



Designation: D1037 – 06a

Standard Test Methods for Evaluating Properties of Wood-Base Fiber and Particle Panel Materials¹

This standard is issued under the fixed designation D1037; 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.

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 D1554.

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.

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.

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1. Scope

1.1 Part A—General Test Methods for Evaluating the Basic Properties of Wood-Base Fiber and Particle Panel Materials.

These test methods cover the determination of the properties of wood-base fiber and particle panel materials that are produced as mat-formed panels such as particleboard, medium-density fiberboard, hardboard, and oriented strand board.

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

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1.2 Part B—Acceptance and Specification Test Methods for Hardboard. The methods for Part B provide test procedures for measuring the following properties of hardboard:

Thickness	Section
Modulus of Rupture	32
Tension Strength Parallel to Surface	33
Tension Strength Perpendicular to Surface	34
Water Absorption and Thickness Swelling	35
Moisture Content and Specific Gravity	36
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TABLE 1 Basic Test Procedures for Evaluating Properties of Wood Base-Fiber and Particle Panel Materials

ASTM Designation	Test Methods for
C177	Steady-State Heat-Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus ^A
C209	Cellulosic Fiber Insulating Board ^A
C236	Steady-State Thermal Performance of Building Assemblies by Means of the Guarded Hot Box ^A
C384	Impedance and Absorption of Acoustical Materials by the Impedance Tube Method ^A
C423	Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method ^A
D149	Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies ^B
D150	A-C Loss Characteristics and Permittivity (Dielectric Constant) of Solid Electrical Insulating Materials ^B
D257	D-C Resistance or Conductance of Insulating Materials ^B
D495	High-Voltage, Low-Current, Dry Arc Resistance of Solid Electrical Insulation ^B
D1666	Conducting Machining Tests of Wood and Wood-Base Materials ^C
D1761	Mechanical Fasteners in Wood ^C
E72	Conducting Strength Tests of Panels for Building Construction ^D
E84	Surface Burning Characteristics of Building Materials ^D
E90	Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions ^A
E96	Water Vapor Transmission of Materials ^A
E97	Directional Reflectance Factor, 45-deg 0-deg, of Opaque Specimens by Broad-Band Filter Reflectometry ^E
E119	Fire Tests of Building Construction and Materials ^D
E136	Behavior of Materials in a Vertical Tube Furnace at 750°C ^D
E152	Fire Tests of Door Assemblies ^D
E162	Surface Flammability of Materials Using a Radiant Heat Energy Source ^D
E661	Performance of Wood and Wood-Based Floor and Roof Sheathing Under Concentrated Static and Impact Loads ^D
E662	Specific Optical Density of Smoke Generated by Solid Materials ^D
E906	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.

1.3 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.

1.4 The values stated in inch-pound units are to be regarded as the standard. The SI equivalents are approximate in many cases. 1 in. = 25.4 mm, 1 lbf = 4.45 N.

1.5 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 ASTM Standards:²

- [C273 Test Method for Shear Properties of Sandwich Core Materials](#)
- [D143 Test Methods for Small Clear Specimens of Timber](#)
- [D905 Test Method for Strength Properties of Adhesive Bonds in Shear by Compression Loading](#)
- [D1554 Terminology Relating to Wood-Base Fiber and Particle Panel Materials](#)
- [D2395 Test Methods for Specific Gravity of Wood and Wood-Based Materials](#)
- [D2915 Practice for Evaluating Allowable Properties for Grades of Structural Lumber](#)
- [D3043 Test Methods for Structural Panels in Flexure](#)
- [D3501 Test Methods for Wood-Based Structural Panels in Compression](#)
- [D4442 Test Methods for Direct Moisture Content Measurement of Wood and Wood-Base Materials](#)
- [E4 Practices for Force Verification of Testing Machines](#)
- [E691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method](#)

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

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:

² For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

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

3.3 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

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

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

4. Apparatus

4.1 *Testing Machine*—For strength and fastener holding tests, any standard testing machine (see **Note 1**) capable of applying and measuring the load with an error not to exceed ±1.0 % shall be used as provided in Practices **E4**.

NOTE 1—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.

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 (see **Note 2**). In the evaluation of a panel material, specimens for test should be obtained from a representative number of panels. In properties reflecting differences due to the machine direction of the panel, specimens from each panel shall be selected both with the long dimension parallel to the long dimension of the panel, and with the long dimension perpendicular to the long dimension of the panel.

NOTE 2—Guidance on statistical sampling is provided in Practice **D2915**.

6. Moisture Content and Conditioning Requirements

6.1 The physical and mechanical properties of building panels depend on the moisture content at time of test.

6.2 The moisture conditioning selection for each test procedure within this standard depends upon the purpose of the particular tests under consideration. All specimens within each test sample shall be conditioned as required to meet the specific test objectives.

6.3 The following moisture conditioning regimens are commonly employed with the test procedures of this standard:

6.3.1 *Dry “As Received”*—Specimens to be tested “as received” shall be tested without supplemental conditioning to alter the moisture content.

6.3.2 *Dry “Conditioned”*—Specimens to be tested air-dry shall be conditioned to a constant weight and moisture content in a conditioning chamber maintained at a relative humidity of $65 \pm 5\%$ and a temperature of $68 \pm 6^\circ\text{F}$ ($20 \pm 3^\circ\text{C}$) (See **Note 3**).

NOTE 3—This conditioning regime represents a common standard for wood and wood-based materials.

6.3.3 *Water Soaked*—Specimens to be tested in the soaked condition shall be submerged in water at $68 \pm 2^\circ\text{F}$ ($20 \pm 1^\circ\text{C}$) for 24-h (see **Note 4**) before the test and shall be tested within 30 minutes upon removal from the water.

NOTE 4—When it is desired to obtain the effect of complete saturation, the specimens shall be soaked for a longer period.

6.3.4 *Accelerated Aging*—Accelerated aging cycles shall be completed per Section 7 of this standard.

6.3.5 *Other*—Other conditioning methods that are designed to meet the test objectives may be employed provided that they are clearly described in the test report.

6.4 Specimens shall be subjected to the conditioning regimens of section 6.3 after they have been cut to the final dimensional sizes required for the test procedures within this standard.

6.5 When water soaked conditioning (section 6.3.3), accelerated aging conditioning (section 6.3.4) or other conditioning method is employed to simulate an application moisture exposure:

6.5.1 The sample weights and dimensions shall be recorded before and after conditioning. Any computed stresses shall be based upon the pre-conditioned dimensions.

6.5.2 A matched set of material shall be tested in the dry (section 6.3.1 or 6.3.2) condition to estimate the relative strength loss due to the moisture cycle. The condition selected for the matched set shall be based upon the test objectives.

6.6 For all testing within this standard, the moisture conditioning method selected and resulting test sample moisture contents shall be reported.

7. Accelerated Aging

7.1 Scope and Significance

7.1.1 The accelerated aging test shall be used to obtain a measure of the inherent ability of a material to withstand severe exposure conditions and maintain its mechanical and physical properties. The cycling exposure to which the material shall be subjected is a simulated condition developed to evaluate how a material will stand up under aging conditions. All of the tests listed in this standard may not be required for any specific investigation or specification. Static bending (Section 9), nail-holding (Sections 13 to 15) and water absorption and thickness swelling (Section 23) 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 the case, appropriate specimens shall be prepared and subjected to the six cycles of accelerated aging before the property is evaluated.

7.2 Test Specimens

7.2.1 The test specimens shall be cut to size for testing as specified in the pertinent sections of this standard before being subjected to the cyclic exposure listed in section 7.3. When tests involving fasteners are made, the fasteners shall be driven prior to the aging exposure. Corrosion-resistant fasteners shall be used because extractives or other materials present will corrode ordinary steel fasteners.

7.3 Accelerated Aging Cycles

7.3.1 Subject each specimen to six complete cycles of accelerated aging. If the cycle is to be broken, as for a weekend, the break shall be made during the freezing portion of the cycle. Each cycle shall consist of the following:

7.3.2 Immersion in water at $120 \pm 3^\circ\text{F}$ ($49 \pm 2^\circ\text{C}$) for 1 h,

7.3.3 Exposure to steam and water vapor at $200 \pm 5^\circ\text{F}$ ($93 \pm 3^\circ\text{C}$) for 3 h,

7.3.4 Freezing at $10 \pm 5^\circ\text{F}$ ($-12 \pm 3^\circ\text{C}$) for 20 h,

7.3.5 Heating at $210 \pm 3^\circ\text{F}$ ($99 \pm 2^\circ\text{C}$) in dry air for 3 h,

7.3.6 Exposure again to steam and water vapor at $200 \pm 5^\circ\text{F}$ ($93 \pm 3^\circ\text{C}$) for 3 h, and

7.3.7 Heating in dry air at $210 \pm 3^\circ\text{F}$ ($99 \pm 2^\circ\text{C}$) for 18 h.

7.3.8 After the completion of the six-cycle accelerated aging the specimens shall be conditioned at a temperature of $68 \pm 6^\circ\text{F}$ ($20 \pm 3^\circ\text{C}$) and a relative humidity of $65 \pm 2\%$ for at least 48 h before testing.

7.4 Handling and Support of Specimens During Exposure

7.4.1 The specimens shall be supported vertically in racks during accelerated aging. One example is shown in Fig. 1. Specimens shall fit in the racks loosely with at least 1-in. (25 mm) separation between specimens so as to freely permit

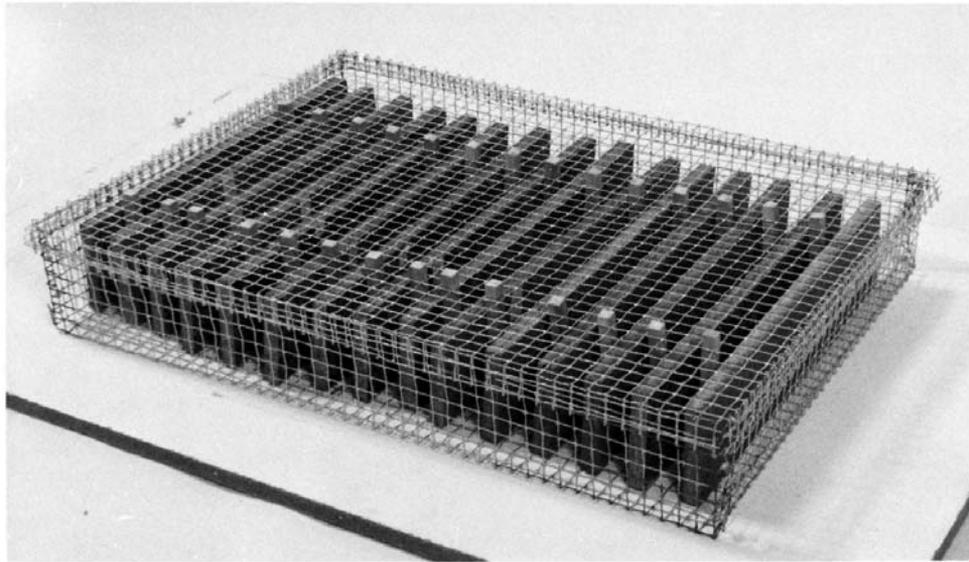


FIG. 1 Specimens Supported Vertically in Rack

swelling both parallel and perpendicular to the plane of the panel of the specimen. 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.

7.5 Apparatus

7.5.1 Tank and Controls for Soaking and Steaming:

7.5.1.1 *Tank or Vat*—A tank or vat, such as shown in Fig. 2, shall be used to conduct the exposures listed in 7.3.2, 7.3.3, and 7.3.6 of the accelerated aging test. A unit of the size shown is 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:

7.5.1.2 Corrosion-resistant container, because of extractives developed during these cycles and present in wood-base materials,

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

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

7.5.1.5 A loose-fitting cover that will permit some steam to escape during steam and water vapor phase.

7.5.1.6 Supports shall be provided in the bottom of the tank to keep the specimens from direct contact with the water.

7.5.1.7 The tank may be insulated or uninsulated; but if insulated, the cover is to be left open during the steaming portion of the cycle. Heat loss during the soaking exposure (7.3.2) 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 (7.3.3 and 7.3.6) 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.

7.5.2 *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. 3. In this instance, an air-operated dry kiln controller provides the temperature control required for either the soaking exposure (7.3.2) or the exposure to steam and water vapor (7.3.3 and 7.3.6). In operation for the soaking exposure (7.3.2) 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 (49°C) 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 the exposures of 7.3.3 and 7.3.6, the controller is set for 200°F (93°C) so steam is automatically metered to maintain that temperature. Valve 2 is adjusted so that cycles of steam “on” are long with respect to steam “off.” This system requires a supply of compressed air.

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

7.5.3 *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.

7.6 Inspection of Material During Cyclic Exposure

7.6.1 The test specimens shall be frequently inspected during the accelerated aging exposure for any signs of delamination or other disintegration. If there is any apparent damage to the material, it shall be described in the report, as well as the cycle exposure in which the damage became apparent.

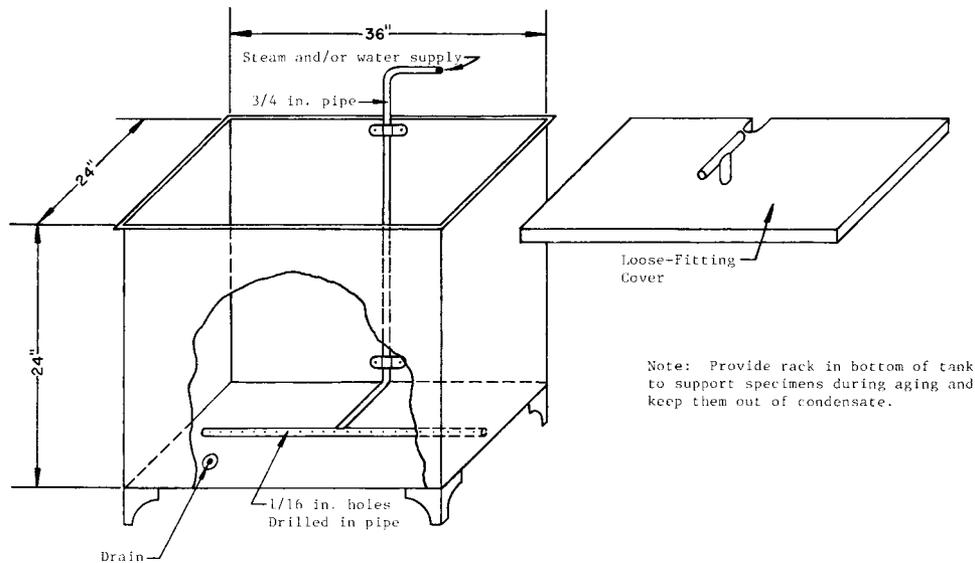


FIG. 2 Sketch of Stainless Steel Tank for Accelerated Aging Small Specimens

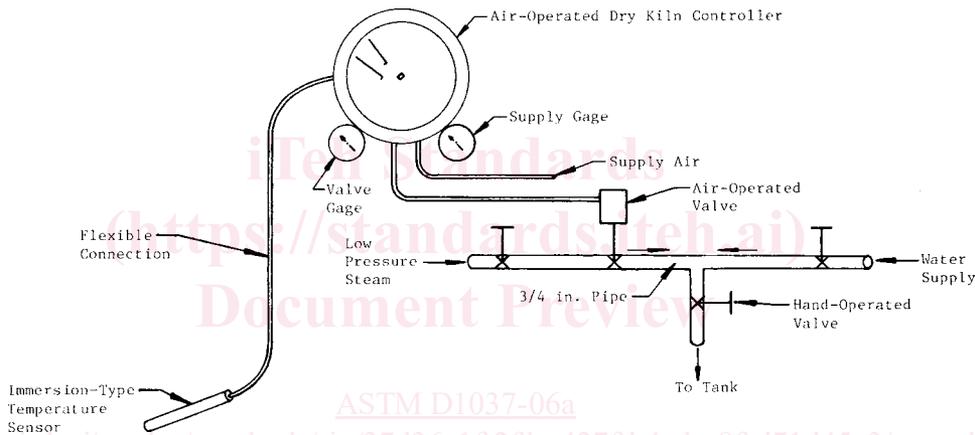


FIG. 3 Diagram of Air-Operated Controller for 120°F (49°C) Soaking and 200°F (93°C) Spraying

7.7 Comparisons and Report

7.7.1 Tests for the appropriate properties shall be conducted after the final conditioning period (7.3.8) and the results shall be compared 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.

8. Size, Physical Properties and Appearance of Panels

8.1 Size of Finished Panels

8.1.1 When measurements of finished panels are required, the width and length of each finished panel shall be obtained by measuring the width and length at each end and at mid-length to an accuracy of ±0.3 % or 1/16 in. (2 mm), whichever is smaller.

8.2 Variation in Thickness

8.2.1 For the determination of variations in thickness, specimens at least 6-in. (152-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 0.001 in. (0.025 mm).

8.3 Specific Gravity

8.3.1 When specific gravity of the finished panel is required, specific gravity shall be tested in accordance with Test Methods D2395 Method A from a panel specimen with a minimum surface area of 9 in.² (58 cm²).

8.4 Moisture Content

8.4.1 The moisture content shall be measured in accordance with Test Methods D4442 Method B from a panel specimen with a minimum surface area of 9 in.² (58 cm²). See Note 5.

NOTE 5—The moisture content may be determined based upon the “as-tested” and “oven-dry” mass of specimens tested using one of the test procedures listed within this standard.

8.5 Surface Finish

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

9. Static Bending

9.1 Scope

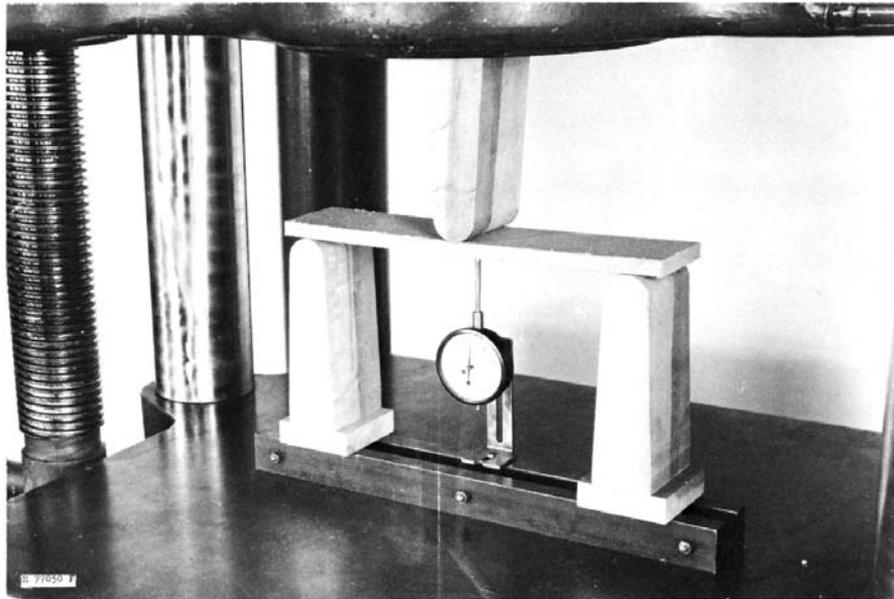


FIG. 4 Static Bending Test Assembly

9.1.1 Static bending tests shall be made to determine the flexural properties, such as modulus of rupture and apparent modulus of elasticity. When required, the stress at proportional limit and work-to-maximum load can be determined. To evaluate directional properties, an equal number of specimens shall be tested with their long-axis parallel and perpendicular to the long-axis of the panel.

9.2 Test Specimen

9.2.1 Each test specimen shall be $3 \pm \frac{1}{32}$ in. (76 ± 1 mm) in width if the nominal thickness is greater than $\frac{1}{4}$ in. (6 mm), and $2 \pm \frac{1}{32}$ in. (51 ± 1 mm) in width if the nominal thickness is $\frac{1}{4}$ in. or less (see Note 6). The length of each specimen shall be 2 in. (51 mm) plus 24 times the nominal thickness (see Notes 7 and 8). The width and length, of each specimen shall be measured to an accuracy of ± 0.3 %. The thickness of each specimen shall be measured to an accuracy of 0.001 in. (0.025 mm).

NOTE 6—Based on industry practice, OSB is typically tested with a width of 4.5 in. (114 mm) in accordance with Test Methods D3043 Method D.

NOTE 7—In cutting specimens to meet the length requirements of 2 in. (51 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 panel under test should be used for determining the specimen length.

NOTE 8—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.

9.3 Span and Supports

9.3.1 The span for each test shall be 24 times the nominal thickness (depth) of the specimen (see Note 9), measured to an accuracy of $\pm \frac{1}{16}$ in. (2 mm). 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 bearing plates that are permitted to tilt and roll as the specimen deflects. When rounded supports, such as those shown in Fig. 4, are used, the radius of the rounded portion shall be at least $1\frac{1}{2}$ times the thickness of the material being tested. If the material under test deviates from a plane, laterally adjustable supports shall be provided (see Note 10).

NOTE 9—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 10—Laterally adjustable supports may be necessary for the specimens tested in the soaked condition because of warping or twisting that may occur due to soaking. Details of laterally adjustable supports may be found in Fig. 1 of Test Methods D3043.

9.4 Procedure

9.4.1 The specimens shall be loaded at the center of span with the load applied to the top surface of the specimen, as the product will be installed. If the product can be installed in either direction then equal number of specimens shall be tested face-up and face-down. Testing shall maintain a uniform loading rate through a rounded loading block as shown in Fig. 4. The bearing blocks shall be at least 3 in. (76 mm) in width. The radius of the rounded portion of the loading block shall be approximately equal to $1\frac{1}{2}$ times the thickness of the specimen.

9.4.2 For each specimen, the character and the sequence of the failure shall be noted, whether or not the initial failure was in compression or tension. See Note 11.

NOTE 11—Photographs of typical failures will be helpful.

9.5 Speed of Testing

9.5.1 The load shall be applied continuously throughout the test at a uniform rate of motion of the movable crosshead of the testing machine calculated in accordance with Eq 1. See Notes

12-14. The crosshead speed, adjusted for thickness, shall not vary by more than $\pm 50\%$ from that specified for a given test. The speed of testing shall be recorded on the data sheet.

$$N = \frac{zL^2}{6d} \quad (1)$$

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 12—The crosshead 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 13—Based on Eq 1, the calculated rate of head descent is:

0.12 in./min (3 mm/min)	for 1/4 in. (6 mm) thickness,
0.24 in./min (6 mm/min)	for 1/2 in. (12 mm) thickness,
0.36 in./min (9 mm/min)	for 3/4 in. (19 mm) thickness,
0.48 in./min (12 mm/min)	for 1 in. (25 mm) thickness.

NOTE 14—If a faster test speed is desired for Quality Assurance purposes, the principles of section 8.5 of Test Methods D3043 should be followed.

9.6 Load-Deflection Measurements

9.6.1 The load-deflection data shall be obtained until the maximum load is achieved. The deflection of the specimen shall be measured at the mid-span point by means of an indicating dial gage or linear voltage differential transducer (LVDT) or linear potentiometer (see Note 15) 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. 4. 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. 5 shows a typical load-deflection curve.

NOTE 15—The range of standard 0.001-in. (0.02-mm) indicating dial is 1 in. (25 mm). The total deflection of some thicknesses of panels 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.

9.7 Calculation and Report

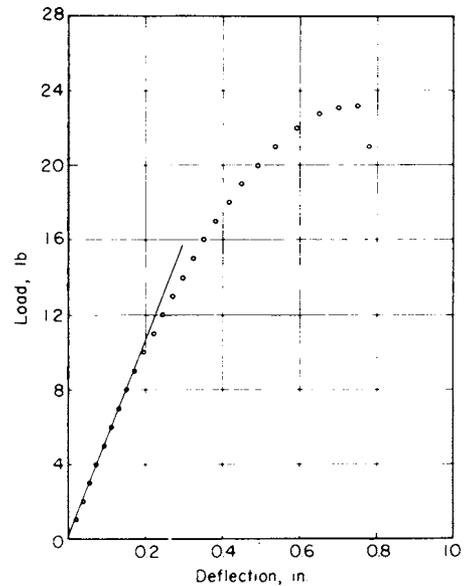
9.7.1 The modulus of rupture, apparent modulus of elasticity, and when required, stress at proportional limit and work-to-maximum load shall be calculated for each specimen in accordance with the following equations:

$$R_b = \frac{3P_{max}L}{2bd^2} \quad (2)$$

$$E = \frac{L^3 \Delta P}{4bd^3 \Delta y} \quad (3)$$

$$S_{pl} = \frac{3P_{pl}L}{2bd^2} \quad (4)$$

$$W_{ml} = \frac{a}{bdL} \quad (5)$$



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
kg	1.8	3.6	5.4	7.2	9
				24	28
				10.8	12.6

FIG. 5 Typical Load-Deflection Curve for Static Bending Test

where:

- a = area under load-deflection curve to maximum load, lbf-in. (N-m),
- b = width of specimen measured in dry condition, in. (mm),
- d = thickness (depth) of specimen measured in dry condition, in. (mm),
- E = apparent modulus of elasticity, psi (kPa),
- L = length of span, in. (mm),
- $\Delta P/\Delta y$ = slope of the straight line portion of the load-deflection curve (see Note 16), lbf/in. (N/mm),
- P_{max} = maximum load, lbf (N),
- P_{pl} = load at proportional limit (see Note 17), lbf (N),
- R_b = modulus of rupture, psi (kPa),
- S_{pl} = stress at proportional limit, psi (kPa), and
- W_{ml} = work to maximum load, lbf-in./in.³ (N-mm/mm³).

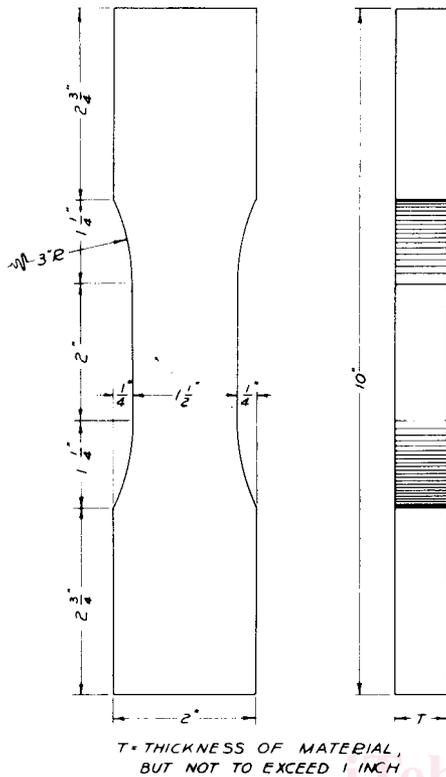
NOTE 16—A linear regression of the load-deflection curve between 10% and 40% of P_{max} generally produces satisfactory results for ($\Delta P/\Delta y$).

NOTE 17— P_{pl} can be determined at the point on the load-deflection curve where the slope of the tangent deviates from the slope of the straight line ($\Delta P/\Delta y$) more than a given threshold value. The threshold value can be established based on statistical and graphical methods and experience. The value of 10% normally gives a good estimate but it depends on the calculation procedure, the type and condition of product.

9.7.2 The report shall include the orientation of the face of the panel during the test (face-up or face down), the description of failure, and the calculated properties for each specimen. For modulus of elasticity and stress at proportional limit the parameters used in calculations shall be reported.

10. Tension Parallel to Surface

10.1 Scope



T = THICKNESS OF MATERIAL, BUT NOT TO EXCEED 1 INCH

Metric Equivalents

in.	1/4	1	1 1/4	1 1/2	2	2 3/4	3	10
mm	6	25.4	32	38	51	70	76	254

FIG. 6 Detail of Specimen for Tension Test Parallel to Surface

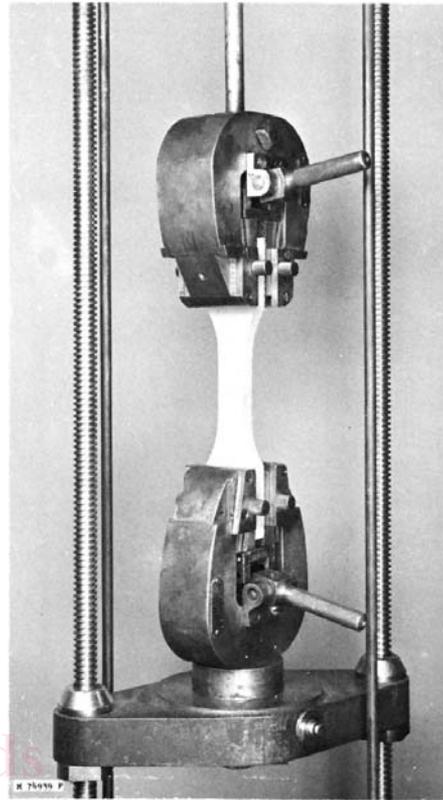


FIG. 7 Assembly for Tension Test Parallel to Surface

10.1.1 The tension test parallel to the surface shall be made to determine the tensile strength in the plane of the panel. When required, the axial stiffness or modulus of elasticity can be determined. To evaluate directional properties, an equal number of specimens shall be tested with their long-axis parallel and perpendicular to the long-axis of the panel. See Note 18.

NOTE 18—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 inch in thickness, the material be sawn to 1/2 in. (12 mm) thickness. Test values obtained from resawn specimens may be only approximate, because strengths of material near the surface may vary from the remainder.

10.2 Test Specimen

10.2.1 Each test specimen shall be prepared as shown in Fig. 6. The reduced section shall be cut to the size shown with a band saw. The minimum width of each specimen at the reduced section shall be measured to an accuracy of ±0.3 %. The corresponding thickness shall be measured to an accuracy of 0.001 in. (0.025 mm).

10.3 Procedure

10.3.1 The specimen shall be loaded using self-aligning, self-tightening grips that distribute the force evenly over the grip surface and do not allow slipping, with gripping surfaces at least 2-in. (50-mm) square, to transmit the load from the testing machine to the specimen. Fig. 7 shows a typical assembly for the tension test of building panels.

10.3.2 For each specimen, the character and location of the failure shall be noted.

10.4 Speed of Testing

10.4.1 The load shall be applied continuously throughout the test at a uniform rate of motion of the movable crosshead of the testing machine of 0.15 in./min (4 mm/min) ± 50 %. See Note 12.

10.5 Load-Deformation Measurements

10.5.1 When required, obtain load-deformation curves. To measure the deformation, attach an extensometer or other suitable device over the central portion of the specimen. Points of attachment (gage points) shall be within the reduced section of the specimen. Read the deformation to the nearest 0.0001 in. (0.0025 mm). Choose increments of loading so that not less than 12 readings are obtained before proportional limit.

10.6 Calculation and Report

10.6.1 The maximum tensile stress and, when required, modulus of elasticity shall be calculated for each specimen in accordance with the following equations:

$$R_t = \frac{P_{max}}{bd} \tag{6}$$

$$E_t = \frac{lg \Delta P}{bd \Delta y} \tag{7}$$

where:

b = width of the reduced cross-section of the specimen measured in dry condition, in. (mm),

- d = thickness of the specimen measured in dry condition, in. (mm),
 E_t = modulus of elasticity in tension parallel to the surface of the panel, psi (MPa),
 l_g = gage length or distance between the gage points of extensometer, in. (mm),
 $\Delta P/\Delta y$ = slope of the straight line portion of the load-deformation curve (see **Note 16**), lbf/in. (N/mm),
 P_{max} = maximum load, lbf (N), and
 R_t = maximum tensile stress, psi (MPa).

10.6.2 The report shall include the calculated properties and the description of failure for each specimen. If the failure is within ½ in. (12 mm) of either grip, the test value shall be discarded.

11. Tension Perpendicular to Surface (Internal Bond)

11.1 Scope

11.1.1 The tension test perpendicular to the surface shall be made to determine cohesion of the panel in the direction perpendicular to the plane of the panel.

11.2 Test Specimen

11.2.1 The test specimen shall be 2-in. (50-mm) square and the thickness shall be that of the finished panel. The dimensions of the specimen shall be measured to an accuracy of $\pm 0.3\%$.

11.3 Procedure

11.3.1 Loading blocks of steel or aluminum alloy 2-in. (50-mm) square and 1 in. (25 mm) in thickness shall be effectively bonded with a suitable adhesive (see **Note 19**) to the square faces of the specimen. The resulting bond shall exceed the cohesive strength of the material perpendicular to the plane of the panel. **Fig. 8** shows details of the specimen and loading fixtures. 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 19—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. Other resins such as hot melt cements or water based adhesives may be used provided the conditions of gluing do not significantly alter the moisture condition of the specimen. The pressure required to bond the blocks to the specimen will depend on the density of the panel and the adhesive used, and should not damage the specimen.

11.3.2 Engage the loading fixtures, such as are shown in **Fig. 8**, 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.

11.4 Speed of Testing

11.4.1 The load shall be applied 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. It is not intended that the testing machine speed shall be varied for small differences in panel thickness such as an embossed surface, but rather that it shall not vary more than $\pm 50\%$ from that specified herein. See **Note 12**.

11.5 Calculation and Report

11.5.1 The internal bond of each specimen shall be calculated in accordance with the following equation:

$$IB = \frac{P_{max}}{ab} \quad (8)$$

where:

- a = width of the specimen measured in dry condition, in. (mm),
 b = length of the specimen measured in dry condition, in. (mm),
 P_{max} = maximum load, lbf (N), and
 IB = internal bond strength, psi (MPa).

11.5.2 The report shall include the location of the plane of failure such as the face/layer or the upper, middle or lower third. If any of the specimens fails due to failure of the adhesive bond to the loading block, the test result of that specimen shall be discarded.

12. Compression Parallel to Surface

12.1 Scope

12.1.1 The compression test parallel to the surface shall be made to determine the compressive strength in the plane of the panel. When required, the axial stiffness or modulus of elasticity and stress at proportional limit can be determined. To evaluate directional properties, an equal number of specimens shall be tested with their long-axis parallel and perpendicular to the long-axis of the panel.

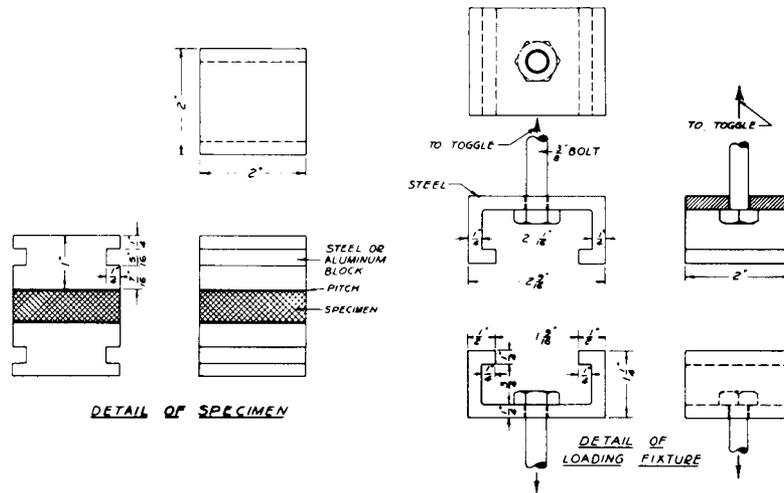
12.2 Test Methods

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

12.2.2 *Method A (Laminated Specimen)*, shall be used for materials ¾ 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. Laminate two thicknesses when the material is ½ in. (13 mm) or greater thickness. Use three thicknesses for materials with thickness less than ½ in. (13 mm). The nominal size of the specimen shall be 1 by 4 in. (25 by 102 mm) by the thickness as laminated. The 4-in. (102-mm) long dimension shall be parallel to the applied force.

12.2.3 *Method B (Lateral Support)*, shall be used for materials less than ¾ in. (10 mm) in thickness, particularly when modulus of elasticity and stress at proportional limit are required. Specimens shall be 1 by 4 in. (25 by 102 mm) by the thickness as manufactured and evaluations made in a suitable lateral support device. The 4-in. (102-mm) long dimension shall be parallel to the applied force.

12.2.4 *Method C (Short Column)*, shall be used when maximum crushing strength only is required or where the thickness of the panel material is 1 in. (25 mm) 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. (25 mm), the thickness shall be as manufactured, and the length (height



Metric Equivalents

in.	1/4	5/16	3/8	7/16	1/2	3/4	1 1/4	1 1/16	2	2 1/16	2 9/16
mm	6	7.5	9	10.5	12.7	19	31.7	39	51	52	64.3

FIG. 8 Detail of Specimen and Loading Fixture for Tension Test Perpendicular to Surface

as tested) shall be four times the thickness. When the material being evaluated is more than 1 in. (25 mm) in thickness, the width shall be equal to the nominal thickness and the length (height as loaded) shall be four times the nominal thickness.

12.3 Test Specimen

12.3.1 The test specimens shall be carefully sawn with surfaces smooth and planes at right angles to the faces of the panels as manufactured. For the laminated specimens (Method A), pieces of panel 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 (see Note 20). Bonding pressures shall not exceed 50 psi (345 kPa). Test specimens shall be sawn from the laminated pieces after at least 8 h of curing of the resin at room temperature. The thickness shall be measured to at least the nearest 0.001 in. (0.025 mm). The width shall be measured to an accuracy of ±0.3 %.

NOTE 20—An adhesive that contains water or other swelling agent might produce internal stresses adjacent to the glue lines.

12.4 Method of Loading

12.4.1 The specimen shall be loaded through a spherical loading block, preferably of the suspended self-aligning type. The specimen shall be centered carefully in the testing machine in a vertical plane as shown in Fig. 9 for unsupported 4-in. (102-mm) specimen and in Fig. 10 for laterally supported pack device. See Note 21.

NOTE 21—The lateral support device is detailed in Fig. 2 of Test Methods D3501.

12.5 Speed of Testing

12.5.1 The load shall be applied continuously throughout the test at a uniform rate of motion of the movable crosshead of the testing machine of 0.005 in./in. (mm/mm) of length per min. Speed of test therefore for the 4-in. specimen of Methods A and B shall be 0.02 in./min (0.5 mm/min.). See Note 12. The

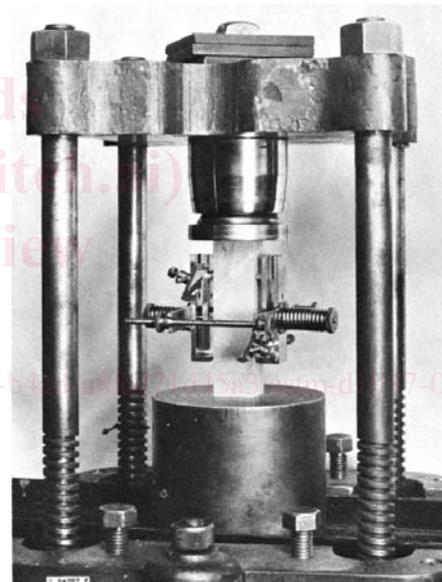


FIG. 9 Assembly for Compression Parallel to Surface Test of Unsupported Specimen

crosshead speed shall not vary by more than ±50 % from that specified for a given test.

12.6 Load-Deformation Measurements

12.6.1 When required, obtain load-deformation curves for the full duration of each test. Fig. 9 shows a Lamb's Roller Compressometer on an unsupported specimen. Fig. 10 shows a Marten's Mirror Compressometer on a laterally supported specimen. Use these or equally accurate instruments for measuring deformation. Attach compressometer over the central portion of the length; points of attachment (gage points) shall be at least 1 in. (25 mm) from the ends of specimen. Choose increments in loading so that not less than 12 readings are obtained before proportional limit. Read deformation to the nearest 0.0001 in. (0.0025 mm).

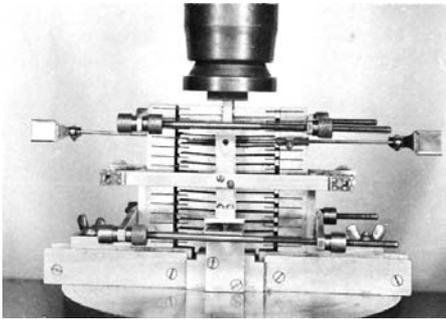


FIG. 10 Assembly for Compression Parallel to Surface Test of a Laterally Supported Specimen

12.7 Calculation and Report

12.7.1 The compressive strength and, when required, modulus of elasticity and stress at proportional limit shall be calculated in accordance with the following equations:

$$R_c = \frac{P_{max}}{bd} \quad (9)$$

$$E = \frac{l_g \Delta P}{bd \Delta y} \quad (10)$$

$$S_{pl} = \frac{P_{pl}}{bd} \quad (11)$$

where:

b = width of specimen measured in dry condition, in. (mm),

d = thickness of specimen measured in dry condition, in. (mm),

E_t = modulus of elasticity in tension parallel to the surface of the panel, psi (MPa),

l_g = distance between the gage points of compressometer, in. (mm),

$\Delta P/\Delta y$ = slope of the straight line portion of the load-deformation curve (see Note 16), lbf/in. (N/mm),

P_{max} = maximum load, lbf (N),

P_{pl} = load at proportional limit (see Note 17), lbf (N),

R_c = compressive strength, psi (MPa), and

S_{pl} = stress at proportional limit, psi (MPa).

12.7.2 The report shall indicate which method (laminated specimen, lateral support, or short column) was used and the calculated properties for each specimen. The type of failure of each specimen shall be determined and included in the report.

13. Lateral Nail Resistance

13.1 Scope

13.1.1 Nail-holding tests shall be made to measure the panel's resistance to lateral movement of a nail through a panel (Note 22). To evaluate directional properties, an equal number of specimens shall be tested with the movement of the nail parallel and perpendicular to the long-axis of the panel.

NOTE 22—If this test is performed on some panels, the nail may bend and pull out of the stirrup. If this happens, the maximum load does not characterize the true resistance of the panel and this result should be noted. In these situations, the nail may be replaced with a hardened steel dowel of an equivalent diameter to avoid nail bending and determine the true resistance of the panel.

NOTE 23—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 panels can only be compared exactly if the thicknesses are equal.

13.2 Test Specimen

13.2.1 The test specimen shall be 3 in. (76 mm) in width and of convenient length with the thickness of the panel as manufactured. The test fastener (see Note 24) shall be driven at the right angle to the face of the panel so that about an equal length of nail projects from each face. The fastener shall be centered on the width and located $\frac{1}{4}$, $\frac{3}{8}$, $\frac{1}{2}$, or $\frac{3}{4}$ in. (6, 10, 13, or 19 mm) from one end (see Note 25). Tests shall be made for all four edge distances for each material tested. The thickness of each specimen shall be measured to an accuracy of $\pm 0.3\%$.

NOTE 24—A smooth shank six penny (6d) common wire nail with a 0.113 in. (2.90 mm) diameter shank is commonly used for this test. Other fasteners, including hardened steel dowels of equivalent diameter may be selected to meet the test objectives. It is advisable to measure the variation in diameter of the fastener.

NOTE 25—The edge distance is the distance from the center of the fastener to the edge of the panel.

13.3 Specimens Tested in the Dry Condition

13.3.1 When the tests are conducted with dry “as received” (section 6.3.1) or dry “conditioned” (section 6.3.2) materials, the tests shall be made immediately after the fasteners have been driven.

13.4 Specimens Moisture Cycled Before Test

13.4.1 When a water soaked (section 6.3.3), accelerated aging (section 6.3.4) or other conditioning method is employed to simulate an application moisture exposure with this test method, the fastener shall be driven prior to the moisture cycle.

13.5 Method of Loading

13.5.1 Clamp the end of the specimen opposite to the end with the test fastener in a position parallel to the movement of the testing machine. A grip such as the type used for tension tests parallel to the plane of the panel is suitable. Engage the fastener 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. 11. The stirrup and connections are detailed in Fig. 12. See Note 26.

NOTE 26—For other types of fasteners, such as staples, modification of the stirrup may be necessary.

13.6 Speed of Testing

13.6.1 The specimen shall be loaded 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) $\pm 50\%$. See Note 12.

13.7 Test Data and Report

13.7.1 The load required to move the fastener 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. See Note 27. The type and diameter of fastener used shall be described in the report.

NOTE 27—In some cases it is useful to report the resistance in lbf/in. (N/mm) dividing the maximum load by the depth of fastener penetration; for example, when different panel thicknesses are compared.