Designation: D 1037 – 99

Standard Test Methods for Evaluating Properties of Wood-Base Fiber and Particle Panel Materials[1]

This standard is issued under the fixed designation D 1037; 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.

INTRODUCTION

The test methods presented herein have been developed and are presented to serve two distinct purposes. They are divided into two parts, Parts A and B, depending on the purpose for which they are intended. The choice between a particular test method and its alternative should be made with a full understanding of the intended purpose of each, because values obtained from tests may, in some cases, differ. Of the test methods presented in both parts, some have been in generally accepted use for many years, some are modifications and refinements of previously developed test methods, and some are more recent developments. Where test methods are suitable for more than one of the purposes, they are delineated in Part A, but not repeated in Part B. It is the intent that reference to the appropriate section of the test method shall suffice in specifications developed for the different materials.

Part A. General Test Methods for Evaluating the Basic Properties of Wood-Base Fiber and Particle Panel Materials—Part A is for use in obtaining basic properties suitable for comparison studies with other materials of construction. These refined test methods are applicable for this purpose to all materials covered by Definitions D 1554.

Part B. Acceptance and Specification Test Methods for Hardboard—Part B is for specific use in specifications for procurement and acceptance testing of hardboard. These test methods are generally employed for those purposes in the industry. By confining their intended use as indicated, it has been possible to achieve adequate precision of results combined with economy and speed in testing, which are desirable for specification use.

PART A—GENERAL TEST METHODS FOR EVALUATING THE BASIC PROPERTIES OF WOOD-BASE FIBER AND PARTICLE PANEL MATERIALS

1. Scope

1.1 These test methods cover the determination of the properties of wood-base fiber and particle panel materials as follows:

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[1] These test methods are under the jurisdiction of ASTM Committee D-7 on Wood and are the direct responsibility of Subcommittee D07.03 on Panel Products.

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Compression-Shear Test 137-146

1.2 There are accepted basic test procedures for various fundamental properties of materials that may be used without modification for evaluating certain properties of wood-based fiber and particle panel materials. These test methods are included elsewhere in the *Annual Book of ASTM Standards.* The pertinent ones are listed in Table 1. A few of the test methods referenced are for construction where the wood-base materials often are used.

1.3 The values stated in inch-pound units are to be regarded as the standard. The metric equivalents of inch-pound units may be approximate.

1.4 *This standard does not purport to address all of the safety problems, 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 273 Test Method for Shear Test in Flatwise Plane of Flat Sandwich Constructions or Sandwich Cores[2]

D 143 Methods of Testing Small Clear Specimens of Timber[3]

D 905 Test Method for Strength Properties of Adhesive Bonds in Shear by Compression Loading[4]

D 1554 Definitions of Terms Relating to Wood-Base Fiber and Particle Panel Materials[3]

D 3501 Methods of Testing Plywood in Compression[3]

TABLE 1 Basic Test Procedures for Evaluating Properties of Wood Base-Fiber and Particle Panel Materials

ASTM Designation	Test Methods for
C 177	Steady-State Heat-Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus[A]
C 209	Cellulosic Fiber Insulating Board[A]
C 236	Steady-State Thermal Performance of Building Assemblies by Means of the Guarded Hot Box[A]
C 384	Impedance and Absorption of Acoustical Materials by the Impedance Tube Method[A]
C 423	Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method[A]
D 149	Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies[B]
D 150	A-C Loss Characteristics and Permittivity (Dielectric Constant) of Solid Electrical Insulating Materials[B]
D 257	D-C Resistance or Conductance of Insulating Materials[B]
D 495	High-Voltage, Low-Current, Dry Arc Resistance of Solid Electrical Insulation[B]
D 1666	Conducting Machining Tests of Wood and Wood-Base Materials[C]
D 1761	Mechanical Fasteners in Wood[C]
E 72	Conducting Strength Tests of Panels for Building Construction[D]
E 84	Surface Burning Characteristics of Building Materials[D]
E 90	Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions[A]
E 96	Water Vapor Transmission of Materials[A]
E 97	Directional Reflectance Factor, 45-deg 0-deg, of Opaque Specimens by Broad-Band Filter Reflectometry[E]
E 119	Fire Tests of Building Construction and Materials[D]
E 136	Behavior of Materials in a Vertical Tube Furnace at 750°C[D]
E 152	Fire Tests of Door Assemblies[D]
E 162	Surface Flammability of Materials Using a Radiant Heat Energy Source[D]
E 661	Performance of Wood and Wood-Based Floor and Roof Sheathing Under Concentrated Static and Impact Loads[D]
E 662	Specific Optical Density of Smoke Generated by Solid Materials[D]
E 906	Heat and Visible Smoke Release Rates for Materials and Products[D]

[A] *Annual Book of ASTM Standards*, Vol 04.06.
[B] *Annual Book of ASTM Standards*, Vol 10.01.
[C] *Annual Book of ASTM Standards*, Vol 04.10.
[D] *Annual Book of ASTM Standards*, Vol 04.07.
[E] *Annual Book of ASTM Standards*, Vol 14.02.

3. Significance and Use

3.1 These test methods cover small-specimen tests for wood-base fiber and particle panel materials that are made to provide:

3.1.1 Data for comparing the mechanical and physical properties of various materials,

3.1.2 Data for determining the influence on the basic properties of such factors as raw material and processing variables, post-treatments of panels, and environmental influences, and

3.1.3 Data for manufacturing control, product research and development, and specification acceptance.

4. Selection of Test Method

4.1 Not all the tests outlined in these test methods may be necessary to evaluate any particular board for any specified use. In each instance, therefore, it will be necessary to determine which tests shall be made.

5. Test Specimens

5.1 The number of specimens to be chosen for test and the method of their selection depend on the purpose of the particular tests under consideration, so that no general rule can be given to cover all instances. It is recommended that whenever possible, a sufficient number of tests be made to permit statistical treatment of the test data. In the evaluation of a board material, specimens for test should be obtained from a representative number of boards. In properties reflecting differences due to the machine direction of the board, specimens from each board shall be selected both with the long dimension parallel to the long dimension of the sheet, and with the long dimension perpendicular to the long dimension of the sheet.

6. Control of Moisture Content and Temperature

6.1 The physical and mechanical properties of building boards depend on the moisture content at time of test. Therefore, material for test in the dry condition shall be conditioned to constant weight and moisture content in a conditioning chamber maintained at a relative humidity of 65 ± 1 % and a temperature of 20 ± 3°C (68 ± 6°F) (Note 1 and Note 2). If there is any departure from this recommended condition, it shall be so stated in this report.

NOTE 1—In following the recommendation that the temperature be controlled to 20 ± 3°C (68 ± 6°F), it should be understood that it is desirable to maintain the temperature as nearly constant as possible at some temperature within this range.

[2] *Annual Book of ASTM Standards,* Vol 15.03.
[3] *Annual Book of ASTM Standards,* Vol 04.10.
[4] *Annual Book of ASTM Standards,* Vol 15.06.

NOTE 2—Requirements for relative humidity vary for different materials. The condition given above meets the standard for wood and wood-base materials.

SIZE AND APPEARANCE OF BOARDS

7. Size of Finished Boards

7.1 When measurements of finished boards are required, the width of each finished board shall be obtained by measuring the width at each end and at midlength to an accuracy of not less than ±0.3 % or 1⁄16 in. (2 mm), whichever is smaller. Likewise, three measurements of length shall be made, one near each edge, and one at midwidth with like accuracy.

8. Variation in Thickness

8.1 For the determination of variations in thickness, specimens at least 6-in. (150-mm) square shall be used. The thickness of each specimen shall be measured at five points, near each corner and near the center, and the average thickness and the variation in thickness noted. These measurements shall be made to an accuracy of not less than ±0.3 %, when possible.

9. Specific Gravity

9.1 Specific gravity (or density) and moisture content determinations are required on each static bending test specimen. The moisture content shall be determined from a coupon taken from each bending specimen, and the specific gravity computed from the dimensions and weight of the bending specimen at time of test and the moisture content. The average specific gravity of the bending specimens as determined after conditioning to equilibrium (Section 6) shall be reported as the specific gravity of the board. The maximum and minimum values for specific gravity (based on volume at test and weight when oven–dry) shall also be noted.

NOTE 3—When it is desired to make specific gravity determinations independent of any other test, specimens of any convenient size may be selected. These shall be measured, weighed, and dried as outlined in Sections 127 and 128.

10. Surface Finish

10.1 The finish of both surfaces shall be described. A photograph of each surface may be taken to show the texture of the board. This photograph shall show suitable numbering so that the building board may be properly identified.

STATIC BENDING

11. Scope

11.1 Static bending tests shall be made both on specimens when conditioned and when soaked. One half of the test specimens shall be prepared with the long dimension parallel and the other half with the long dimension perpendicular to the long dimension of the board in order to evaluate directional properties.

12. Test Specimen

12.1 Each test specimen shall be 3 in. (76 mm) in width if the nominal thickness is greater than ¼ in. (6 mm), and 2 in. (50 mm) in width if the nominal thickness is ¼ in. or less. The depth (thickness) shall be the thickness of the material. The length of each specimen shall be 2 in. (50 mm) plus 24 times the nominal depth (Note 4 and Note 5). The width, length, and thickness of each specimen shall be measured to an accuracy of not less than ±0.3 %.

NOTE 4—In cutting specimens to meet the length requirements of 2 in. (50 mm) plus 24 times the nominal thickness, it is not intended that the length be changed for small variations in thickness. Rather it is the thought that the nominal thickness of the board under test should be used for determining the specimen length.

NOTE 5—Long-span specimens are desired for tests in bending so that the effects of deflections due to shear deformations will be minimized and the values of moduli of elasticity obtained from the bending tests will approximate the true moduli of the materials.

13. Specimens Soaked Before Test

13.1 The specimens to be tested in the soaked condition shall be submerged in water at 20 ± 3°C (68 ± 6°F) for 24 h before the test and shall be tested immediately upon removal from the water. When it is desired to obtain the effect of complete saturation the specimens shall be soaked for such longer period as may be necessary. The time of soaking and the amount of water absorbed shall be reported.

14. Span and Supports

14.1 The span for each test shall be 24 times the nominal thickness (depth) of the specimen (Note 6). The supports shall be such that no appreciable crushing of the specimen will occur at these points during the test. The supports either shall be rounded or shall be knife edges provided with rollers and plates under the specimen at these points. When rounded supports, such as those shown in Fig. 1, are used, the radius of the rounded portion shall be at least 1½ times the thickness of the material being tested. If the material under test deviates from a plane (Note 7), laterally adjustable supports[5] shall be provided.

NOTE 6—Establishment of a span-depth ratio is required to allow an accurate comparison of test values for materials of different thicknesses. It should be noted that the span is based on the nominal thickness of the material and it is not intended that the spans be changed for small variations in thickness.

NOTE 7—The laterally adjustable knife edges may be necessary for the specimens tested in the soaked condition because of warping or twisting that may occur due to soaking.

15. Center Loading

15.1 The specimens shall be loaded at the center of span with the load applied to the finished face at a uniform rate through a loading block rounded as is shown in Fig. 1. The bearing blocks shall be at least 3 in. (76 mm) in width and shall have a thickness (parallel to span) equal to twice the radius of curvature of the rounded portion of the loading block. The radius of the rounded portion shall be approximately equal to 1½ times the thickness of the specimen.

16. Speed of Testing

16.1 Apply the load continuously throughout the test at a uniform rate of motion of the movable crosshead of the testing machine calculated as follows (Note 8 and Note 9):

[5] Details of laterally adjustable supports may be found in Fig. 1 of Methods D 3501.

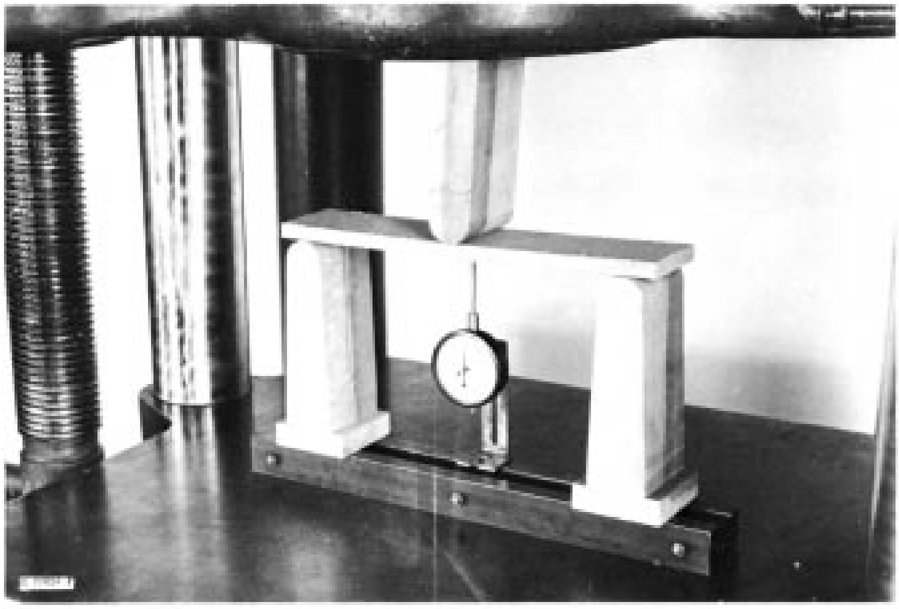


FIG. 1 Static Bending Test Assembly

$$N = zL^2/6d \quad (1)$$

where:

N = rate of motion of moving head, in./min (mm/min),
z = unit rate of fiber strain, in./in. (mm/mm) of outer fiber length per minute (0.005),
L = span, in. (mm), and
d = depth (thickness) of specimen, in. (mm).

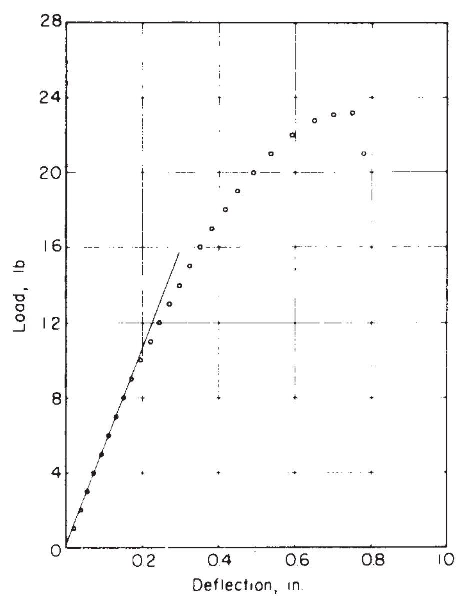
NOTE 8—The testing machine speed used shall not vary by more than ±50 % from that specified for a given test. The testing machine speed used shall be recorded on the data sheet. The crossheaded speed shall mean the free-running, or no-load, crosshead speed for testing machines of the mechanical-drive type, and the loaded crosshead speed for testing machines of the hydraulic-loading type.

NOTE 9—The calculated rates of head descent are, therefore, 0.12 in./min (3 mm/min) for specimens ¼in. (6 mm) in thickness, 0.24 in./min (6 mm/min) for specimens ½ in. (12 mm) in thickness, 0.36 in./min (9 mm/min) for specimens ¾ in. (18 mm) in thickness and 0.48 in./min (12 mm/min) for specimens 1 in. (25 mm) in thickness.

17. Load-Deflection Curves

17.1 Obtain load-deflection curves to maximum load for all bending tests. Obtain the deflection of the center of the specimen by measuring the deflection of the bottom of the specimen at the center by means of an indicating dial (Note 10) attached to the base of the testing jig, with the dial plunger in contact with the bottom of the specimen at the center. This arrangement is shown in Fig. 1. Note the load and deflection at first failure and at maximum load. Take readings of deflection at least to the nearest 0.005 in. (0.10 mm). Fig. 2 shows a typical load-deflection curve. Deflections also may be measured with transducer-type gages and plotted simultaneously against load.

NOTE 10—The range of standard 0.001-in. (0.02-mm) indicating dials is 1 in. (25 mm). The total deflection of some thicknesses of boards may exceed 1 in. at failure. When this happens, either a 2-in. (50-mm) total-travel indicating dial or a suitable 2:1 reducing lever in conjunction with a 1-in. travel dial should be used so that maximum deflections can be obtained.



Metric Equivalents

in.	0.2	0.4		0.6	0.8		1.0
mm	5	10		15	20		25
lb	4	8	12	16	20	24	28
kg	1.8	3.6	5.4	7.2	9	10.8	12.6

FIG. 2 Typical Load-Deflection Curve for Static Bending Test

18. Description of Failure

18.1 Note the character of the failure. The report shall include the sequence of failure and note whether or not the initial failure was in compression or tension. Photographs of typical failures will be helpful.

19. Moisture Content and Specific Gravity

19.1 Weigh the specimen immediately before the test, and after the test cut a moisture 1 in. (25 mm) by the width of specimen from the body of the specimen. Determine the moisture content and specific gravity of each specimen in accordance with Sections 9, 127, and 128.

20. Calculation and Report

20.1 Calculate the modulus of rupture for each specimen by the following equation, and include the values determined in the report:

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

20.2 Calculate the stress at proportional limit for each specimen by the following equation, and include the values determined in the report:

$$Spl = 3P_1L/2bd^2 \quad (3)$$

20.3 Calculate the stiffness (apparent modulus of elasticity) for each specimen by the following equation, and include the values determined in the report:

$$E = P_1L^3/4bd^3y_1 \quad (4)$$

20.4 Calculate the work-to-maximum load for each specimen by the following equation, and include the values determined in the report:

$$Wml = A/bdL \quad (5)$$

where:
- A = area under load-deflection curve to maximum load, lbf·in. (N·m),
- b = width of specimen, in. (mm),
- d = thickness (depth) of specimen, in. (mm),
- E = stiffness (apparent modulus of elasticity), psi (kPa),
- L = length of span, in. (mm),
- P = maximum load, lbf (N),
- P_1 = load at proportional limit, lbf (N),
- R = modulus of rupture, psi (kPa),
- Spl = stress at proportional limit, psi (kPa),
- Wml = work to maximum load, lbf·in./in.^{3}(N·mm/mm^3), and
- y_1 = center deflection at proportional limit load, in. (mm).

TENSILE STRENGTH PARALLEL TO SURFACE

21. Scope

21.1 The test for tensile strength parallel to the surface shall be made on specimens both in the dry and in the soaked condition. Tests shall be made on specimens both with the long dimension parallel and perpendicular to the long dimension of the board to determine whether or not the material has directional properties.

NOTE 11—This test may be applied to material 1 in. (25 mm) or less in thickness. When the materials exceed 1 in. in thickness, crushing at the grips during test is likely to adversely affect the test values obtained. It is recommended that for material greater than 1 in. in thickness, the material be resawed to ½ in. (12 mm) thickness. Test values obtained from resawed specimens may be only approximate, because strengths of material near the surface may vary from the remainder.

22. Test Specimen

22.1 Each test specimen shall be prepared as shown in Fig. 3. The reduced section shall be cut to the size shown with a band saw. The thickness and the minimum width of each specimen at the reduced section shall be measured to an accuracy of not less than ±0.3 %. The minimum width of the reduced section shall be determined to at least the nearest 0.01 in. (0.25 mm). These two dimensions shall be used to determine the net cross-sectional area for determining maximum stress.

23. Specimens Soaked Before Test

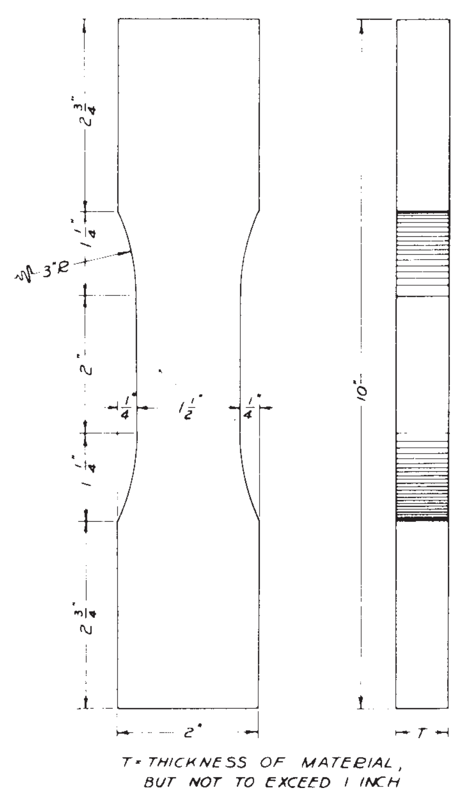
23.1 Specimens to be tested in the soaked condition shall be prepared in accordance with Section 13.

24. Method of Loading

24.1 Use self-aligning, self-tightening grips with serrated gripping surfaces at least 2 in. (50 mm) in width and at least 2 in. in length to transmit the load from the testing machine to the specimen. Fig. 4 shows a typical assembly for the tension test of building boards.

25. Speed of Testing

25.1 Apply the load continuously throughout the test at a uniform rate of motion of the movable crosshead of the testing machine of 0.15 in./min (4 mm/min) (see Note 8).



Metric Equivalents

in.	¼	1	1¼	1½	2	2¾	3	10
mm	6	25.4	32	38	51	70	76	254

FIG. 3 Detail of Specimen for Tension Test Parallel to Surface

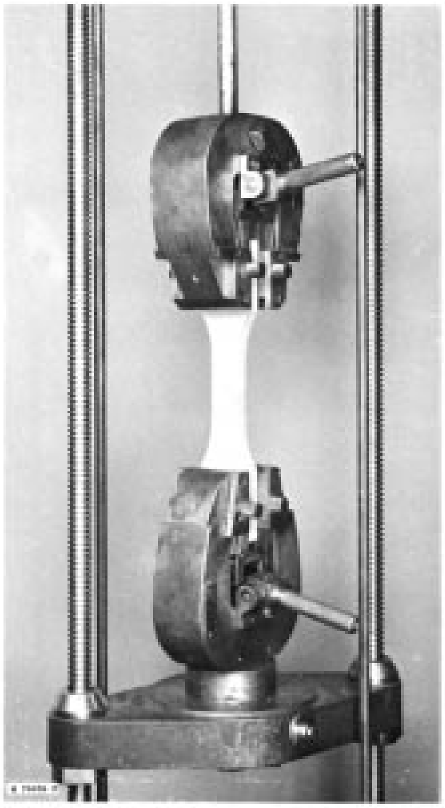


FIG. 4 Assembly for Tension Test Parallel to Surface

26. Test Data and Report

26.1 Obtain maximum loads from which calculate the stress. If the failure is within ½ in. (12 mm) of either grip, disregard the test value. The report shall include maximum loads and the location and description of the failures.

27. Moisture Content

27.1 Determine the moisture content of each specimen as specified in Sections 9, 14 and 15.

TENSILE STRENGTH PERPENDICULAR TO SURFACE

28. Scope

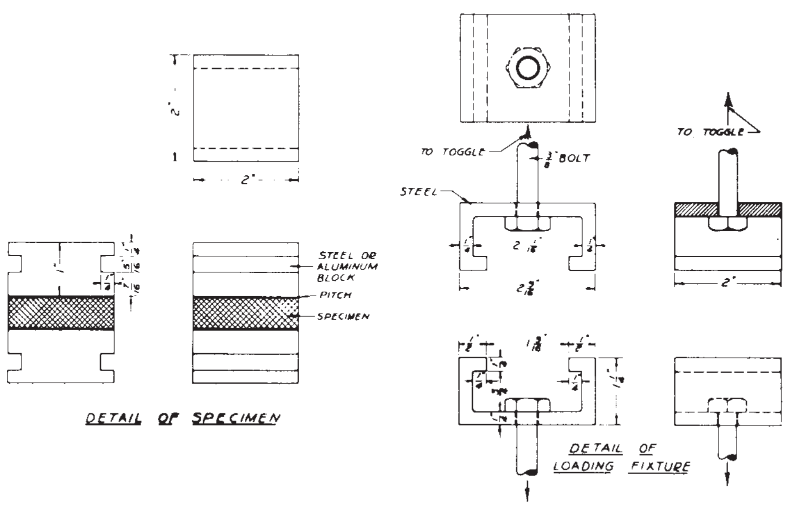
28.1 The test for tensile strength perpendicular to the surface shall be made on specimens in the dry condition to determine cohesion of the fiberboard in the direction perpendicular to the plane of the board.

NOTE 12—This test is included because of the increased use of fiberboards, hardboards, and particle boards where wood, plywood, or other materials are glued to the board, or where the internal bond strength of the board is an important property. Tests in the soaked condition shall be made if the material is to be used under severe conditions.

29. Test Specimen

29.1 The test specimen shall be 2-in. (50-mm) square and the thickness shall be that of the finished board. Loading blocks of steel or aluminum alloy 2-in. square and 1 in. (25 mm) in thickness shall be effectively bonded with a suitable adhesive (Note 13) to the 2-in. square faces of the specimen as shown in Fig. 5, which is a detail of the specimen and loading fixtures. Cross-sectional dimensions of the specimen shall be measured to an accuracy of not less than ±0.3 %. The maximum distance from the center of the universal joint or self-aligning head to the glued surface of the specimen shall be 3 in. (76 mm).

NOTE 13—Any suitable adhesive that provides an adequate bond may be used for bonding the specimen to the loading blocks. Epoxy resins are recommended as a satisfactory bonding agent. The pressure required to bond the blocks to the specimen will depend on the density of the board and the adhesive used, and should not be so great as to measurably damage the specimen. The resulting bond shall be at least as strong as the cohesive strength of the material perpendicular to the plane of the panel.



Metric Equivalents

in.	¼	5⁄16	3⁄8	7⁄16	½	¾	1¼	19⁄16	2	21⁄16	29⁄16
mm	6	7.5	9	10.5	12.7	19	31.7	39	51	52	64.3

FIG. 5 Detail of Specimen and Loading Fixture for Tension Test Perpendicular to Surface

30. Procedure

30.1 Engage the loading fixtures, such as are shown in Fig. 5, attached to the heads of the testing machine, with the blocks attached to the specimen. Stress the specimen by separation of the heads of the testing machine until failure occurs. The direction of loading shall be as nearly perpendicular to the faces of the specimen as possible, and the center of load shall pass through the center of the specimen.

31. Speed of Testing

31.1 Apply the load continuously throughout the test at a uniform rate of motion of the movable crosshead of the testing machine 0.08 in./in. (cm/cm) of thickness per min.

NOTE 14—It is not intended that the testing machine speed shall be varied for small differences in fiberboard thickness, but rather that it shall not vary more than ±50 % from that specified above (see Note 8).

32. Test Data and Report

32.1 Obtain maximum loads from which calculate the stress at failure. Calculate strength values in pounds per square inch (kilopascals), for which the measured dimensions of the specimen shall be used. Include the location of the line of failure in the report.

33. Moisture Content

33.1 Determine the moisture content of each specimen on a separate sample prepared from the same material, as specified in Sections 127 and 128.

COMPRESSION STRENGTH PARALLEL TO SURFACE

34. Scope

34.1 The test for compression strength parallel to the surface shall be made on specimens both in the dry and in the soaked condition. Tests shall be made of specimens both with the load applied parallel and perpendicular to the long dimension of the board to determine whether or not the material has directional properties.

34.2 Because of the large variation in character of wood-base fiber and particle panel materials and the differences in manufactured thicknesses, one procedure is not applicable for all materials. One of the three procedures detailed as follows shall be used depending on the character and thickness of the board being evaluated:

34.2.1 *Procedure A (Laminated Specimen)*, shall be used for materials ⅜ in. (10 mm) or more but less than 1 in. (25 mm) in nominal thickness, particularly when modulus of elasticity and stress at proportional limit are required. In this procedure when materials less than 1 in. in thickness are evaluated, two or three thicknesses shall be laminated to provide a nominal thickness of at least 1 in. but no amount more than that amount than necessary. The nominal size of the specimen shall be 1 by 4 in. (25 by 101 mm) (with the 4-in. dimension parallel to the applied force) by the thickness as laminated.

34.2.2 *Procedure B (Lateral Support)*, shall be used for materials less than ⅜ in. in thickness, particularly when modulus of elasticity and stress at proportional limit are required. Specimens shall be 1 by 4 in. by the thickness as manufactured and evaluations made in a suitable lateral support device. The 4-in. long dimensions shall be parallel to the applied force.

34.2.3 *Procedure C (Short Column)*, shall be used when maximum crushing strength only is required or where the thickness of the board material is 1 in. or more and either maximum crushing strength modulus of elasticity, and stress at proportional limit or only maximum crushing strength is required. When the material being evaluated is 1 in. or less in thickness, the width of the specimen shall be 1 in., the thickness shall be as manufactured, and the length (height as tested) shall be four times the thickness. When the material being evaluated is more than 1 in. in thickness, the width shall be equal to the nominal thickness and the length (height as loaded) shall be four times the nominal thickness.

35. Test Specimen

35.1 The test specimens shall be carefully sawed with surfaces smooth and planes at right angles to the faces of the boards as manufactured. For the laminated specimens (Procedure A), pieces of board at least 1 in. (25 mm) larger in length and width than the finished size of specimen shall be laminated using thin spreads of epoxy resin or other adhesive that does not contain water or other swelling agent (Note 15). Pressures shall not exceed 50 psi (343.2 kPa). Specimens shall be sawed from the laminated pieces after at least 8 h of curing of the resin at room temperature. The width and thickness shall be measured to at least the nearest 0.001 in. (0.025 mm). These two dimensions shall be used to calculate net cross-sectional area for modulus of elasticity, and stress at proportional limit and maximum load.

NOTE 15—An adhesive that contains water or other swelling agent might produce initial stresses adjacent to the glue lines.

36. Specimens Soaked Before Test

36.1 Specimens to be tested in the soaked condition shall be prepared in accordance with Section 13.

37. Procedure

37.1 Load the specimens through a spherical loading block, preferably of the suspended self-aligning type. Center them carefully in the testing machine in a vertical plane as shown in Fig. 6 (unsupported 4-in. (101-mm specimen)) and Fig. 7 (laterally supported pack device).[6] Apply loading at a uniform rate of head travel of the testing machine of 0.005 in. (0.12 mm)/in. of length/min.

NOTE 16—Speed of test therefore for the 4-in. specimen of Test Methods A and B shall be 0.020 in./min (see Note 8 for permitted variation in testing speed).

38. Load-Deformation Curves

38.1 When required, obtain load-deformation curves for the full duration of each test. Fig. 6 shows a Lamb's Roller Compressometer on an unsupported specimen. Fig. 7 shows a

[6] The lateral support device is detailed in Fig. 2 of Methods D 3501.

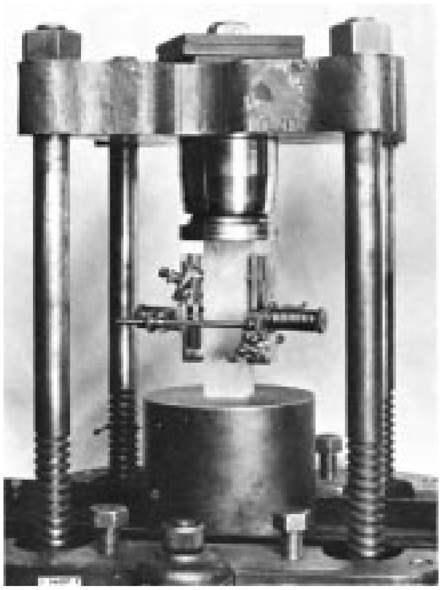


FIG. 6 Assembly for Compression Parallel to Surface Test of Unsupported Specimen

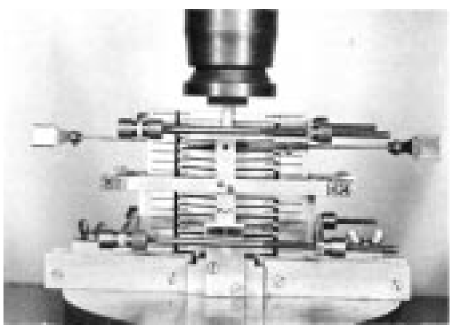


FIG. 7 Assembly for Compression Parallel to Surface Test of a Laterally Supported Specimen

Marten's Mirror Compressometer on a laterally supported specimen. Use these or equally accurate instruments for measuring deformation. Choose increments in loading so that not less than 12 and preferably at least 15 readings are obtained before proportional limit. Read deformation to the nearest 0.0001 in. (0.002 mm). Attach compressometers over the central portion of the length; points of attachment (gage points) shall be at least 1 in. (25 mm) from the ends of specimens.

39. Moisture Content and Specific Gravity

39.1 Use the entire compression parallel to surface specimen for moisture content determination except when the capacity of the drying oven is too small for convenient drying of the number of specimens being evaluated, when it will be permissible to dry short lengths. Weigh the specimen immediately before test and determine the moisture content and specific gravity for each specimen in accordance with Section 9.

40. Calculation and Report

40.1 The report shall indicate which procedure (laminated, laterally supported, or short column) was used. Calculate the values of modulus of elasticity, stress at proportional limit, and maximum crushing strength by using the measured cross-sectional dimensions of each specimen. Describe the type of failure.

LATERAL NAIL RESISTANCE TEST

41. Scope

41.1 Nail-holding tests shall be made to measure the resistance of a nail to lateral movement through a board. One half of the specimens shall be selected and positioned in test so that the movement of the nail will be perpendicular to the long dimension of the board for evaluation of directional properties. When general information is desired the sixpenny common nail or its equivalent should be used. For special applications, however, this procedure is adaptable to other sizes and types of fasteners.

NOTE 17—If this test is performed on some boards, the nail may bend and pull out of the stirrup. If this happens, the maximum load will be an apparent and not the true resistance of the board, and will only indicate that the resistance is some figure higher than the apparent value. When this happens it shall be noted.

NOTE 18—Values obtained from this test are dependent on the thickness of the specimen. Values, however, are not directly proportional to the thickness. For this reason values obtained from tests of different boards can only be compared exactly if the thicknesses are equal.

42. Test Specimen

42.1 Each specimen shall be 3 in. (76 mm) in width and of convenient length, and shall have a nail 0.113 in. (2.80 mm) in diameter (or as near thereto as possible) (Note 19) driven at right angles to the face of the board so that about an equal length of nail projects from each face. The nail shall be centered on the width and located ¼, ⅜, ½, or ¾ in. (6, 9, 12, or 18 mm) (Note 20) from one end. Tests shall be made for all three edge distances for each material tested. The thickness of each specimen shall be measured to an accuracy of not less than ±0.3 %.

NOTE 19—A sixpenny common wire nail meets this requirement. In certain instances it may be more desirable to use a pointed steel pin of known hardness than the nail. The type of nail or pin used shall be described in the report.

NOTE 20—The edge distance is the distance from the center of the nail or other fastener to the edge of the board.

43. Specimens Soaked Before Test

43.1 Specimens to be tested in the soaked condition shall be prepared in accordance with Section 13, and the nails shall be driven before the specimens are soaked.

44. Method of Loading

44.1 Clamp the end of the specimen opposite to the end with the nail in a position parallel to the movement of the testing machine. Grip such as are suitable for tension tests parallel to the plane of the board are suitable. Engage the nail by the stirrup, and connect in turn to one platen of the testing machine by a rod. A typical test assembly for measuring the resistance of a nail in the lateral direction is shown in Fig. 8. The stirrup and connections are detailed in Fig. 9. For other types of fasteners, such as staples, modification of the stirrup may be necessary.

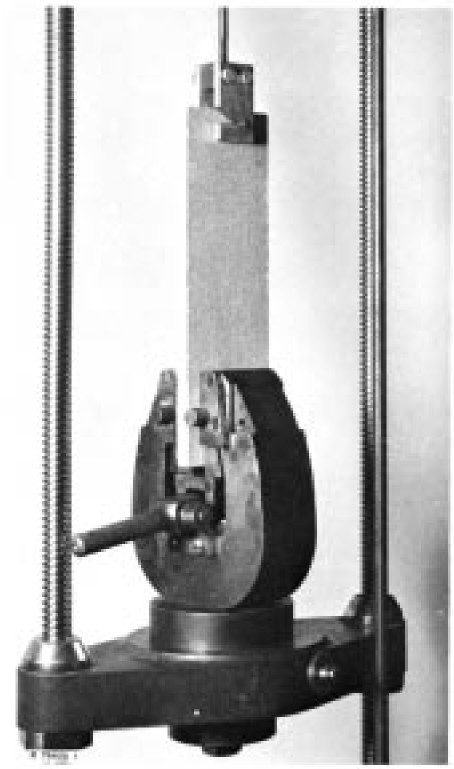


FIG. 8 Test Assembly for Measuring the Resistance of Nails to Lateral Movement

45. Speed of Testing

45.1 Load the specimen continuously throughout the test by separation of the heads of the testing machine at a uniform rate of crosshead speed of 0.25 in./min (6 mm/min) (see Note 8).

46. Test Data and Report

46.1 The load required to move the nail to the edge of the specimen shall be the measure of the lateral resistance. The maximum load and the nature of failure shall be included in the report.

NAIL WITHDRAWAL TEST

47. Scope

47.1 Nail-holding tests shall be made on nails driven through the specimen from face to face to measure the resistance to withdrawal in a plane normal to the face. When general information is desired the sixpenny common nail or its equivalent should be used. For special applications, however, this procedure is adaptable to other sizes and types of fasteners.

48. Test Specimen

48.1 The test specimen shall be of convenient size (at least 3 in. (76 mm) in width and 6 in. (152 mm) in length). Nails 0.113 in. (2.80 mm) in diameter shall be driven through the board at right angles to the face, and at least ½ in. (12 mm) of the shank portion shall project above the surface of the material. The thickness of each specimen shall be measured to an accuracy of not less than ±0.3 %.

NOTE 21—A sixpenny common wire nail meets this requirement. In certain instances it may be more desirable to use a pointed steel pin of known hardness than the nail. A head or other suitable end shall then be provided to engage the load-applying fixture and the nail or pin used shall be described in the report.

NOTE 22—Where the use of a particular nail or fastener requires less than ½ in. of shank projecting above the surface, then only sufficient length shall be left to permit engagement in the testing assembly.

49. Specimens Tested in the Dry Condition

49.1 When the tests are made in the dry state, the withdrawals shall be made immediately after the nails have been driven.

50. Specimens Soaked Before Test

50.1 Specimens to be tested in the soaked conditions shall be prepared in accordance with Section 13, and the nails shall be driven before the specimens are soaked.

51. Method of Loading

51.1 The assembly for the direct-withdrawal test is shown in Fig. 10. Attach the specimen-holding fixture to the lower platen of the testing machine. Insert the specimen in the fixture with the heads of the nails up, as shown. Engage the heads of the nails by the load-applying fixture equipped with a slot for easy attachment. This loading fixture shall be attached to the upper platen of the testing machine. Loads shall be applied by separation of the platens of the testing machine. The fitting is detailed in Fig. 11. For other types of fasteners, such as staples, modification of the loading fixture may be necessary.

52. Speed of Testing

52.1 Apply the load to the specimen throughout the test by a uniform motion of the movable head of the testing machine at a rate of 0.06 in./min (1.5 mm/min) (see Note 8).

53. Test Data and Report

53.1 The maximum load required to withdraw the nail shall be the measure of resistance of the material to direct nail withdrawal, and shall be included in the report.

NAIL-HEAD PULL-THROUGH TEST

54. Scope

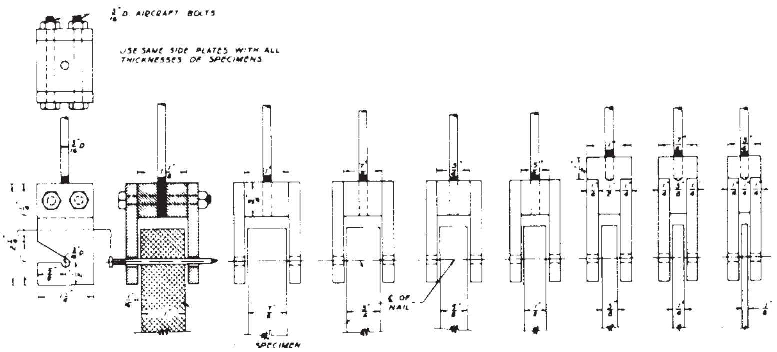
54.1 Nail-head pull-through tests shall be made to measure the resistance of a panel to having the head of a nail or other fastener pulled through the board. This test is to simulate the condition encountered with forces that tend to pull paneling or sheathing from a wall.

55. Test Specimen

55.1 The test specimen shall be of convenient size (at least 3 in. (76 mm) in width by 6 in. (152 mm) in length). Common wire nails 0.113 in. (2.80 mm) in diameter shall be driven through the board at right angles to the face with the nail head flush with the surface of the board (Note 23 and Note 24). The thickness of each specimen shall be measured to an accuracy of not less than ±0.3 %.

NOTE 23—A sixpenny common wire nail meets this requirement.

NOTE 24—For interior applications, the resistance to pull-through of a finishing nail may be preferred. For other applications, some special



Metric Equivalents

in.	1⁄16	1⁄8	3⁄16	3⁄8	1⁄2	5⁄8	3⁄4	7⁄8	1	1 1⁄8	1 1⁄4	2 1⁄4
mm	1.5	3	4.5	9	12.7	15	19	21	25.4	28	32	57

FIG. 9 Detail of Stirrups and Connections for Measuring the Resistance of Nails to Lateral Movement

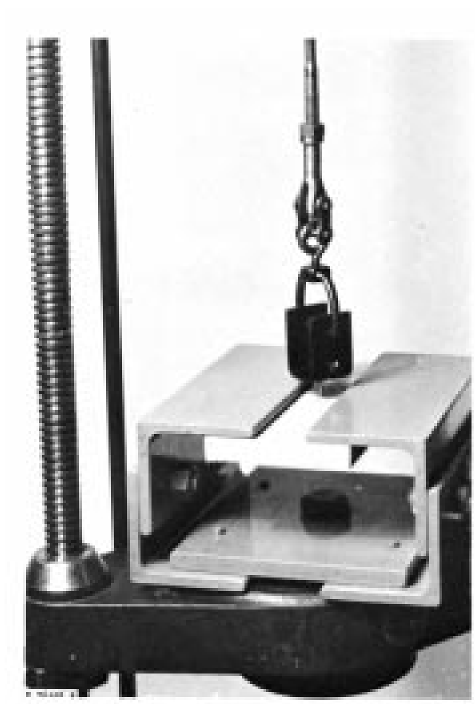
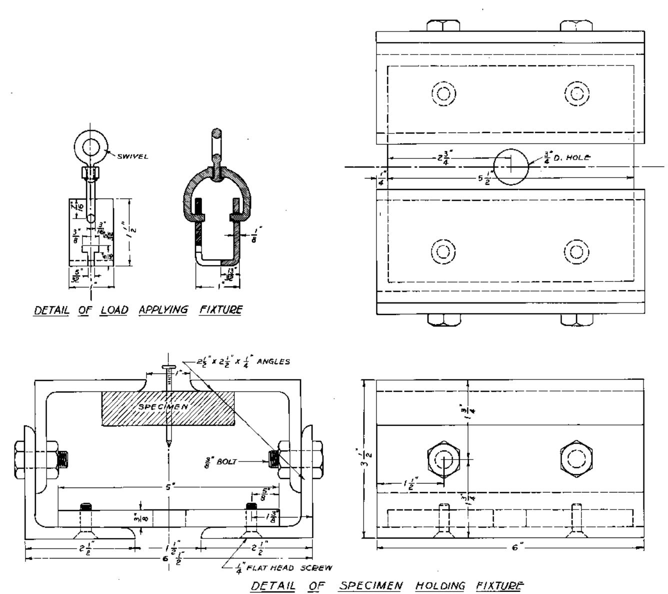


FIG. 10 Test Assembly for Measuring the Resistance of Nails to Direct Withdrawal



NOTE 1—1 in. = 25.4 mm.

FIG. 11 Details of Testing Equipment for Measuring the Resistance of Nails to Direct Withdrawal

fastener like a staple or roofing nail may be desired instead of a common nail. If for any reason a different fastener than the common nail is used, the report of the test shall describe the fastener actually used.

56. Specimens Tested in the Dry Conditions

56.1 When the tests are made in the dry state, the pullthrough shall be made immediately after the nails have been driven.

57. Specimens Soaked Before Test

57.1 Specimens to be tested in the soaked condition shall be prepared in accordance with Section 13, and the nails shall be driven before the specimens are soaked.

58. Method of Loading

58.1 Modify the assembly for the direct withdrawal test detailed in Fig. 11 by replacing the top pair of angles in the specimen-holding fixture with a 6-in. (152-mm) length of 6 by 2¼-in. (152 by 57-mm) American standard channel. The web of the channel shall have a 3-in. (76-mm) diameter opening centered in the web. The edge of this opening provides the support to the specimen during test. Center the specimen-holding fixture and attach it to the lower platen of the testing machine. Insert the specimen in the holding fixture with the point of the nail up. Grip the pointed end of the nail with a tension grip or "Jacob's-type drill chuck" which is attached to the upper platen of the testing machine with a universal joint or toggle linkage, to provide for automatic aligning. Apply loads by separation of the platens of the testing machine. For other types of fasteners than nails, it may be necessary to modify the chuck or tension-grip type of loading fixture.

59. Speed of Testing

59.1 Apply the load to the specimen throughout the test by a uniform motion of the movable head of the testing machine at a rate of 0.06 in./min (1.5 mm/min) (see Note 8).

60. Test Data and Report

60.1 The maximum load required to pull the head of the nail or other fastener through the board shall be the measure of resistance of the material to nail-head pull-through, and shall be included in the report. The report shall describe the type of fastener used and the failure.

DIRECT SCREW WITHDRAWAL TEST

61. Scope

61.1 Screw-holding tests shall be made on screws threaded into the board to measure the resistance to withdrawal in a plane normal to the face. For numerous applications, the withdrawal resistance of screws from the edge of the board is desired. When that value is required the screw withdrawal resistance in the plane parallel to the face shall be determined. When general information is desired for comparing the screw withdrawal resistance of a board with another board or material, the No. 10, 1-in. (25-mm) Type AB sheet metal screw (Note 25) shall be used. For special applications, however, this procedure is adaptable to other sizes and types of screws.

62. Test Specimen

62.1 *Withdrawal Perpendicular to the Plane of the Board*—The test specimen shall be at least 3 in. (76 mm) in width by 4 in. (102 mm) in length. The thickness of the specimen shall be at least 1 in. (25 mm) unless other considerations make it desirable to test with the thickness as manufactured because local bending of the board at withdrawal may affect test results. If necessary, glue up two or more thicknesses of the board to arrive at the 1-in. minimum thickness. One-inch, No. 10 Type AB sheet metal screws (Note 25) shall be threaded into the specimen ⅔ in. (17 mm). Lead holes shall be predrilled using a drill 0.125 in. (3.2 mm) in diameter (Note 27).

62.2 *Withdrawal from the Edge of the Board*—The test specimen shall be 3 in. (76 mm) in width by at least 6 in. (152 mm) in length and the thickness of the board as manufactured (Note 26). One half of the test specimens shall be prepared with the long dimension parallel and the other half with the long dimension perpendicular to the long dimension of the board in order to evaluate directional properties. A 1-in., No. 10 Type AB sheet metal screw (Note 25) shall be threaded into the edge of the board at midthickness ⅔ in. (17 mm). Lead holes shall be predrilled using a drill 0.125 in. (3.2 mm) in diameter (Note 27).

NOTE 25—Number 10 Type AB screws should have a root diameter 0.138 ± 0.003 in. (3.51 ± 0.1 mm) and a pitch of 16 threads per inch.

NOTE 26—In some applications where several thicknesses of hardboard or the thinner particle board are laminated together, it may be desirable to obtain the edge withdrawal resistance of a laminated board. When this is done, the specimen shall be laminated from an odd number of thicknesses and the screws shall be located at the midthickness of the center laminate.

NOTE 27—It is recognized that some other lead hole diameter may give higher withdrawal resistance values for some densities and kinds of board. Departures from this size of lead hole are permitted, but diameter used shall be reported.

63. Specimens Tested in the Dry Condition

63.1 When the tests are made in the dry state, the withdrawals shall be made immediately after the screws have been embedded.

64. Specimens Soaked Before Test

64.1 Specimens to be tested in the soaked condition shall be prepared in accordance with Section 13, and the screws shall be embedded before the specimens are soaked.

65. Method of Loading

65.1 The assembly for the direct screw withdrawal is the same as shown for direct nail withdrawal in Fig. 10. Attach the specimen-holding fixture to the lower platen of the test machine. Insert the specimen in the fixture with the heads of the screws up as shown. Engage the heads of the screws by the load-applying fixture equipped with a slot for easy attachment. Attach this loading fixture to the upper platen of the testing machine. Apply loads by separation of the platens of the testing machine.

66. Speed of Testing

66.1 Apply the load to the specimen throughout the test by a uniform motion of the movable head of the testing machine at a rate of 0.6 in./min (15 mm/min) (see Note 8).

67. Report

67.1 The report shall include the following:

67.1.1 Diameter of lead hole actually used, indicating both type and size of screw,

67.1.2 Any departures for other size of fastener,

67.1.3 Type of withdrawal, differentiated as surface (withdrawal perpendicular to the plane of the board) or edge (withdrawal parallel to the plane of the board) resistance,

67.1.4 Thickness of the board as actually tested, and

67.1.5 If the screw is broken rather than withdrawn, it shall be noted and the test value shall not be included in those values presented in the reports as values of withdrawal.

HARDNESS TEST

68. Scope

68.1 The modified Janka ball test shall be used for determining hardness.

69. Test Specimen

69.1 Each specimen shall be nominally 3 in. (75 mm) in width and 6 in. (150 mm) in length and at least 1 in. (25 mm) thick. Because most boards are manufactured in thicknesses of less than 1 in. (25 mm), the specimen for test shall be made by bonding together several layers of the panel to make the required thickness. A rubber cement or other suitable flexible adhesive shall be used. The finished specimen shall be trimmed after bonding so that edges are smooth. The dimensions of the specimens as tested shall be measured to an accuracy of not less than ±0.3 %.

70. Procedure

70.1 Use of modified ball test with a "ball" 0.444 in. (11.28 mm) in diameter (100 mm^2 projected area) for determining hardness. Record as the measure of hardness the load at which the "ball" has penetrated to one half its diameter, as determined by an electric circuit indicator or by the tightening of the collar against the specimen. The test assembly with a tool of the tightening collar type is shown in Fig. 12.

71. Number of Penetrations

71.1 Make two penetrations on each of the two flat faces of the board. Where one face is different than the other, as for example the smooth face and wire-textured back of most hardboards, report the data obtained from the two faces separately. The locations of the points of penetration shall be at least 1 in. (25 mm) from the edges and ends of the specimen and far enough apart so that one penetration will not affect another one.

72. Speed of Testing

72.1 Apply the load continuously throughout the test at a uniform rate of motion of the movable crosshead of the testing machine of 0.25 in./min (6 mm/min) (see Note 8).

73. Test Data and Report

73.1 The maximum load required to embed the "ball" to one half its diameter shall be the measure of hardness, and shall be included in the report.

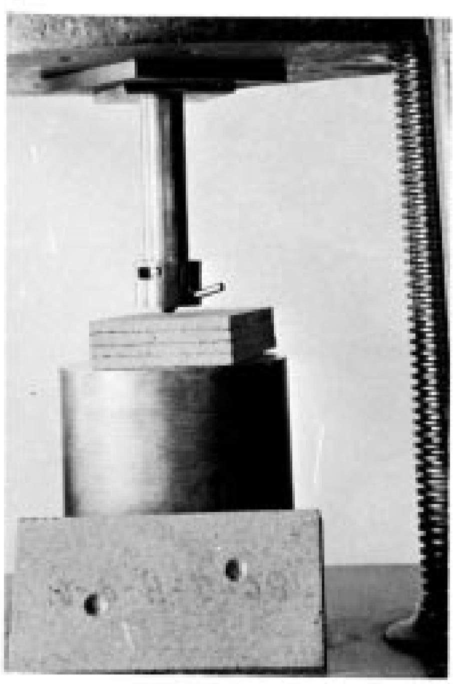


FIG. 12 Janka Ball Test Apparatus for Hardness of Fiberboards

HARDNESS MODULUS TEST

74. Scope

74.1 The hardness modulus method of determining "equivalent Janka ball hardness" may be used for determining hardness of building fiberboards and particle boards.

75. Significance and Use

75.1 The hardness modulus (in pounds per inch of penetration) divided by 5.4 gives the equivalent Janka ball hardness in pounds.[7] The thinness of most wood-base panel materials precludes the use of the regular Janka ball procedure (see Methods D 143) unless several thicknesses are laminated together to provide a thickness of about 1 in. (25 mm) or more.

75.2 This procedure is applicable for materials greater in thickness than ⅛ in. (3 mm). For thicknesses ⅛ in. or less, stacks of material may be used, but extreme care must be used to select the proper slope for hardness modulus.

76. Test Specimen

76.1 Each specimen shall be nominally 3 in. (75 mm) in width and 6 in. (150 mm) in length by the thickness of the material. When materials are ¼ in. (6 mm) or less in thickness, an extra specimen shall be prepared as a backing material during the test. The finished specimen shall be sawed square with smooth edges. The dimensions of the specimens as tested shall be measured to an accuracy of not less than ±0.3 %.

77. Procedure

77.1 The rate of penetration of the modified Janka ball, 0.444 in. (11.3 mm) in diameter (100 mm^2 projected area), shall be used for determining hardness modulus. Suitable modifications of the Janka ball hardness apparatus to measure penetration are shown in Fig. 13 and Fig. 14. Fig. 13 shows the modification manual measurements of penetration and Fig. 14 shows a cone unit with microformer for autographic recording. Fig. 15 shows the kind of load-penetration data obtained from tests. Each test shall be continued until the penetration is about 0.1 in. (2.5 mm). The slope of the straight-line portion of the load penetration curve in pounds per inch shall be the hardness modulus. The equivalent Janka ball hardness value in pounds is obtained dividing this hardness modulus by the factor 5.4.

78. Number of Penetrations

78.1 At least two penetrations shall be made on each of the two flat faces of each specimen. Where one face is different from the other as, for example, the smooth face and wire-textured back of most hardboards, the data obtained from the two faces shall be reported separately. The locations of the points of penetration shall be at least 1 in. (25 mm) from the edges and ends of specimens and far enough apart so that one penetration will not affect another one.

[7] For further information on this relationship consult "Hardness Modulus as an Alternate Measure of Hardness to the Janka Ball for Wood and Wood-Base Materials," by W. C. Lewis, U.S. Forest Service, research note FPL-0189, March 1968. Available from Forest Products Laboratory, One Gifford Pinchot Dr., Madison, WI 53705-2398.

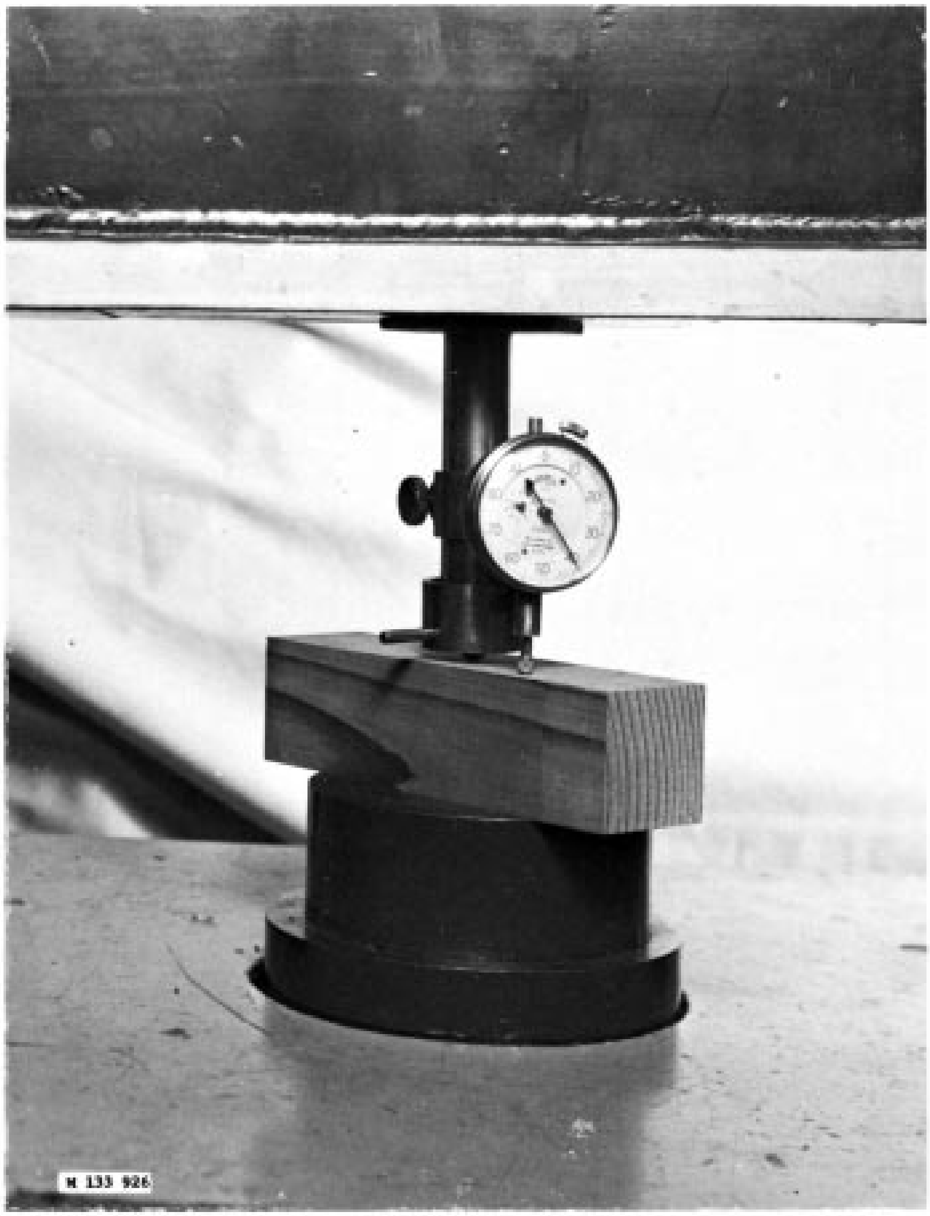


FIG. 13 Janka-Ball Hardness Tool Equipped with a Micrometer Dial for Measuring Penetration

79. Speeding of Testing

79.1 The load shall be applied continuously throughout the test at a uniform rate of motion of the movable crosshead of the testing machine of 0.05 in./min (1.3 mm/min) (see 1.3).

80. Test Data and Report

80.1 The hardness modulus as determined from the load-penetration curve and the calculated equivalent Janka ball hardness value shall be included in the report. When moisture content or specific gravity, or both, are required, this shall be determined as specified in Sections 127 and 128 and included in the report.

SHEAR STRENGTH IN THE PLANE OF THE BOARD

81. Scope

81.1 Shear strength tests shall be made on specimens prepared by laminating each specimen so that the plane of the

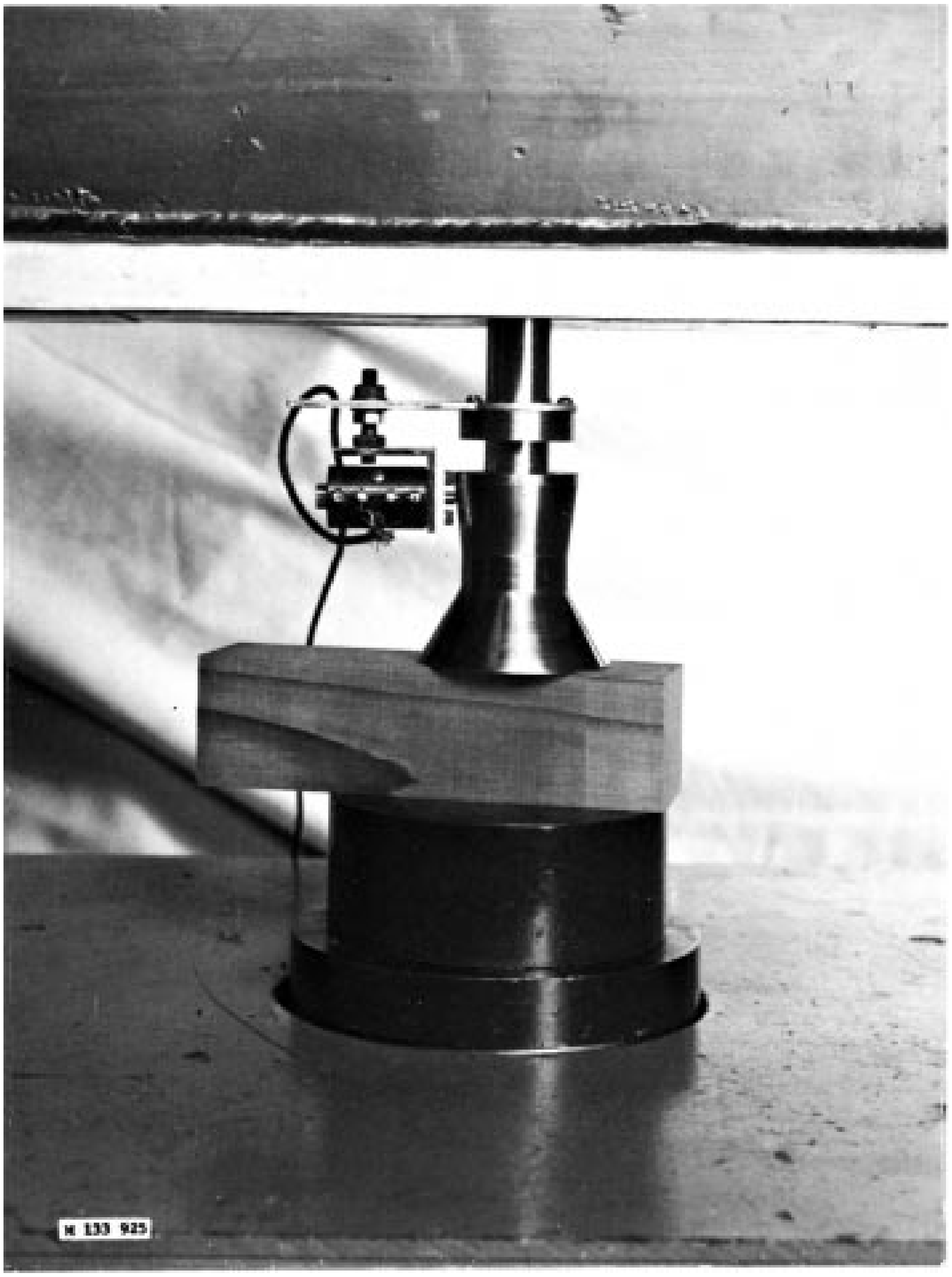


FIG. 14 Janka-Ball Hardness Tool Adapted with Cone and Microformer Unit for Direct Autographic Recording of Load-Penetration Data

shear failure will be in the board proper and not in the glue lines. This test, except for the method of preparing the specimen, follows the procedure described in Section 90 to 94 of Methods D 143.

82. Test Specimen

82.1 The shear-parallel-to-plane of board tests shall be made on 2 by 2 by 2½-in. (50 by 50 by 63-mm) specimens notched as illustrated in Fig. 16. It is the intent in this test to have the plane of shear parallel to the surfaces of the board and to have the failure approximately midway between the two surfaces of the board. The specimen shall be glued up by laminating sufficient thicknesses (Note 28) of the board together to produce the desired 2-in. (50-mm) thickness of specimen as shown in Fig. 16. The actual area of the shear surface shall be measured.

NOTE 28—When the shear strength of a thin board like hardboard is desired, it will be permissible to use a thicker material such as plywood for outer laminations to reduce the total amount of gluing. When that procedure is used, at least the center lamination and preferably the three center laminations shall be of the board under test.

83. Procedure

83.1 Use a shear tool similar to that illustrated in Fig. 18 of Methods D 143, providing a ⅛-in. (3-mm) offset between the inner edge of the supporting surface and the plane, along which failure occurs. Apply the load to, and support the specimen on, the ends of the specimens as indicated by the large arrow in

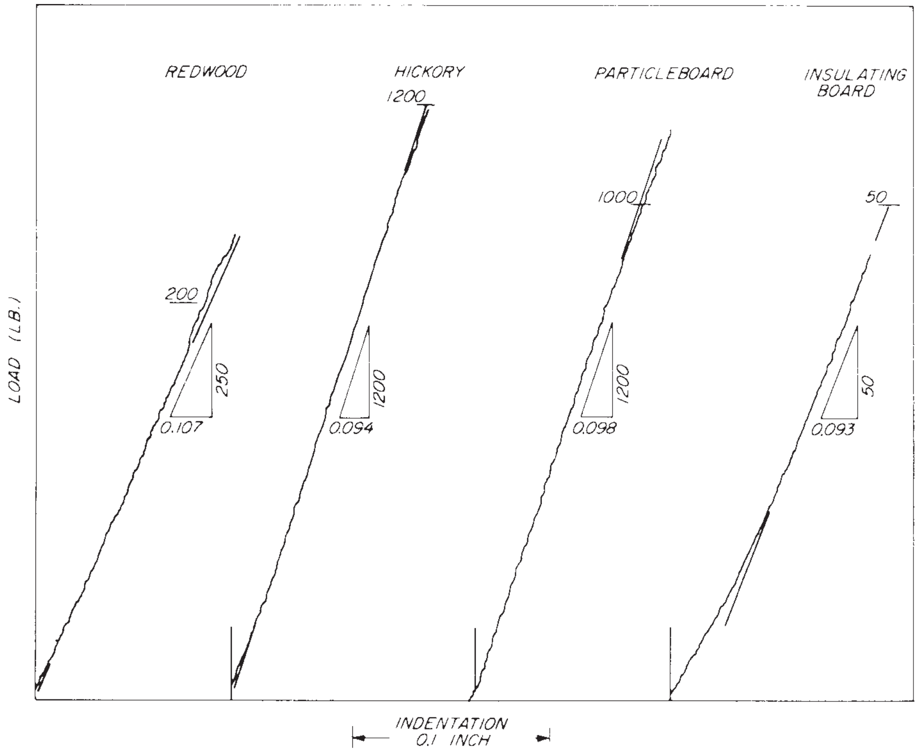
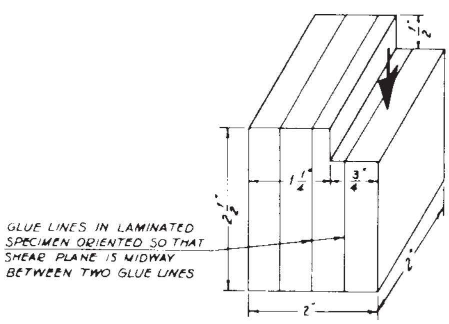


FIG. 15 Typical Load-Indentation Lines Obtained with Autographic Equipment for Wood and Wood-Base Panel Materials. Values Shown on Triangles Were Ones Used to Compute the Hardness Modulus Values



Metric Equivalents

in.	½	¾	1¼	2	2½
mm	12.7	19	31.7	51	63.5

FIG. 16 Shear Parallel to Surface Test Specimen

Fig. 16. Take care in placing the specimens in the shear tool to see that the crossbar is adjusted so that the edges of the specimen are vertical and the end rests evenly on the support over the contact area. Observe the maximum load only.

84. Speed of Testing

84.1 Apply the load continuously throughout the test at a uniform rate of motion of the movable crosshead of the testing machine of 0.024 in./min (0.61 mm/min) (see Note 8).

85. Test Failures

85.1 Record the character and type of failure. In all cases where the failure at the base of the specimen extends back onto the supporting surface, the test shall be culled.

86. Moisture Content

86.1 Use the portion of the specimen that is sheared off as a moisture specimen.

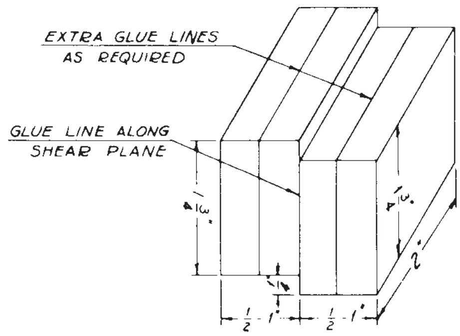
GLUE-LINE SHEAR TEST (BLOCK TYPE)

87. Scope

87.1 The block-type glue-line shear test shall be used to evaluate glued board constructions such as are obtained when thicknesses are laminated together to provide a greater thickness than when manufactured. When desired, the specimens may be modified to evaluate glue lines between the test material and solid wood or veneer by laminating the specimen so that the glue line to be evaluated is so oriented in the specimen that it coincides with the plane of shear in the specimen. This test procedure is adopted from Test Method D 905, except for the rate of loading (see 89.1).

88. Test Specimen

88.1 The test specimen shall be 2 in. (50 mm) in width and 2 in. in height, and shall be fabricated as shown in Fig. 17. The specimen shall be from 1 to 2 in. (25 to 50 mm) thick, as necessary, depending on the thickness of the board (Note 29). Specimens shall be sawed from panels glued up in sizes of at least 6-in. (152-mm) square. Care shall be taken in preparing test specimens to make the loaded surfaces smooth and parallel to each other and perpendicular to the glue line in the shear plane. Care shall be exercised in reducing the lengths of the laminations to 1¾ in. (44 mm) to ensure that the saw cuts extend to, but not beyond the glue line. The width and height



Metric Equivalents

in.	¼	1	1¾	2
mm	6	25.4	44	51

FIG. 17 Block-Type Glue-Line Shear Test Specimen

of the specimen at the glue line shall be measured to at least the nearest 0.01 in. (0.25 mm). These measurements shall determine the shear area.

NOTE 29—When the glue-line shear strength of a thin board like hardboard is desired, it will be permissible to use a thicker material such as plywood for outer laminations to reduce the total amount of gluing. The material on either side of the glue line in the plane of shear shall be the board under test unless the test involves a glue line of board and another material.

89. Loading Procedure

89.1 Apply the load through a self-aligning seat to ensure uniform lateral distribution of load. Apply the load with a continuous motion of the movable head of the testing machine at 0.024 in. (0.6 mm)/min. Use the loading tool required for the shear in the plane of the board test, adjusted so that failure will occur along or adjacent to the glue line (no offset), to load the specimen. The shear tool is shown in detail in Fig. 1 of Test Method D 905.

90. Test Failures

90.1 Report the shear stress at failure, based on the maximum load, the overlap area between the two laminations, and the percentage of fiber failure, for each specimen.

FALLING BALL IMPACT TEST

91. Scope

91.1 The falling ball impact test shall be used to measure the impact resistance of boards from the kind of damage that occurs in service when struck by moving objects. In this test a 2-in. (50-mm) diameter steel ball is dropped on a supported panel of board from increasing heights, each drop being made at the same point, the center, in the panel, until the panel fails. The height of drop in inches that produces a visible failure on the opposite face of the one receiving the impact is recorded as the index of resistance to impact.

92. Apparatus

92.1 A suitable assembly for making the falling ball impact test is shown in Fig. 18. Two frames of 1½-in. (38-mm) thick plywood, 9 by 10-in. (228 by 254-mm) outside dimension with

FIG. 18 Test Assembly for Falling Ball Impact Test

a 6-in. (152-mm) central square shall be provided with eight ⅜-in. (9-mm) carriage bolts for clamping the specimen between the frames. The eight bolts shall be spaced equidistant on and 8⅝-in. (218-mm) diameter circle. A 2-in. (50-mm) diameter steel ball (weighing 1.18 lb, 536 g) and a suitable means of holding and releasing it from predetermined heights shall be provided. During the test the frame and specimen shall be supported solidly on a suitable base.

93. Test Specimen

93.1 The impact test specimens shall be 9 by 10 in. (228 by 254 mm) by the thickness of the material. No facing material other than that which is a regular part of the board shall be applied to the board prior to test.

94. Procedure

94.1 Before the test, clamp the specimen securely between the frames. Drop the steel ball with an initial drop of 1 in. (25 mm) so that it strikes approximately at the center of the specimen. Make repeated drops from increasing heights until a visible fracture is produced on the top surface and on the bottom surface of the specimen. Increments of drop shall be 1 in. (25 mm), measuring the distance from the bottom of the ball to the top surface of the specimen. Record the heights of drop that produce the visible fractures on the two surfaces. Catch the ball after each drop so that there will be only one impact for each drop.

95. Report

95.1 The report shall include the following:

95.1.1 Description of the failure,

95.1.2 Heights of drop that produced failures on each face, and

95.1.3 The measured thickness of each test specimen.

ABRASION RESISTANCE BY THE U.S. NAVY WEAR TESTER

96. Scope

96.1 Abrasion resistance tests shall be made on the board to determine the wear under simulated conditions of uniform abrasion.

NOTE 30—Other test methods have been used to measure abrasion resistance of other materials. The test method delineated here has been used extensively for measuring the resistance of wood and other wood-base materials like plywood to surface abrasion, so values are available for comparing the resistance of wood-base fiber and particle panel materials with the materials most commonly used alternately to them.[8]

97. Test Specimen

97.1 The area of the test specimen to be abraded shall be 2 by 3 in. (50 by 76 mm), and the specimen shall be fabricated from a piece of the board 2 by 4 in. (50 by 101 mm) by the thickness of the material (Note 31) as shown in Fig. 19. The specimens shall be conditioned before test (see Section 6) and the test made in the same conditioned atmosphere. The actual dimensions of the abrading area of the specimen shall be measured to the nearest 0.01 in. (0.2 mm). The thickness of the test specimen shall be measured to at least the nearest 0.001 in. (0.02 mm) near each corner and the center.

NOTE 31—When the board tested is less than ½ in. (12 mm) thick, either sufficient thicknesses shall be laminated together to provide the ½-in. thickness or the specimen shall be backed by a thickness of wood or plywood sufficient to provide the ½-in. total thickness of specimen required.

98. Procedure

98.1 Conduct the test on the Navy-type abrasion machine[9] as shown in Fig. 20, using as the abrading medium new No. 80-grit aluminum oxide, or equivalent. Apply the grit continuously (Note 32) to the 14-in. (355-mm) diameter steel disk, which serves as a platform supporting the specimen and rotates at the rate of 23½ r/min. Rotate the specimen in the same direction as the steel disk at the rate of 32½ r/min. Superimpose a load of 10 lb (4.5 kg) on the test specimen. The machine is designed so that twice each revolution the specimen is raised ¹⁄₁₆ in. (1.6 mm) above the steel disk and immediately lowered. Determine the decrease in the thickness of the specimen at the end of each 100 revolutions of the steel disk by measuring the thickness of the specimen to the nearest 0.001 in. (0.02 mm) near each corner and at the center, after brushing to remove any dust or abrading material adhering to the surface of the specimen. The mean of the five recordings shall be taken as the loss in thickness. Repeat this procedure until the specimen has 500 revolutions of wear or as required (Note 33).

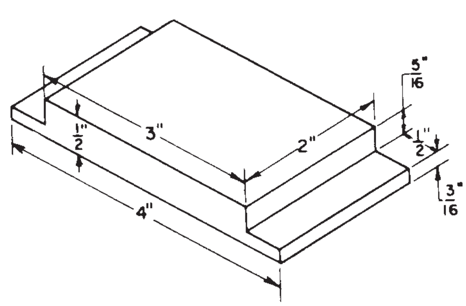
FIG. 20 Navy-Type Wear Machine for Abrasion Resistance Test

NOTE 32—The Navy wear tester is designed so that there is an excess of grit on the abrading disk at all times. During all parts of the abrading action, except when the specimen is in the raised position, the specimen is pushing a small amount of grit ahead of it.

NOTE 33—When values of accumulated wear are plotted as ordinates against revolutions, the slope of the curve is a straight line for wear through uniform materials. When the rate of wear per 100 revolutions of the abrading disk is not uniform after the first 200 revolutions, it is probably due to a change in abrasion resistance with depth from the original surface of the material being tested.

[8] U.S. Forest Products Laboratory Report R1732, "The Abrasion Resistance of Wood as Determined with the U.S. Navy Wear Test Machine."

[9] The Navy-type wear tester may be constructed from drawings obtainable from the U.S. Navy or the Forest Products Laboratory. It is manufactured commercially by the Tinius Olsen Testing Machine Co., Willow Grove, PA.



Metric Equivalents

in.	³⁄₁₆	⁵⁄₁₆	½	2	3	4
mm	4.5	7.5	12.7	51	76	101.6

FIG. 19 Test Specimen for Abrasion Resistance Test

99. Report

99.1 The report shall include the following:

99.1.1 Loss in thickness in inches per 100 revolutions of wear if uniform, and

99.1.2 If the amount of wear changes with depth from the original, surface values for each 100 revolutions.

WATER ABSORPTION AND THICKNESS SWELLING

100. Scope

100.1 A test shall be made to determine the water-absorption characteristics of building boards. For Method A (see Section 104) the water absorption and thickness swelling are expressed as a percent for the specimen after a 2 plus 22–h submersion. For Method B (see Section 105) the water absorption and thickness swelling are expressed as a percent for the specimen after a single continuous submersion time of 24–h. Method A, with its initial 2–h submersion period, provides information on the short term and longer term (2 plus 22–h) water absorption and thickness swelling performance. Because Method A calls for a short removal period after 2 h, the values from Method A and Method B are not necessarily compatible.

101. Test Specimen

101.1 The test specimen shall be 12 by 12 in. (305 by 305 mm) in size, or 6 by 6 in. (152 by 152 mm) in size with all four edges smoothly and squarely trimmed.

102. Conditioning Prior to Test

102.1 The test specimen shall be conditioned as nearly as deemed practical to constant weight and moisture content in a conditioning chamber maintained at a relative humidity of 65 ± 1 % and a temperature of 68 ± 6°F (20 ± 3°C) (Note 34). The moisture content after conditioning shall be reported.

NOTE 34—Conditioning prior to testing is not a common practice for quality control testing and some other circumstances. If the specimen is not conditioned to the defined parameters in Section 102, the deviation from the conditioning requirement shall be reported.

103. Weight, Thickness, and Volume of Test Specimen

103.1 After conditioning, weigh the specimen to an accuracy of not less than ±0.2 % and measure the width, length, and thickness to an accuracy of not less than ±0.3 %. Compute the volume of the specimen from these measurements. Measure the thickness to an accuracy of ±0.3 % at four points midway along each side 1 in. (25 mm) in from the edge of the specimen and average for the thickness swelling determination (Note 35).

NOTE 35—Where a common practice or special consideration requires edge thickness determinations at the edge or another distance from the edge, the edge distance used shall be reported. For textured surfaces, the surface area of the measuring device shall be of sufficient diameter as not to penetrate localized indentations of the surface texture.

METHOD A 2 PLUS 22–h SUBMERSION PERIOD

104. 2 Plus 22–h Submersion in Water

104.1 Submerge the specimen horizontally under 1 in. (25 mm) of distilled water maintained at a temperature of 68 ± 2°F (20 ± 1°C) (Note 36). Fresh water shall be used for each test. As an alternative to the above method of submersion, specimens may be submerged vertically (Note 37). After a 2-h submersion, suspend the specimen to drain for 10 ± 2 min, at the end of which time remove the excess surface water and immediately weigh the specimen and determine the thickness according to Section 103. Submerge the specimen for an additional period of 22–h and repeat the above weighing and measuring procedure.

NOTE 36—When tap water has been proven sufficiently pure so that results of test are not affected, it may be used as an alternative to distilled water.

NOTE 37—The amounts of water absorbed for tests of this duration are not the same for the two methods of submersion. Specimens suspended vertically will absorb considerably more water than those suspended horizontally. Therefore, values obtained from the horizontal and vertical methods are not comparable.

METHOD B SINGLE CONTINUOUS 24–h SUBMERSION PERIOD

105. Single Continuous 24–h Submersion in Water

105.1 The procedure for determining water absorption after a 24–h submersion shall be the same as that provided in Sections 100 through 104 and Sections 106 through 107, except that only two sets of measurements are required, initial and after the 24–h submersion period.

106. Drying After Submersion

106.1 After submersion dry the specimen in an oven at 217 ± 4°F (103 ± 2°C) as outlined in Sections 120 and 121.

107. Calculation and Report

107.1 Calculate the moisture content (based on oven-dry weight) from the weights after conditioning and after the 2 plus 22–h or single continuous 24–h submersion period. Report which submersion period, Method A or Method B, was followed. Calculate the amount of water absorbed from the increase in weight of the specimen during the submersion, and express the water absorption both as the percentage by volume and by weight based on the volume and the weight, respectively, after conditioning. Assume the specific gravity of the water to be 1.00 for this purpose. Express the thickness swelling as a percentage of the original thickness. When any other size of specimen than the 12-in. (305-mm) square one is used, the report shall include the size used. In addition, give the method of submersion if other than horizontal.

LINEAR VARIATION WITH CHANGE IN MOISTURE CONTENT

108. Scope

108.1 Tests of linear variation with changes in moisture content shall be made to measure the dimensional stability of a board with change in moisture content.

109. Test Specimen

109.1 The test specimens, when possible shall be 3 in. (76 mm) in width and at least 12 in. (305 mm) in length. Two specimens shall be provided, one cut parallel with the long dimension of each board and one from the same board cut at right angles to the long dimension. When a board does not permit obtaining a 12-in. (305-mm) specimen, the maximum length possible shall be used, but it shall be at least 6 in. (152 mm).

110. Procedure

110.1 Follow the following or any equally or more accurate method for measuring specimens: Condition to practical equilibrium (Note 38) specimens carefully sawed square and smooth at a relative humidity of 50 ± 2 % and a temperature of 20 ± 3°C (68 ± 6°F). Measure the length of each specimen to the nearest 0.001 in. (0.02 mm) in a comparator like or similar to the one shown in Fig. 21 and Fig. 22 using a standard bar of the same nominal length as the specimen for reference. For each measurement orient the specimen in the same way in the comparator, for example, numbered surface up with numbers reading from the side toward the operator. Then condition the specimens to practical equilibrium (Note 39 and Note 40) at a relative humidity of 90 ± 5 % and a temperature of 20 ± 3°C (68 ± 6°F), place in the comparator oriented as before, and measure the length again to the nearest 0.001 in. (0.02 mm).

NOTE 38—Practical equilibrium is defined as the state of time-change in weight where for practical purposes the specimen is neither gaining nor losing moisture content more than 0.05 weight percent in a 24-h period. It is helpful in determining the end point in conditioning to plot weight change against time. When the curve becomes asymptotic to a horizontal line, practical equilibrium is indicated.

NOTE 39—Where values of linear change with change in moisture content associated with exposure to a greater humidity change are desired, equilibrium at a relative humidity of 30 ± 1 % may be used for the lower humidity condition rather than the 50 % specified in this section. The report shall state the actual humidity conditions used. When the change between 30 and 90 % relative humidity is desired, it is suggested the specimens be prepared in pairs, conditioned at 50 % relative humidity, and then one specimen of each pair be conditioned at 90 % relative humidity and the other one at 30 % relative humidity.

NOTE 40—Certain wood products experience difficulty reaching an equilibrium moisture content when exposed to 90 % relative humidity, making the standard 50 to 90 % relative humidity test method unreliable for those products. As an alternative to the standard 90 % upper relative humidity level, equilibrium at 80 ± 3 % may be used. The coefficient of variability for linear variation tested with an 80 % upper relative humidity should be less than that of the 90 % relative humidity test because of the smaller allowable range in endpoint relative humidity and the possible differences in hygroexpansivity of a given material between 80 and 90 % relative humidity.

111. Calculation and Report

111.1 Report the linear variation with change in moisture content as the percentage change in length based on the length at 50 % relative humidity. Report the conditions used. When change in length from 30 to 90 % relative humidity is desired, this may be estimated with sufficient accuracy by adding the changes in length between 50 and 90 % and 50 and 30 % relative humidity.

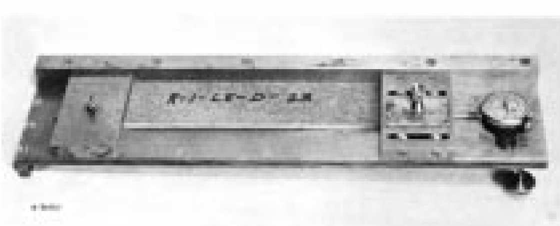


FIG. 21 Dial Gage Comparator for Determining Linear Variation with Change in Moisture Content

ACCELERATED AGING

112. Scope and Significance

112.1 The accelerated aging test shall be used to obtain a measure of the inherent ability of a material to withstand severe exposure conditions. The cycling exposure to which the material shall be subjected is a simulated condition developed to determine relatively how a material will stand up under aging conditions. All of the tests listed below may not be required for any specific investigation or specification. When a property is required, the test shall be made in accordance with the test methods outlined as follows:

Test	Sections
(*1*) Static Bending	11-20
(*2*) Lateral Nail Resistance	41-46
(*3*) Nail Withdrawal	47-53
(*4*) Nail Head Pull-Through	54-60
(*5*) Water Absorption	100-107

112.2 The above tests are usually sufficient to evaluate the resistance of a wood-base panel material to aging. In some instances it may be desirable to evaluate the effect of accelerated aging on some other property. When this is so, appropriate specimens shall be prepared and subjected to the six cycles of accelerated aging before the property is determined.

113. Test Specimens

113.1 The test specimens shall be cut to size for testing as specified in the pertinent sections listed in 113.1 before being subjected to the cyclic exposure listed in 114.1. When tests involving nails are made, the nails shall be driven prior to the aging exposure (Note 41).

NOTE 41—Corrosion-resistant nails shall be used because extractives or other materials present will corrode ordinary steel fasteners.

114. Accelerated Aging Cycles

114.1 Subject each specimen to six complete cycles of accelerated aging. Each cycle shall consist of the following:

114.1.1 Immerse in water at 120 ± 3°F (49± 2°C) for 1 h.

114.1.2 Expose to steam and water vapor at 200 ± 5°F (93 ± 3°C) for 3 h.

114.1.3 Store at 10 ± 5°F (−12 ± 3°C) for 20 h.

114.1.4 Heat at 210 ± 3°F (99 ± 2°C) in dry air for 3 h.

114.1.5 Expose again to steam and water vapor at 200± 5°F (99.3 ± 3°C) for 3 h.

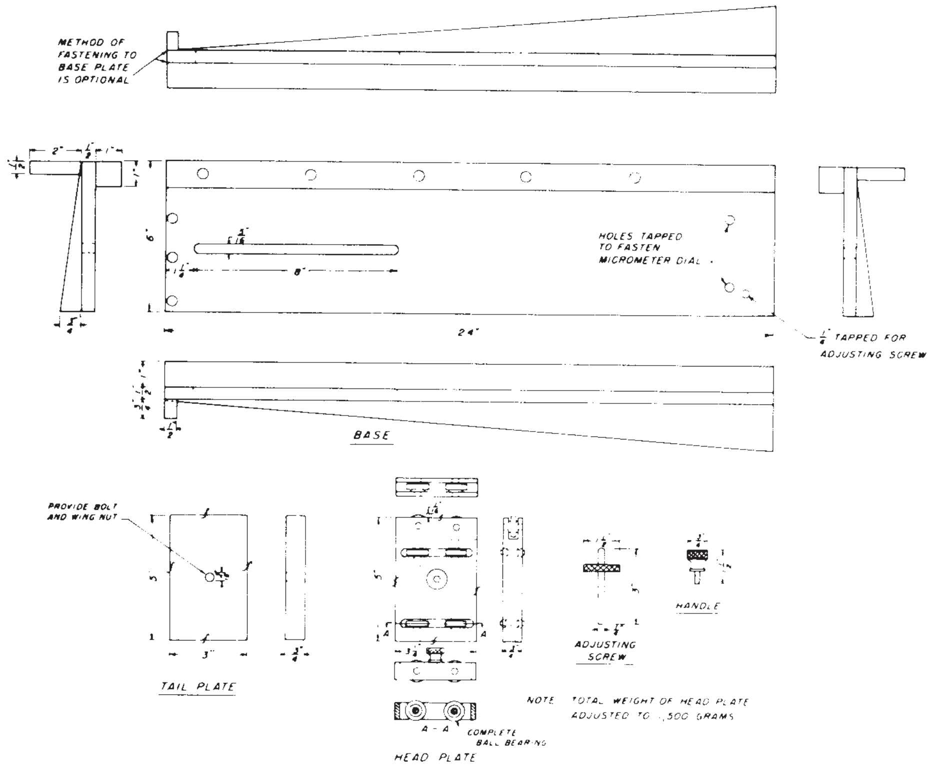
114.1.6 Heat in dry air at 210 ± 3°F (99 ± 2°C) for 18 h.

NOTE 42—If the cycle is to be broken, as for a weekend, the break is to be made during the freezing portion of the cycle.

114.2 After the completion of the six cycles of exposure, further condition the material for test at a temperature of 20 ± 3°C (68 ± 6°F) and a relative humidity of 65 ± 1 % for at least 48 h before test.

115. Handling and Support of Specimens During Exposure

115.1 The specimens shall be supported vertically in racks during accelerated aging. One example is shown in Fig. 23. Specimens shall fit in the racks loosely with at least 1-in. (25-mm) separation between specimens so that swelling either



NOTE 1—1 in. = 25.4 mm.

FIG. 22 Details of Dial Gage Comparator for Measuring Linear Variation with Change in Moisture Content

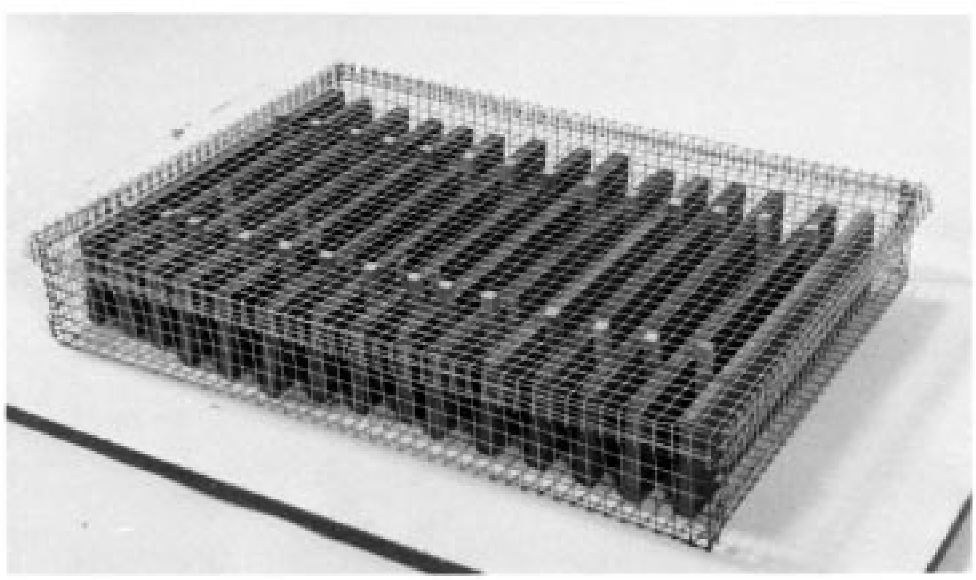


FIG. 23 Specimens Supported Vertically in Rack

parallel or perpendicular to the plane of the board will not produce undesirable forces on the specimens. Racks shall not appreciably shield specimens nor prevent draining after soaking. Further, when in the tank during the exposure to steam and water vapor, specimens shall be placed so that jets of steam and vapor will not erode the specimens.

116. Apparatus

116.1 *Tank and Controls for Soaking and Steaming*:

116.1.1 *Tank or Vat*—A tank or vat such as shown in Fig. 24 shall be provided for performing 114.1.1, 114.1.2, and 114.1.5 of the accelerated aging test. A unit of the size shown is

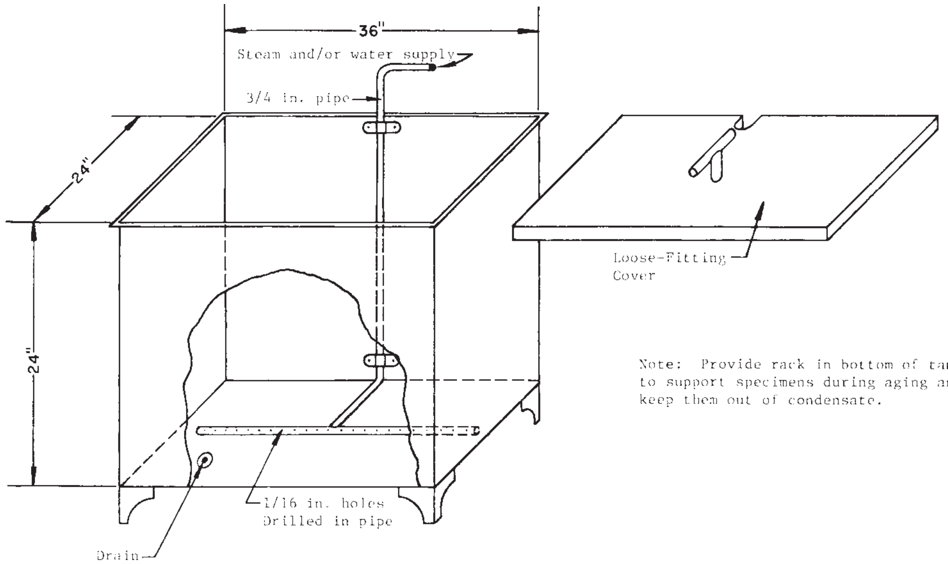


FIG. 24 Sketch of Stainless Steel Tank for Accelerated Aging Small Specimens

adequate for specimens of the size required in this standard. For tests of larger components, units as long as 9 ft (2.7 m) have proven to be satisfactory. The essential features of the tank are as follows:

116.1.1.1 That it be corrosion-resistant because of extractives developed during these cycles and present in wood-base materials,

116.1.1.2 A pipe to the bottom with a diffuser (perforated T-pipe),

116.1.1.3 A drain, although for larger tanks a pump has proven to be advantageous, and

116.1.1.4 A loose-fitting cover that will permit some steam to escape during steam and water vapor phase. The tank may be insulated or uninsulated; but if insulated, the cover is to be left open during steaming portion of the cycle. Heat loss during the 120°F (48.9°C) soaking cycle (114.1.1) requires addition of heat by steam or the equivalent. This provides for circulation around the specimens being soaked and aids in maintaining the desired temperature with greater uniformity. Heat loss during the exposure to steam and water vapor (114.1.2 and 114.1.5) along with the escaping steam aids in providing a dynamic condition. During those steps the drain should be open to permit condensate to drain; or as an alternative method, the water level in the tank should be about 2 in. (51 mm) above the perforated pipes so that the steam percolates through it. Supports should be provided in the bottom of the tank to keep the specimens from direct contact with the water.

116.1.2 *Controls and Source for Soaking and Steaming*—A suitable unit for providing heat for soaking and exposure to steam and water vapor is shown diagrammatically in Fig. 25. In this instance, an air-operated dry kiln controller provides the temperature control required for either the 120°F (48.9°C) soaking (Step 1) or the exposure to steam and water vapor (114.1.2 and 114.1.5). In operation for 114.1.1 the tank is filled to the desired level by opening valves 1 and 3, after which valve 3 is closed. The controller is set at 120°F and the sensor is placed in the water at mid-depth. Valve 2 is opened and steam flows into the water until desired temperature is attained and air-operated valve closes. Temperature is maintained automatically by addition of steam as required. For 114.1.2 and 114.1.5, the controller is set for 200°F (93°C) so steam is automatically metered to maintain that temperature. Valve 2 is

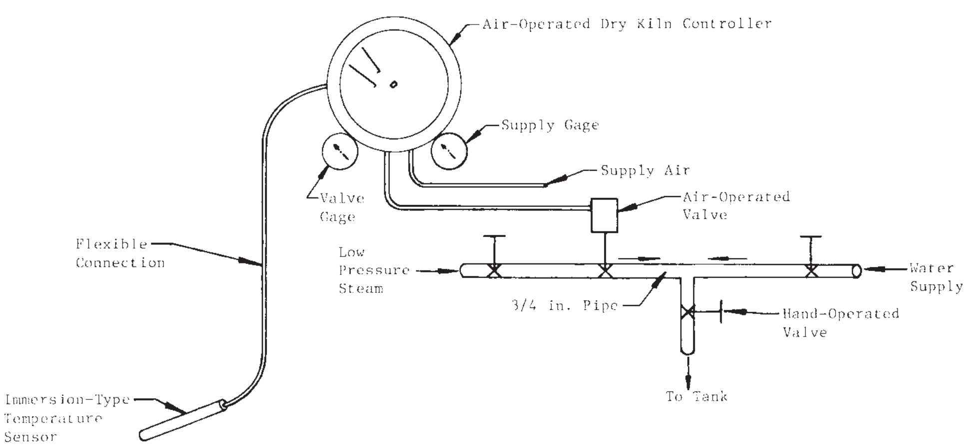


FIG. 25 Diagram of Air-Operated Controller for 120°F (49°C) Soaking and 200°F (93°C) Spraying

adjusted so that cycles of steam" on" are long with respect to steam "off." This system requires a supply of compressed air, something not available in some instances.

116.1.2.1 An electrically controlled valve using thermistor-actuated relays will function as well. When steam is not readily available, it is recommended that a small boiler be used as a source. This positive system of operation and control has proven to be satisfactory and requires a minimum of manpower time.

116.1.3 *Oven*—The oven for heating the specimens at 200°F (93°C) shall be of the positive ventilating type of sufficient capacity to maintain the desired temperature and remove moisture as fast as it is evaporated.

117. Inspection of Material During Cyclic Exposure

117.1 Make frequent inspections of the material during the aging cycles for any signs of delamination or other disintegration. If there is any apparent damage to the material, describe it in the report, as well as the stage of the cycle in which the damage became apparent.

118. Comparisons and Report

118.1 After the tests following the accelerated aging treatment are completed, calculate the results as specified in the appropriate test and compare them with the corresponding values obtained from tests made on material that did not have the accelerated aging treatment. Calculations shall be based on both the original dimensions and dimensions after accelerated aging.

CUPPING AND TWISTING

119. Procedure

119.1 When required, measurements of cupping and twisting may be made on specimens after accelerated aging (see Sections 112-116). Cupping may be determined by placing a straightedge across opposite edges of the specimen, and measuring the maximum distance to the concave face. Twisting may be determined by placing the specimen with three corners touching a level surface, and measuring the distance from the raised corner to the surface. Include the size of specimen and necessary details regarding methods of measurement in the report.

MOISTURE CONTENT AND SPECIFIC GRAVITY

120. Procedure

120.1 Determine the specific gravity (or density) of each static bending specimen at time of test from the dimensions, weight, and moisture content, as provided in Sections 9, 19, and 121. When specific gravity determinations are required on specimens of prism form from other tests, like procedure may be used. The moisture content of a specimen may be determined from a coupon cut from the test specimen as in the static bending test, or the entire test specimen may be used for the moisture determination.

120.2 When for any reason additional determinations of moisture content and specific gravity (or density) are required, prepare separate samples for this determination from the same material as is used in preparing the test specimens. These moisture content and specific gravity specimens shall be the full thickness of the material and 3 in. (76 mm) wide and 6 in. (152 mm) long. Smaller specimens may be used when deemed necessary. Condition the specimens in accordance with the provisions of Section 5.

120.3 Measure the dimensions to an accuracy of not less than ±0.3 %, and the weight to an accuracy of not less than ±0.2 %. Obtain the oven-dry weight after drying the specimen in an oven at 217 ± 4°F (103 ± 2°C) until approximately constant weight is attained.

121. Calculation

121.1 The moisture content shall be calculated as follows:

$$M = 100[(W - F)/F] \tag{6}$$

where:
M = moisture content, %,
W = initial weight, and
F = final weight when oven-dry.

121.2 Calculate the specific gravity as follows (Note 43):

$$\text{sp gr} = KF/Lwt \tag{7}$$

where:
F = final weight when oven dry, g,
L = length of coupon, in. (mm),
w = width of coupon, in. (mm),
t = thickness of coupon, in. (mm), and
K = 1, when SI units of weight and measurement are used; or 0.061, when SI units of weight and inch-pound units of measurement are used.

NOTE 43—The specific gravity as determined by this equation is based on volume at test and weight when oven-dry.

121.3 When desired, the density based on weight and volume of the specimens after conditioning may be calculated.

INTERLAMINAR SHEAR

122. Scope

122.1 Tests in interlaminar shear (shear in the plane of the board) shall be made on specimens bonded between two steel loading plates loaded in compression to obtain strength and deformation properties of wood-base panel materials. One half of the test specimens shall be prepared with the long dimension perpendicular to the long dimension of the board in order to evaluate any directional properties.

123. Significance and Use

123.1 Shear properties in the plane of the board (interlaminar shear) duplicate the kind of stressing in shear encountered in such glued structural assemblies as structural sandwiches and adjacent to gluelines between flanges and webs in box and I-beams and gusset plates in trusses. The procedure used follows closely the requirements of Test Method C 273. While it apparently yields values in the same plane as the "block shear" test of Sections 87-90, values obtained are not comparable because of effects of friction in the tool and the fact that failure in the block shear test can only occur in a ⅛-in. (3-mm) thick area in the middle of the board. The interlaminar shear strength test offers the additional advantage that shear deformation data can be obtained when desirable.

124. Test Specimen

124.1 The interlaminar shear tests shall be made on specimens 2 in. (50 mm) wide and 6 in. (150 mm) long by the thickness of the material, when the board material is ½ in. (12.5 mm) in thickness or less. For materials more than ½ in. (12.5 mm) thick, the specimen shall have a width of at least twice the thickness but not less than 2 in. (50 mm) and a length at least 12 times the thickness (Note 44). The edges of the specimen shall be sawed square and smooth. The length, width, and thickness shall be measured to an accuracy of at least ±0.3 %.

124.2 Steel loading plates ¾ in. (about 20 mm) thick, having a width equal to the specimen width and a length equal to the specimen length plus ¼ in. (7 mm) shall be bonded to each face of the specimen as shown in Fig. 26 using suitable adhesive (Note 45). The loading ends of the plates shall project ¼ in. (7 mm) beyond the end of the specimen and they shall be beveled at 45° and oriented as shown. Extreme care shall be used in applying adhesive so minimum spreads are used to prevent it infusing into the specimen and thus reinforcing the board.

NOTE 44—A length ratio of 12:1 is prescribed as a minimum so that secondary normal stresses are minimal.

NOTE 45—See Note 13.

125. Loading Procedure

125.1 The load shall be applied through notched fittings such that the line of action of the direct compressive force shall pass through the diagonally opposite corners of the specimen as shown in Fig. 26. The lower fitting shall be placed on a spherical bearing block as shown in Fig. 27 so that the load is uniformly distributed across the width of the specimen.

126. Speed of Testing

126.1 The load shall be applied continuously throughout the test at a uniform rate of motion of the movable crosshead of the testing machine equal to 0.002 times the length (inch or centimetre) per minute (see Note 8).

127. Load-Deformation Data

127.1 When shearing modulus is required, data for plotting load-deformation curves can be obtained by using the dial gage arrangement shown in Fig. 27, which measures the displacement of one plate with respect to the other. The interlaminar shearing modulus is defined as the slope of the straight-line portion of the stress-strain curve. A secant modulus may be calculated for data that do not have an initial straight-line relationship. If shearing modulus values are included in the report, the method used to determine them shall also be reported.

128. Moisture Content and Specific Gravity

128.1 If moisture content or specific gravity, or both, are required, a separate specimen taken from the board adjacent to

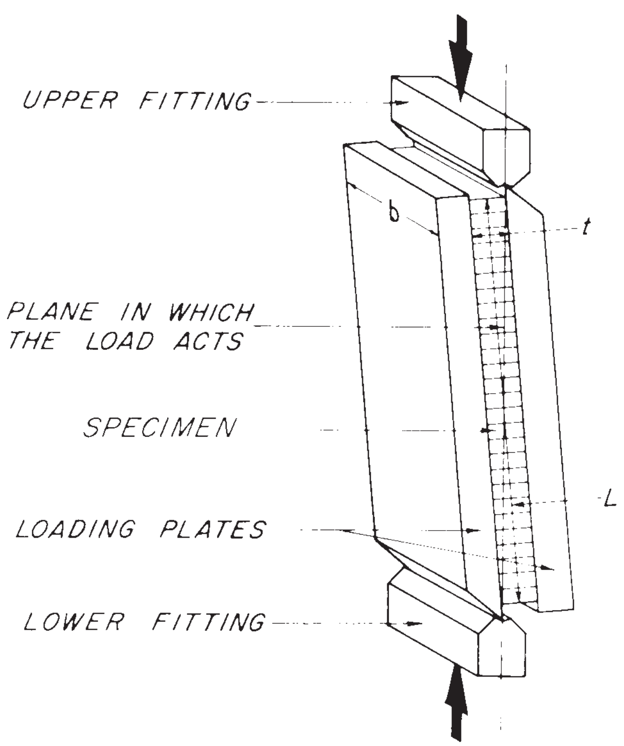


FIG. 26 Detail of Specimen and Loading Apparatus for Determining Interlaminar Shearing Properties

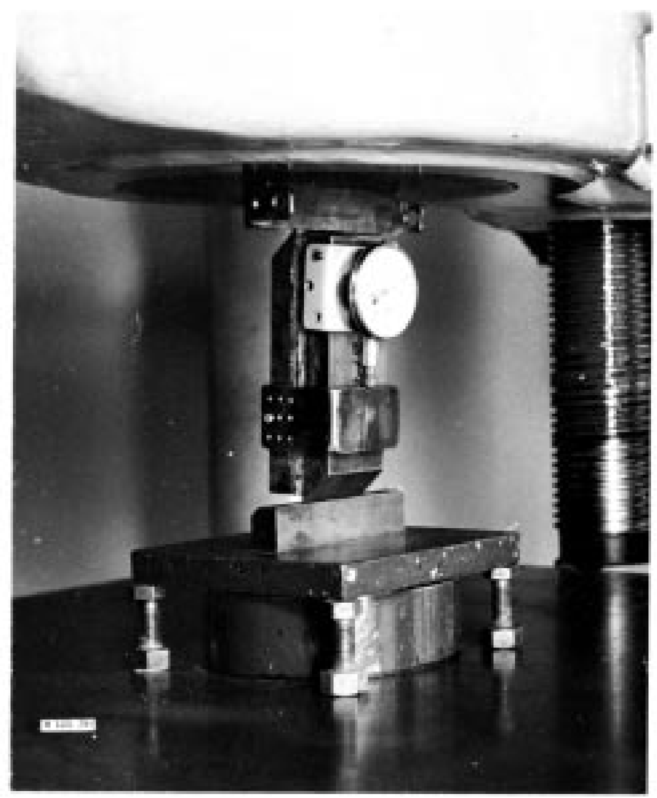


FIG. 27 Test Assembly for Determining Interlaminar Shearing Properties, Showing Dial Gage Apparatus for Measuring Shear Displacement

the shear specimen shall be used and the determinations made as detailed in Sections 120 and 121.

129. Calculation and Report

129.1 The interlaminar shearing strength shall be calculated for each specimen by the following equation, and the values determined shall be included in the report:

$$fs = P/Lb \tag{8}$$

129.2 The interlaminar shearing modulus shall be calculated for each specimen by the following equation (Note 46), and the values determined shall be included in the report:

$$G = P_1 d/ Lbr \tag{9}$$

where:

b = width of specimen, in. (mm),
d = thickness of specimen, in. (mm),
fs = interlaminar shearing strength, psi (kPa),
G = interlaminar shearing modulus, psi (kPa),
L = length of specimen, in. (mm),
P = maximum load, lb (kg),
P_1 = load at proportional limit or point where secant intersects load-deformation curve, lb (kg), and
r = dial reading or displacement of one plate with respect to the other at load P_1, in. (mm).

NOTE 46—The equation in 129.2 assumes that the strains in the loading plates and in the bond between the plates and the specimen are negligible.

EDGEWISE SHEAR

130. Scope

130.1 Tests in edgewise shear (shear normal to the plane of the board) (panel shear) shall be made on specimens clamped between two pairs of steel loading rails. These rails when loaded in compression introduce shear forces in the specimen that produce failures across the panel. With most board materials, failure is in combination diagonal tension and compression. One half of the specimens shall be prepared with the long dimension parallel and the other half with the long dimension perpendicular to the long dimension of the board in order to evaluate directional properties.

131. Significance and Use

131.1 This test produces the kind of shear stressing that occurs when shear forces are introduced along the edges of the material. The usual applications are where the board is used as a panel and racking forces are involved. When panel areas are large with respect to thickness, buckling may occur due to diagonal compressive forces. When this is so, actual strengths may be lower than produced from this test.

132. Test Specimen

132.1 Each specimen, 3½ by 10 in. (89 by 254 µm) by the thickness of the material, shall be prepared as shown in Fig. 28. The thickness and length of the specimen shall be measured to an accuracy of not less than ±0.3 %. These two dimensions shall be used to determine the cross-sectional area for calculating the maximum shearing stress. The hardened steel loading rails with serrated gripping surfaces shall be bolted to the specimen with eight ⅜-in. (9.5-mm) high-strength bolts. A detailed drawing of the loading rails and bolts is shown in Fig. 29. The bolts shall be sufficiently tight to prevent the rails from slipping when the load is applied so as to avoid bolt-bearing failures in the board material. The pressure necessary to prevent slipping will depend upon the density of the material. In order to obtain sufficient gripping pressure when testing some low-density boards, a certain amount of crushing of the specimen beneath the loading rails is unavoidable.

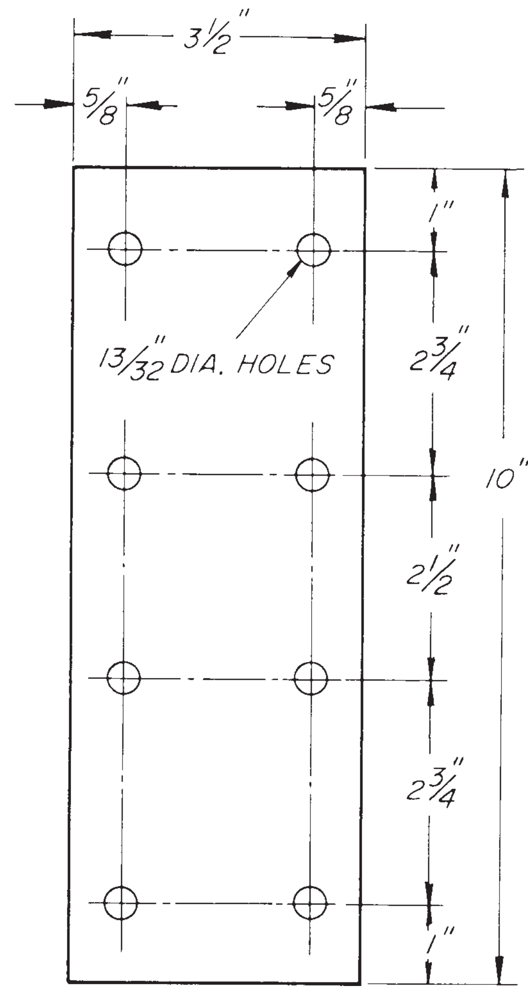


FIG. 28 Detail of Edgewise Shear Specimen

133. Loading Procedure

133.1 The load shall be applied through notched fittings such that the line of action of the direct compressive force shall pass through the diagonally opposite corners of the shear area between the pairs of loading rails. The lower fitting shall be placed on a spherical bearing block so that the load is applied uniformly. The upper fitting shall be positioned directly above the lower fitting; thus the direct compressive force is applied vertically as shown in Fig. 30.

134. Speed of Testing

134.1 The load shall be applied continuously throughout the test at a uniform rate of motion of the movable crosshead of the testing machine of 0.02 in./min (0.5 mm/min) (see Note 8).

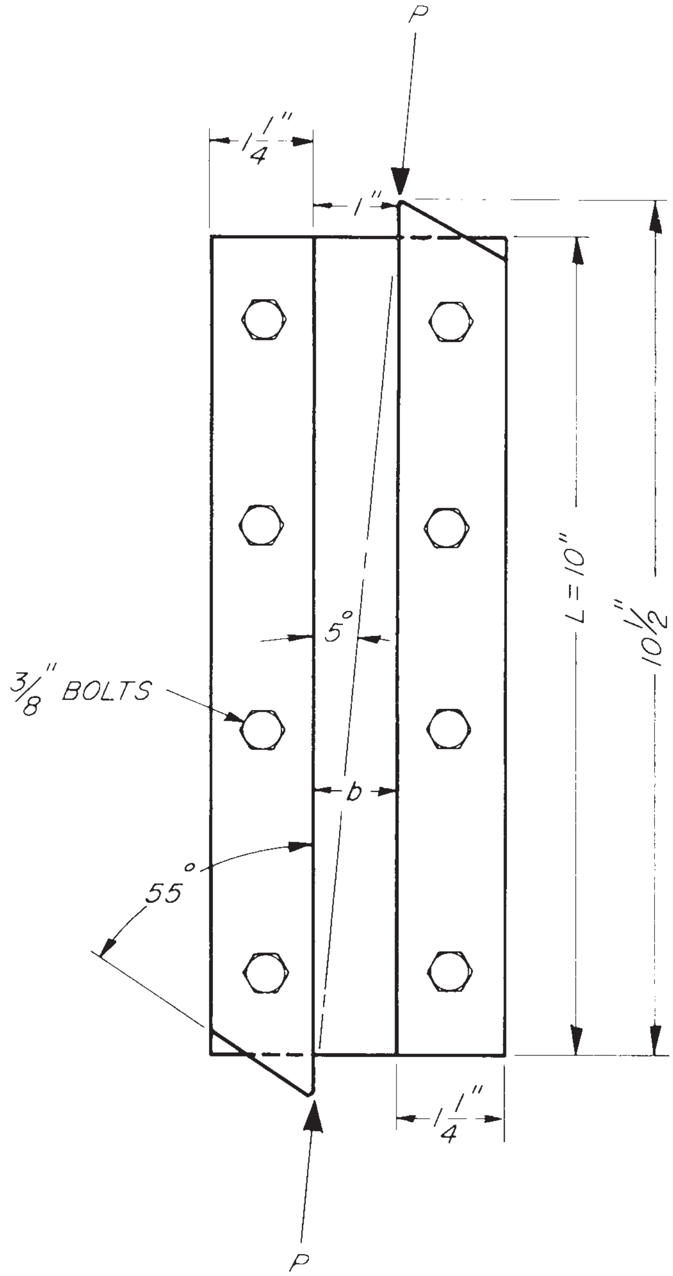


FIG. 29 Detail of Loading Rails Used with Edgewise Shear Specimen

135. Moisture Content and Specific Gravity

135.1 If moisture content or specific gravity or both, are required, a specimen cut from the undamaged part (between holes) shall be cut out after test and then measured, weighed, and ovendried as detailed in Sections 120 and 121.

136. Calculation and Report

136.1 The edgewise shear strength shall be calculated for each specimen by the following formula, and the values determined shall be included in the report:

$$fs = P/Ld \tag{10}$$

FIG. 30 Test Assembly for Determining the Edgewise Shearing Strength of Wood-Base Panel Products

where:

d = thickness of specimen, in. (mm),
fs = edgewise shear strength, psi (kPa)
L = length of specimen, in. (mm), and
P = maximum compressive load, lb (kg).

The kind of failure shall also be described.

COMPRESSION-SHEAR TEST METHOD

137. Scope

137.1 This test destructively determines the compression-shear strength of a particleboard or fiberboard specimen without gluing or clamping. It provides an indication of the bond quality of a material subjected to shear deformation, that correlates to the Tensile Strength Perpendicular to Surface (internal bond) test, Sections 28-33.

137.2 It is appropriate for specimens 0.250 in. (6.35 mm) to 1.312 in. (33.32 mm) in thickness in the dry or wet condition if the specimen exhibits sufficient compressive strength perpendicular to the surface so that the primary mode of failure is shear in a plane nearly parallel to the surface.

137.3 The specimen may be tested with the shear stress applied parallel or perpendicular to the panel length, or at any angle in between.

138. Summary of Test Method

138.1 The test employs the principle that an axially loaded column develops maximum-shear stress at an angle 45° to the direction of an applied compressive load. A short columnar assembly of upper and lower sections, to which a compressive load is applied at a uniform rate, is formed by placing a specimen between friction surfaces of mating shear jaws that are oriented at 45° to the axis of the column (Fig. 31). Components of the applied load subject the specimen to compression stress perpendicular to the surface, and shear stress parallel to the surface of the specimen. The shear jaws can be adjusted so that the applied load is always directed through the geometric center of the test specimen. The surfaces of the jaws are designed to transfer the shear force to the specimen. Removable restraining bars, one on the upper end of the upper-shear jaw, and one on the lower end of the lower-shear jaw position the specimen for testing, and also transmit some shear if transfer by the jaw surfaces is incomplete. The base of the lower section of the test column rides on a journaled-roller assembly that permits unrestrained lateral movement to occur as shear strain develops. A hemispherical-pivot point is attached to the top of the upper section of the test column to enable unevenly thick, or improperly cut specimens with slight dimensional variations to be tested without modification.

139. Significance and Use

139.1 The intent of the compression shear test method is to provide a quick, simple, reproducible, and quantitatively accurate means for measuring the bond quality of fiber- and particle-panel products.

139.2 Panel producers can use it to monitor quality control, and secondary manufacturers and researchers can evaluate the relative strength of panels with similar particle geometries.

139.3 The results of the compression shear test can be used directly as a measure of bond quality, or the results may be correlated, using appropriate statistical procedures, to those of the Tensile Strength Perpendicular to Surface test outlined in Sections 28-33.

140. Interferences

140.1 The configuration of the test specimen results in some nonuniformity of stress across and through the specimen. Thus, the plane of maximum shear is not precisely parallel to the panel face. However, results correlate well with the common method of evaluating bond quality as specified in Sections 28-33, Tensile Strength Perpendicular to the Surface.

140.2 Shear failure should occur near the center plane of the specimen. When shear failure occurs on, or near the surface of the specimen, it may not be indicative of a poorly bonded face, since stress concentrations at the interface ofthe bar, and specimen may initiate unwarranted failure.

140.2.1 When shear failure occurs at, or near the specimen's surface, a verification test with a representative specimen shall be conducted as directed in Sections 28-33, Tensile Strength Perpendicular to the Surface, to determine if the surface is actually the weakest plane.

140.3 Panel types having different particle geometries or orientations, but the same Tensile Strength Perpendicular to the surface values, Sections 28-33, may have different compression-shear values. Therefore, it may be necessary for each user to develop specific correlations for each panel type to be tested.

140.4 Particles aligned perpendicular to the shear force may fail in rolling shear, determined by wood strength, not bond strength.

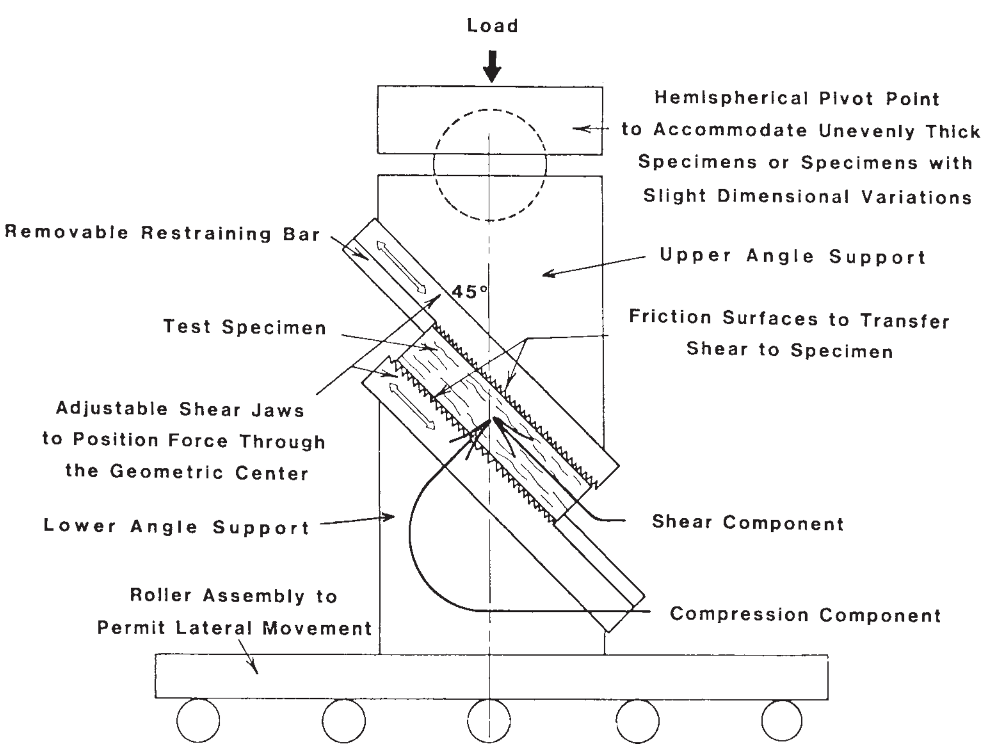


FIG. 31 Principle of Compression-Shear Test

140.4.1 When bond strength of oriented structural board (OSB) is desired, the test specimen shall be cut so that the orientation of all layers of the specimen shall be aligned at 45° to the shear force.

141. Apparatus

141.1 The compression-shear test apparatus consists of the compression-shear device, illustrated in Fig. 32, and any machine (see Note 47) that can apply a compressive force measurable within± 2 % accuracy at a rate that will develop 5000 lb (2268 kg) within 4 s, ±2 s, when platens, or cross head and load cell are in contact with a 5 ⅞-in. (149.2-mm) diameter, ⅞-in. (22.2-mm) or thicker steel plate.

NOTE 47—Experience indicates that a machine with a 5000 lb load capacity should be sufficient for testing commercially produced commodity panel types. However, high strength experimental, or specialty-panel types may require a machine capacity of up to 10 000 lb.

142. Test Specimen

142.1 The test specimen shall be 2 ± 1⁄16-in. (50.8 ± 1.6-mm) wide with all corners forming right angles, and the length, ±1⁄16 in. (±1.6 mm), shall be in accordance with thickness as listed in Table 2. A specimen that is to be tested in a swollen state may be cut before or after swelling. For a specimen to be tested in the swollen state (see Note 48), and cut prior to swelling, the thickness of the specimen as it shall be tested shall be anticipated in order to establish specimen length. Also, to compensate for any anticipated change in length, the length shall be increased or decreased by the amount of the anticipated change.

FIG. 32 Compression-Shear Device

TABLE 2 Specimen Length as a Function of Thickness[A]

Thickness Range, in. (mm)	Length, in. (mm)
0.250 to 0.312 (6.35 to 7.93)	2.000 (50.80)
0.313 to 0.437 (7.94 to 11.10)	2.125 (53.98)
0.438 to 0.562 (11.11 to 14.28)	2.250 (57.15)
0.563 to 0.687 (14.29 to 17.45)	2.375 (60.33)
0.688 to 0.812 (17.46 to 20.63)	2.500 (63.50)
0.813 to 0.937 (20.64 to 23.80)	2.625 (66.68)
0.938 to 1.062 (23.81 to 26.98)	2.750 (69.85)
1.063 to 1.187 (26.99 to 30.15)	2.875 (73.03)
1.188 to 1.312 (30.16 to 33.32)	3.000 (76.20)

[A] The thickness at the time of testing is the basis for establishing length. For example, a specimen 0.520-in. (13.21-mm) thick shall be 2.250-in. (57.15-mm) long. In instances where the thickness variation of a group of similar specimens would dictate cutting specimens of different lengths, the length of all specimens in the group shall be governed by the thickest specimen. For example, in a group composed of two specimens that individually measure 0.410 and 0.465-in. (10.41 and 11.81-mm) thick, each specimen shall be 2.250-in. (57.15-mm) long.

NOTE 48—Individual agencies promulgating the compression-shear test as a quality control test shall decide what method of wetting shall be appropriate. Otherwise, users shall decide the appropriate method, and shall report it in accordance with 146.1.4.

143. Preparation of Apparatus

143.1 Symmetrically position the upper- and lower-shear jaws, with restraining bars attached, so that the applied force will be directed through the geometric center of the test specimen.

143.1.1 The correct positioning of a specimen can be checked by marking, and aligning the specimen as follows: Use a 45/90° square to determine the geometric center of the long edge of the specimen and draw two 45° lines through this point to form an *X*.

143.1.2 Place the test specimen flush against the lower-restraining bar and shear jaw, and position the lower-shear jaw so that the indicator line on the lower-angle support is aligned with the vertical line on the test specimen; then position the upper-shear jaw so that the indicator line of the upper-angle support is aligned with the same line on the test specimen when each shear jaw's face and restraining bar are flush with the test specimen, as illustrated in Fig. 33.

144. Procedure

144.1 Position the compression-shear device in the testing machine that will apply the compressive load.

144.2 For each specimen to be tested, determine to an accuracy of not less than ±0.3 %, one length, width, thickness, and weight measurement, and record this data.

144.3 Place a test specimen in the device; apply a compressive load at the rate specified in 142.1, and record the maximum load to failure.

145. Calculation

145.1 Assume that the shear area is the product of the measured length and width dimensions, even when the plane of failure is not parallel to the surface.

145.2 Calculate the maximum-shear stress for each specimen by the following equation:

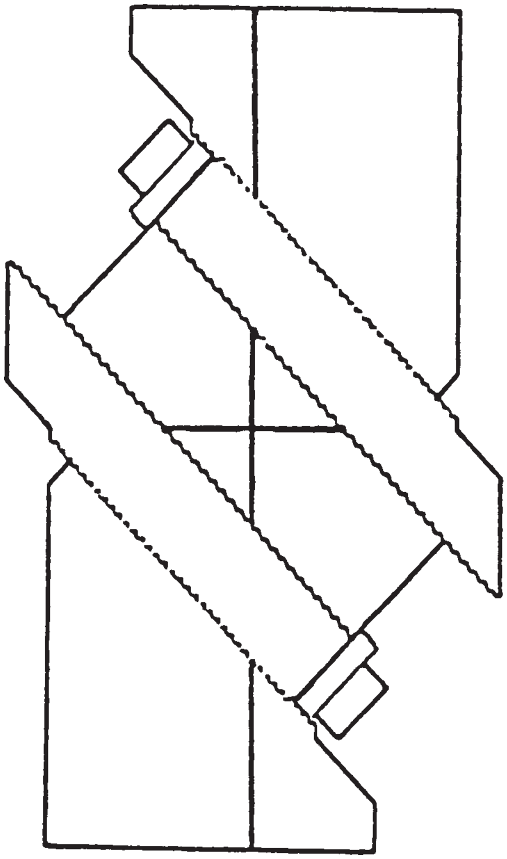


FIG. 33 Proper Positioning of Test Specimen and Shear Jaws on Angle Supports

$$T = P/\sqrt{2}A \quad (11)$$

where:
T = maximum-shear stress, psi (Pa),
P = maximum load, lbf (N), and
A = product of length and width dimensions, in.^{2}(mm^2).

146. Report

146.1 The report shall include the following:

146.1.1 The brand name and model number of the machine used to apply the compressive load, and how the load was delivered, that is, through manual or motorized application.

146.1.2 The actual length, width, and thickness of the specimen, in. (mm).

146.1.3 The orientation of panel length, or machine direction to the direction of shear stress.

146.1.4 Special conditions of test, if any (see Note 48).

146.1.5 The maximum load, lbf (N).

146.1.6 The maximum shear stress as calculated in 145.2.

146.1.7 The percent moisture content at time of test as determined in accordance with Section 121.

PART B—ACCEPTANCE AND SPECIFICATION TEST METHODS FOR HARDBOARD

147. Scope

147.1 The methods for Part B provide test procedures for measuring the following properties of hardboard:

	Sections
Thickness	152-155
Modulus of Rupture	156-159
Tensile Strength Parallel to Surface	160 to 161
Tensile Strength Perpendicular to Surface	162 to 163
Water Absorption and Thickness Swelling	164 to 165
Moisture Content and Specific Gravity	166 to 167

148. Referenced Documents

148.1 *ASTM Standards:*

E 4 Practices for Load Verification of Testing Machines[10]

E 691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method[11]

149. Test Panel

149.1 A test panel of minimum dimensions of 40 by 48 in. (1.0 by 1.2 m) shall be sawed for each test board whenever possible. The 48-in. dimension of the test panel shall be across the longer dimension of the board as it is usually obtained. When the test boards are less than 40 by 48 in. in size, a sufficient number of boards shall be selected for each test series to yield the equivalent number of specimens, as shown in Fig. 34.

150. Test Specimens

150.1 Specimens shall be sawed from the test panel, as shown in Fig. 34, exercising care so that edges are straight, smooth, and square, and so that ends and sides are mutually perpendicular to each other.

151. Conditioning

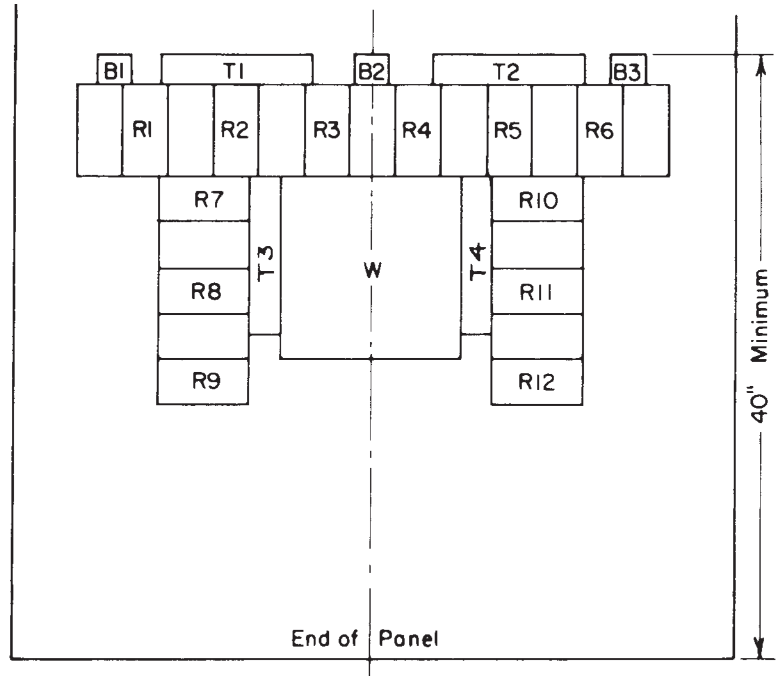
151.1 Except in case of disputes, test all specimens at the moisture content as shipped or received. In cases of dispute, condition the specimens with a constant weight prior to testing, at a relative humidity of 50 ± 2 % and a temperature of 72 ± 2°F (22 ± 1°C).

THICKNESS

152. Apparatus

152.1 An instrument such as a dial gage indicator on which the contacting surfaces are flat and have a minimum diameter of 7⁄16 in. (11 mm) shall be used. Pressure on the contacting

[10] *Annual Book of ASTM Standards*, Vol 03.01.
[11] *Annual Book of ASTM Standards*, Vol 14.02.



Modulus of rupture (*R*)—twelve 3 by 6 in. (76 by 152 mm)
Tensile strength parallel to surface (*T*)—four 2 by 10 in. (50 by 254 mm)
Tensile strength perpendicular to surface (*B*)—three 2 by 2 in. (50 by 50 mm)
Water absorption and swelling (*W*)—one 12 by 12 in. (304 by 304 mm)

NOTE 1—The suffix numbers may be used to identify individual specimens by location and to record specimen test data.

FIG. 34 Diagram for Cutting Test Specimens from Hardboard Test Panel

surfaces shall be not less than 7 psi (48 kPa) nor greater than 12 psi (83 kPa), and the instrument shall be such that determinations of thickness are accurate to 0.001 in. (0.02 mm).

153. Test Specimen

153.1 The twelve 3 by 6-in. (76 by 152-mm) modulus-of-rupture specimens, as specified in Section 158, shall be used for the determinations of thickness.

154. Procedure

154.1 Measure the thickness at two points on each specimen approximately 1 in. (25 mm) in from the center of the long edges to the nearest 0.001 in. (0.02 mm).

155. Calculation and Report

155.1 Report the average thickness of the twelve specimens for each test panel to the nearest 0.001 in. (0.02 mm).

MODULUS OF RUPTURE

156. Apparatus

156.1 *Testing Machine*—Any standard testing machine (Note 49) capable of applying and measuring the load with an error not to exceed ± 1.0 %, as provided in Practices E 4.

NOTE 49—Some testing machines operated at speeds allowed in these test procedures without proper damping devices or in need of adjustment may yield values in error because of "follow-through" due to mass inertia effects in the weighing system. Care must be exercised in the selection of testing machines so that values obtained from test are not in error more than the amount stipulated.

156.2 *Span and Supports*—The supports and loading block shall be rounded to a radius of not less than 3⁄16 in. (5 mm) or more than 3⁄8 in. (10 mm) and shall be at least 3 in. (76 mm) long. The span shall be 4 in. (101 mm) from center to center of the supports (Note 50).

NOTE 50—The span of 4 in. is for use when testing nominal thicknesses no less than 1⁄10 in. (2.5 mm) nor greater than 3⁄8 in. For thicknesses less than 1⁄10 in. a span of 2 in. (50 mm) shall be used.

157. Test Specimen

157.1 The test specimen shall be 3 by 6 in. (76 by 152 mm). Six specimens with the long dimension parallel and six specimens with the long dimension perpendicular to the long dimension of the test board shall be taken for testing, as shown in Fig. 34.

158. Procedure

158.1 *Thickness*—Measure the thickness of each specimen to the nearest 0.001 in. (0.02 mm) using the apparatus and procedure specified in Sections 152 and 154.

158.2 *Width*—Measure the width of each specimen to the nearest 0.01 in. (0.2 mm) at the line of load application.

158.3 *Load Application*—Center the specimen flatwise on the parallel supports. Place the specimens for testing so that the screen or rough side, or back surface of S2S when it can be determined, is placed in tension. Apply the load continuously at midspan at an approximately uniform rate of motion of the movable crosshead not less than ½ in./min (12 mm/min) nor more than 1 in./min (25 mm/min) (Note 51) until definite failure occurs, and note the maximum load to accuracy of the testing machine.

NOTE 51—This speed is the differential speed between the moving crosshead and the supports.

159. Calculation and Report

159.1 Calculate the modulus of rupture, *R*, in pounds per square inch (or kilopascals), for each specimen by the following equation:

$$R = 3PL/2bd^2 \tag{12}$$

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

159.2 Report the average modulus of rupture of the twelve specimens for each test panel to the nearest 100 psi (689 kPa).

TENSILE STRENGTH PARALLEL TO SURFACE

160. Procedure

160.1 The procedure for determining tensile strength parallel to the surface shall be the same as that provided in Sections 21 and 27, except that the uniform rate of separation of the jaws of the tensile grips shall be not less than 0.125 or more than 0.175 in./min (3.18 to 4.45 mm/min). Select for the test two specimens with the long dimension parallel and two specimens with the long dimension perpendicular to the long dimension of the test board, as shown in Fig. 34.

161. Calculation and Report

161.1 Calculate the unit stress at failure by dividing the load at failure by the cross-sectional area (thickness to the nearest 0.001 in. (0.02 mm) and width to the nearest 0.01 in. (0.2 mm)).

161.2 Report the average tensile strength of the four specimens for each test panel to the nearest 100 psi (689 kPa).

TENSILE STRENGTH PERPENDICULAR TO SURFACE

162. Procedure

162.1 The procedure for determining tensile strength perpendicular to surface shall be the same as that provided in Section 28-33, except that the uniform rate of separation of the heads of the testing machine shall not be less than 0.125 or more than 0.175 in./min (3.18 to 4.45 mm/min). Select three specimens for test as shown in Fig. 34. Saw each test specimen accurately so that it is 2 ± 0.01 in. (50 ± 0.2 mm) on a side. If improper adhesion of the metal loading blocks to the specimen is indicated by less than 95 % fiber transfer at failure, repeat the tests using supplemental specimens obtained from the same general area of the test panel as the original specimens.

163. Calculation and Report

163.1 Calculate the unit stress at failure by dividing the load at failure by four.

163.2 Report the average tensile strength of the three specimens from each test panel to the nearest 5 psi (34 kPa).

WATER ABSORPTION AND THICKNESS SWELLING

164. Procedure

164.1 The procedure for determining water absorption after a 24-h immersion shall be the same as that provided in Sections 100-107, except that only two sets of measurements are required, initial and after the 24-h immersion. Select a single 12-in. (304-mm) square specimen (Note 50) for test, as shown in Fig. 34.

NOTE 52—A 6 by 6-in. (152 by 152-mm) specimen may be used for convenience as an alternate size. The smaller specimen will usually yield slightly higher values for water absorption. In cases where dispute is likely because of amount of water absorbed, the 12-in. square specimens should be used.

165. Calculation and Report

165.1 Calculate the water absorption and average thickness swelling values for each test panel, and report to the nearest 1 % on a weight basis.

MOISTURE CONTENT AND SPECIFIC GRAVITY

166. Procedure

166.1 Determine the moisture content and specific gravity of each modulus-of-rupture specimen, based on the volume at test and the weight when ovendry, as provided in Sections 120 and 121.

167. Calculation and Report

167.1 Calculate the moisture content and specific gravity for each specimen using the equations given in Section 121.

167.2 Report average values for each test panel to the nearest 0.1 % for moisture content and 0.01 for sp gr.

NOTE 53—For some specification purposes it may be advantageous to report density instead of specific gravity. When this is so, report the average density in pounds per cubic foot, *D*, to the nearest pound per cubic foot. Density may be calculated by multiplying the specific gravity by 62.4.

REPORT, PRECISION AND BIAS, AND KEYWORDS

168. Report

168.1 The data recorded shall include, in addition to the actual test results and data called for specifically under each test, a description of the material, sampling procedure, record of any conditioning or treatment, and notes regarding any specific details that may have a bearing on the test results.

169. Precision and Bias

169.1 Statements on precision and bias will be developed prior to the next revision of these methods. Precision will be estimated in accordance with the interlaboratory test program prescribed by Practice E 691.

170. Keywords

170.1 particle panel; particle panel materials; wood; wood-base fiber