48)	610 (24)
1525 (60)	760 (30)

FIG. 2 Sag Bar

18.2 Place the sag bar on a flat surface, such as a rigid aluminum bar of a length appropriate to the size of the sag bar (Note 4).

18.3 Adjust the dial gage indicator to read the thickness of the test frame angle. This will provide an indication of 0 mm (0 in.) when the indicator foot is in the plane of the test panel supporting surface.

18.4 Mark the geometric center of the tile or panel on the finished surface at the intersection of diagonals drawn from corner to corner.

18.5 Install the tile or panel in the test rack within the environmental chamber with the finished surface facing down.

18.6 Record the dial gage reading as the "initial reading."

18.7 Place the sag bar under the test panel with the sag bar feet pressed firmly into contact with the horizontal members of the frame and with the bar parallel with the shortest (if not symmetrical) members of the frame. The feet should be positioned at the center of the span of the longest frame member and the dial gage foot should be located at the panel center as marked in 18.4.

18.8 Adjust the environmental chamber to provide the desired temperature and relative humidity. These conditions should be obtained over a time period not exceeding 15 min. Hold at these conditions for 17 h (which includes the adjustment time). Record the dial gage reading as the" wet reading."

18.9 Return the sample to the conditions used to obtain the "initial reading" in 18.6. Again this change should occur over a time period not exceeding 15 min. Maintain the sample at these conditions for 7 h (again this time period includes the adjustment time). Record the dial gage reading as the "final reading."

NOTE 5—If the sag exceeds the capacity of the dial gage, insert gage blocks between the sag bar feet and the bottom of the test frame to obtain a sag reading. Add the gage block thickness to the indicated reading.

19. Calculation

19.1 Calculate the initial sag below plane and the total moisture-induced sag as follows:

Initial sag below plane = Y
Total moisture-induced sag + initial sag = Z
Recovery = X

where:
Y = initial reading,
Z = total sag with moisture, and
X = total sag after recovery.

then:
Y = Initial sag below plane, mm or in.,
$Z - Y$ = Total mositure induced sag, mm or in., and
$X - Y$ = Recovery, mm or in.

20. Report

20.1 The report shall include the following:

20.1.1 Identification of the test material,

20.1.2 Specimen length, width, and thickness in mm or in. and weight in kg or lb after conditioning at 23°C (73°F) and 50 % relative humidity,

20.1.3 A statement to the effect that the specimens were preconditioned to constant weight at 23°C (73°F) and 50 % relative humidity,

20.1.4 Temperature, °C or °F, and relative humidity, %,

20.1.5 Test duration, h,

20.1.6 Initial sag below plane, mm or in.,

20.1.7 Total moisture induced sag, mm or in., and

20.1.8 Recovery, mm or in.

TRANSVERSE STRENGTH

21. Significance and Use

21.1 Transverse strength and modulus of rupture tests are of practical usefulness in the development and in the quality control of acoustical tile. Performance characteristics in the handling, shipping, and installing of acoustical tile may often be predicted by strength testing. The numerical results obtained are not necessarily comparable for tiles or panels of different thicknesses made from the same base material or for tiles or panels of the same thickness made from different materials.

22. Apparatus

22.1 *Testing Machine*—Any standard mechanical or hydraulic testing machine capable of applying the load at a speed of 50 ± 6 mm (2 ± ¼ in.)/min and measuring the load within ±2 %. The loading beam shall have a bearing surface at least 25 mm (1 in.) high by at least 80 mm (3 in.) wide rounded to a radius of 10 mm (⅜ in.). The supporting surfaces shall be at least 100 mm (4 in.) high by 80 mm (3 in.) wide with a radius of 10 mm (⅜ in.) and shall be set for a span of 250 mm (10 in.). All bearing surfaces shall be self-aligning so as to maintain full contact with the specimen. Means for measuring the deflection at the breaking load shall be provided.

23. Test Specimens

23.1 Test specimens shall be 80 mm (3 in.) wide by 300 mm (12 in.) long. Two specimens each, in the machine direction and across the machine direction, shall be prepared for each test.

24. Conditioning

24.1 Condition cut specimens as described in 5.1 prior to testing.

25. Procedure

25.1 Place the specimen in the testing machine so that the back of the specimen rests on the supporting span, and the load is applied at the midspan on the face of the specimen. Apply the load at a rate of 50± 6 mm (2 ± ¼ in.)/min until a failure occurs. Read and record the load and deflection at break.

26. Modulus of Rupture (MOR)

26.1 The MOR in N/m^2 (lb/in.^{2}) of each specimen is calculated from the following equation, using the data from the transverse strength measurements:

$$\frac{3 \times P \times L}{2 \times b \times d^2} \tag{1}$$

where:
P = maximum load, N (lbf),
L = length of span, mm(in.),
b = specimen width, mm (in.), and
d = specimen thickness, mm (in.).

27. Report

27.1 The report shall include the following:

27.1.1 Identification of the test material,

27.1.2 Method of conditioning including the time of conditioning, temperature, °C or °F, and relative humidity, %,

27.1.3 Statement describing whether the specimens were tested with the finished face up or down,

27.1.4 Statement that the 80-mm (3-in.) wide by 300-mm (12-in.) long specimens were tested over a span of 250 mm (10 in.) with the load applied at midspan,

27.1.5 Average thickness for the five cross machine specimens, mm or in.,

27.1.6 Average thickness for the five machine direction specimens, mm or in.,

27.1.7 Average breaking strength for the five cross machine specimens, N or lbf, and

27.1.8 Average breaking strength for the five machine direction specimens, N or lbf,

27.1.9 Average MOR for the five cross machine specimens, N/mm^2 (lb/in.^{2}), and

27.1.10 Average MOR for the five machine direction specimens, N/mm^2 (lb/in.^{2}).

PRECISION AND BIAS

28. Precision and Bias

28.1 *Precision*—The precision of these test methods has not been established.

28.2 *Bias*—No statement can be made on the bias of these test methods since the true values of the properties have not been established by standard reference materials.

29. Keywords

29.1 friability; hardness; sag; strength properties; transverse strength