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CANCELLATION
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CANADIAN GOVERNMENT SPECIFICATIONS BOARD

Provisional Schedule
of

METHODS OF SAMPLING AND TESTING FIBREBOARD

CGSB Provisional Schedule 9-GP-17P dated October 1953 is hereby
cancelled and superseded by 11-GP-0 dated 22 January 1960.

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OCTOBER 1953

CANADIAN GOVERNMENT SPECIFICATIONS BOARD

9-GP-17P

PROVISIONAL
SCHEDULE
OF
METHODS OF SAMPLING
AND TESTING FIBREBOARD

SAMPLING

Samples shall be taken at random so as to give a fair representation of the entire shipment. A sample of sufficient size for all the required tests shall be taken from each of four boards* from any carload or from each of one-half of one percent of the number of boards in less than carload shipments. The samples shall not be cut into smaller pieces before delivery to the testing laboratory. When a shipment consists of more than one car or carrier load, a set of samples shall be taken from each car or carrier. In cases of dispute the sampling shall be undertaken by a representative of the testing laboratory in the presence of representatives of both the manufacturer and purchaser.

- * Note: Based on boards not less than 4' x 8' in dimension. When board sizes are less than 4' x 8', the number of boards sampled shall be increased proportionately. When a carload contains more than one size of the board, separate sampling shall be carried out for each size represented.

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CONDITIONING SPECIMENS FOR TEST

The strength properties of building boards depend on the moisture content at time of test. Therefore, material for test shall be conditioned to approximately constant weight and moisture content before test. Except where otherwise stated, a temperature of $70^{\circ}\text{F} \pm 1^{\circ}\text{F}$ with a relative humidity of $65 \pm 1\frac{1}{2}$ percent is to be used for conditioning specimens for test in the dry state. This condition corresponds to the standards for wood and wood-base materials. If there is any departure from this recommended condition, it shall be so stated in the report.

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THICKNESS

Thickness measurements shall be carried out by micrometer on specimens at least 8 inches square, conditioned according to Method 2.1. The contacting surfaces of the micrometer shall be flat and shall have a diameter of 1/4 inch. Pressure on the contacting surfaces shall not be greater than 5 psi, and care shall be taken that the sample is not deformed when the thickness measurements are taken.

The thickness of each specimen shall be measured by an instrument reading to an accuracy of ± 0.001 in., at 5 points - near each corner and near the centre. The average of these five measurements is taken as the thickness of the specimen.

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THERMAL CONDUCTIVITY *

Scope - For practical purposes, the method is limited to materials having conductivities not in excess of 5.0 B.t.u. per inch per square foot per hour per degree F. It is further limited to thermal conductivity tests between the extreme temperatures of -50°F. and upward of over 212°F., or between mean temperatures above approximately 0°F.

Because of the requirements prescribed as to conditions under which tests shall be made, the conductivity coefficients obtained will not necessarily be the values pertaining under all service conditions. For example, the coefficients are obtained on dry specimens, whereas in service such a condition will seldom be realized.

The method is intended for homogeneous materials in the form of flat slabs. For satisfactory results, the principles governing the size construction, and use of apparatus for the test described in this method should be followed. If the results are to be reported as having been obtained by this method, then all the requirements prescribed in this method shall be met.

It is impossible in a method of this type to establish details of construction and procedure covering all contingencies so that it can be followed by a nontechnical person; consequently, technical knowledge on the part of those using the method concerning the theory of heat flow, temperature measurement, and general testing practices is necessary.

Apparatus

(a) It is not intended in this method to include detailed requirements for construction or operation of any particular guarded hot plate for determining conductivity values. Any plate conforming to the limitations prescribed in the following paragraphs will be satisfactory.

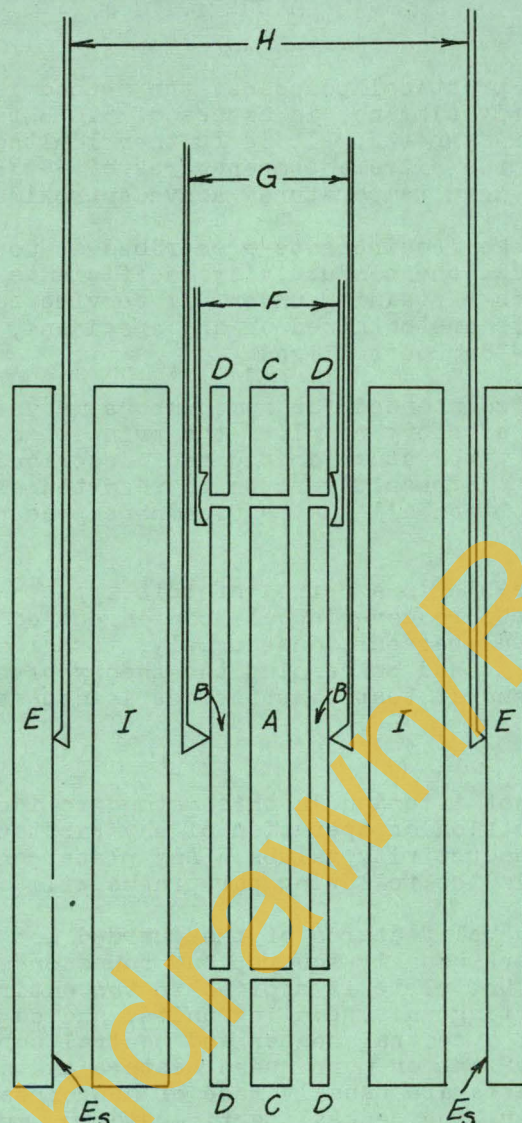
(b) The general features of the guarded hot plate are shown in Fig. 1. The plates are usually square, but round ones are occasionally used. The term guarded hot plate is applied to the entire assembled apparatus, including heating unit, cooling units, and edge insulation. The heating unit consists of a central heater and central surface plates. The guard section consists of one or more guard heaters and the guard surface plates. The surface plates are usually made of noncorrosive, highly conducting metal; however, the central section and the guard section of the heating unit may each be molded of alundum cement or other materials of low conductivity, so as to include both the heater and the surface plates. (see note).

Note: The surface of the heater plates and cooling plates should be finished to as nearly a true plane as possible and should be checked periodically. Variations over 90% of the surface should be nil, with maximum variations on any portion of the surface not exceeding 0.005 inch.

(c) In the design of the guarded hot plate for testing materials for use in any particular temperature or conductivity range, due consideration shall be given to the materials used in the construction of the hot plate with respect to their performance at the temperature to which the plate will be subjected. Consideration shall also be given to the rate at which heat must be supplied and absorbed by the heater and the coolers in designing the electrical resistance and current-carrying capacity of the heating element. Otherwise, no particular variations need be made in the design of hot plates for use in determining the conductivity of materials between such widely differing mean temperatures as 0 and 1200°F.

* Based on Method T1000m-50 of the Technical Association of the Pulp and Paper Industry.

FIGURE 1 - GENERAL FEATURES OF THE GUARDED HOT PLATE



(A - Central Heater) Central Section
 Heating(B - Central Surface Plates) of Heating Unit
 Unit (C - Guard Heater) Guard Section of
 (D - Guard Surface Plates) Heating Unit
 E - Cooling Units
 E_s - Cooling Unit
 Surface Plate
 F - Differential
 Thermocouples
 G - Heating Unit Surface Thermocouples. H.- Cooling Unit Surface Thermo-
 I - Test Specimens. couples

(d) Heating units having metallic surfaces shall have a definite separation or air gap not greater than 1/8 inch between the measuring area of the central surface plate and the guard surface plates. These plates shall have highly emissive surfaces. The separation between the main central section and the guard section of the heating units shall not exceed 3/4 inch, and this separation is allowable only if the spacing bars on either side of the plate separation are of heavy copper in order to distribute the heat on the surface plates. In all other cases the separation shall not exceed 1/8 inch. The test area shall be calculated from the centre of one separation to the centre of the other separation across the central surface of the plate.

Note: In putting a new heating unit into operation for the first time, take care to insure that the two faces of the heating unit maintain essentially equal temperature throughout the temperature range of the apparatus.

(e) The heater of the guarded hot plate shall be provided with at least two thermocouples on each face of the central surface plate, and at least two thermocouples on each face of the guard surface plate, located at opposite edges. These may be read either individually to indicate any temperature difference that may exist between the central and guard surface plates or they may be connected differentially, and thus indicate such temperature difference directly. The differential method of connecting the centre-to-guard thermocouples is preferable as it is more sensitive. When the thermocouples are to be read individually, they may be peened, welded, or soldered to the surface plates. When they are to be connected differentially, they must be electrically insulated from each other. This may be done by installing the thermocouples in shallow grooves in the surface plates with an electrically insulating cement, so that the bead of each thermocouple is in the plane of the plate's surface.

(f) The cooling units shall have the same surface dimensions as the heating unit. They may consist of metallic plates cooled by a fluid, electrically heated plates maintained at temperatures below that of the heating unit, or thermal insulation applied to the cool surface of the test specimen, depending upon the mean temperature desired.

(g) The edge insulation may be of any convenient loose-fill or blanket-type insulating material to reduce edge losses from the heater plate, test specimens, and cooling plates. It shall be of such thickness that the resistance to edge losses shall be at least twice and preferably three or more times the thermal resistance of the specimen in the direction of normal heat flow.

(h) For structural insulating board, the surface temperatures of the test specimen shall be determined by means of thermocouples mounted in the hot and cold plates. Both the hot and cold plates shall be supplied with at least two thermocouples mounted in the surfaces of the plates as described above in paragraph (e). Preferably, the thermocouples should be insulated from the plates and read differentially between the hot and cold plates, the surface temperatures of the specimen being taken as those of the plate surfaces in contact with it.

(i) The thermocouples mounted in the surfaces of the plates shall be made of wire not larger than No. 23 A.W.G.

(j) A potentiometer having a sensitivity of 5 microvolts or less shall be used for all measurements of electromotive force.

(k) Means shall be provided for measuring the distance between surfaces of the hot and cold plates when the specimens are in place.

Test Specimens - The samples shall be selected so as to provide two specimens as nearly identical as possible and of such size as to cover completely the heating unit. They shall be of sufficient thickness to give a true average representation of the material. Since excessive thickness of the specimens and consequent excessive dimensions of the area of the guarded hot plate unnecessarily complicate the manipulation of the test, the specimens should not be too thick. Their thickness shall be great enough to allow a sufficiently accurate measurement of this dimension to calculate the thermal conductivity. The relationship between the maximum thickness of

the test specimen and the minimum dimensions of the guarded hot plate shall be as follows:

Maximum thickness of test specimen, inches	Minimum linear surface dimensions of guarded hot plate (square or round), inches	
	Central section of test area of heating unit	Guard section or guard area of heating unit
1	4	1 $\frac{1}{2}$
1 $\frac{1}{2}$	8	2 $\frac{1}{2}$
2	12	3
(4)	12	(6)

The samples from which the test specimens are to be taken shall be weighed and measured for thickness and other dimensions in the as-received condition and immediately after drying to constant weight at $215 \pm 2^\circ\text{F}$. (If this degree of heat is objectionable, they may be dried in a desiccator at 120 to 140°F). The as-received and the dry weights of the sample and the necessary physical measurements for calculation of the density before and after drying shall be recorded.

The linear dimensions of each sample shall be measured to the closest 1/64 inch on each surface. Each measurement shall be not greater than 4 inches apart. The thickness shall be measured by means of a non-compressing micrometer or thickness gage having contacting surfaces not greater than 5/8 inch in diameter. Measurements shall be made not more than 4 inches apart and not less than 1 inch from the outer edges around the complete periphery of each sample.

Each sample, dried and conditioned as described above shall be cut into two specimens of correct size depending on the average thickness of the sample and linear dimensions of central and guard sections of the heating units of the guarded hot plate in use. The specimens shall be cut without compression, molding, or other distortion of thickness.

The thickness of the specimens as tested shall be as close as possible to the thickness of the original dry samples from which obtained. Specimens of greater thickness than allowable shall be reduced to the maximum allowable thickness by minimum sandpapering or other suitable means.

The surfaces of each test specimen shall be as plane as possible for intimate contact between specimens and plates. Specimens having individual thickness measurements greater than ± 0.010 inch of the average specimen thickness, due to irregular or nonparallel surfaces, shall be corrected to within ± 0.010 inch tolerance by minimum sandpapering or other suitable means. The average thickness of each specimen cut from a single sample and to be used as a pair in testing of that sample shall not differ by more than 0.010 inch.

Pairs of specimens from each sample, prepared in accordance with the above procedure, shall be redried to constant weight and immediately placed in a desiccator at room temperature in order to avoid moisture regain prior to testing.

Procedure - As the specimens are removed from the desiccator for testing, each specimen shall be carefully reweighed to the nearest 0.01 gram and remeasured for thickness as described above, then placed immediately in the guarded hot plate. The assembly of the plates shall be carefully controlled so that the distance between surfaces of the hot and cold plates is exactly equal to the average thickness of the test specimens. This is a necessary precaution for structural insulating board in order to avoid errors due to improper contact of the surfaces and to compression or reduction in thickness.

At least three and preferably four determinations shall be made on each specimen at a mean temperature of $75 \pm 5^\circ\text{F}$. The temperature difference across the specimen shall be at least 40°F . The atmosphere surrounding the test equipment shall have a dew-point temperature not higher than the coolest part of any surface or material in, or forming a part of, the test apparatus.

Since thermocouples mounted in the surfaces are used to determine surface temperature, the thickness of the test specimen is taken as the distance between the surfaces of the hot and cold plates. When the specimen is in place in the apparatus, the plates shall be adjusted with clamps or pressure so that this thickness shall be within ± 0.010 inch of the average specimen thickness prior to testing. Upon completion of the test, the specimens shall be redried to constant weight and cooled to room temperature in a desiccator prior to retesting at the next mean temperature.

The heating element of the central heater shall be supplied with electrical energy regulated to give the desired temperature gradient through the test specimen and held constant within $\pm 0.25\%$, means being provided to measure this energy. Automatic regulation is recommended; where this is not available, the energy input shall be regulated by manual adjustment. Then the rate of input to the guard ring shall be adjusted so that the temperature difference between the centre and guard surface plates during the 5-hour test observation period shall be not greater than $\pm 0.1\%$ of the average temperature drop between the two halves of the specimen, as determined by the differential or surface thermocouples.

The cooling units shall be adjusted so that the temperature drops through the two test specimens do not differ by more than 1.0%.

After steady state has been reached, the test shall be continued making the necessary observations to determine temperature difference, centre-to-guard thermal balance, and heat input, until successive observations made at intervals of not more than 1 hour, over a period of 5 hours, give thermal conductivity values that are constant to within 1.0%. Upon completion of the test, the specimen shall be re-weighed and the weight recorded.

Calculations - The density of the dried sample, the original moisture content and the moisture regain during the test shall be calculated as follows:

Let

D = density after drying (pounds per cubic foot or grams per cubic centimeter)

M = moisture in sample as-received (pounds per cubic foot or grams per cubic centimeter)

I = moisture regain (pound per cubic foot or grams per cubic centimeter)

E = weight of sample after drying (pounds or grams)

B = volume of sample after drying (cubic feet or cubic centimeters)

H = weight of sample as received (pounds or grams)

F = weight of sample prior to test (pounds or grams)

G = weight of specimen after test (pounds or grams)

then

$$D = \frac{E}{B}$$

$$M = \frac{H - E}{B}$$

and

$$I = (G - F) \times \frac{E}{F} \times \frac{1}{B} = \frac{E(G - F)}{BF}$$

The thermal conductivity shall be calculated according to the following equation:

$$k = \frac{QL}{AT(t_1 - t_2)} = \frac{qL}{A(t_1 - t_2)}$$

where: k = thermal conductivity
 Q = total quantity of heat transferred
 T = time
 q = Q/T = rate of heat flow
 A = actual area normal to the path of heat flow (flat surface)
 t_1 = temperature of the hot surface
 t_2 = temperature of the cold surface
 L = length of path of heat flow (thickness)

Report - The complete report of the results of each test shall include:

1. Name and any other identification of the material.
2. Average thickness of each pair of specimens tested.
3. Dry weight of sample before test.
4. Density of dried sample (before test)
5. Moisture in sample as-received.
6. Moisture regain during test of each pair of specimens
7. Mean temperature range
8. Maximum hot-surface temperature
9. Minimum cold-surface temperature
10. Mean temperature of each test.
11. Heat input in B.t.u. per sq. ft. per hour of each test.
12. Thermal conductivity of each test.

CANADIAN GOVERNMENT SPECIFICATIONS BOARD

Ottawa, Canada.

TRANSVERSE BREAKING STRENGTH AND DEFLECTION

Scope - Static bending tests shall be made on conditioned (Method 2.1) specimens and/or soaked specimens, as specified. Four test specimens shall be prepared from each sample board with the long dimension parallel and four specimens with the long dimension at right angles to the long dimension of the board, in order to evaluate directional properties.

Test Specimen - Each test specimen shall be 3 inches in width if the nominal thickness is greater than $\frac{1}{4}$ inch and 2 inches in width if the nominal thickness is $\frac{1}{4}$ inch or less. The depth (thickness) shall be the thickness of the material. The length of each specimen shall be 2 inches plus 24 times the depth (Note 1). The width and length of each specimen shall be measured to the nearest 0.01 inch and the thickness measured to the nearest 0.001 inch.

Note 1: 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.

Specimens Soaked before Test - The specimens to be tested in the soaked condition shall be submerged in water at room temperature for 24 hours before test and shall be tested immediately upon removal from the water.

Span and Supports - The span for each test shall be 24 times the nominal thickness (depth) of the specimen (Note 2). 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 (Fig. 1) or shall be knife edges provided with rollers and plates under the specimen at these points. When rounded supports 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 (Note 3), laterally-adjustable supports shall be provided.

Note 2: - A constant span-to depth ratio is required to allow an accurate comparison of test values for materials of different thickness.

Note 3: 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.

Method of Loading - The specimens shall be loaded at the centre of the span with the load applied at a uniform rate through a rounded bearing block. The bearing block shall

be at least 3 inches in width and shall have a length (in the direction of the 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 $1\frac{1}{2}$ times the thickness of the specimen. One-half of the specimens shall have the load applied to the finished face and the remaining half shall have the load applied to the unfinished face.

Speed of Testing - The load shall be applied continuously throughout the test at a uniform rate of motion of the movable crosshead of the testing machine as calculated by the following formula (Notes 4 and 5):

$$N = \frac{zL^2}{6d}$$

where:

N = rate of motion of moving head in inches per minute
z = unit rate of fibre strain in inches per inch of outer fibre length per minute = 0.005 for hardpressed fibreboard.
= 0.02 for insulating fibreboard.
L = span in inches
d = depth (thickness) of specimen in inches.

Note 4: The testing machine speed used shall not vary by more than plus or minus 50 percent from that specified for a given test. The testing machine speed used shall be recorded on the data sheet. 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 5: The calculated rates of head descent for hardpressed and insulating fibreboard, respectively are therefore 0.12 (0.48) inch per min. for specimens $\frac{1}{4}$ inch in thickness, 0.24 (0.96) inch per min. for specimens $\frac{1}{2}$ inch in thickness, 0.36 (1.44) inch per min. for specimens $\frac{3}{4}$ inch in thickness, and 0.48 (1.92) inch per min. for specimens 1 inch in thickness.

Load-Deflection Curves - Load-deflection curves shall be obtained to maximum load for all bending tests. The deflection of the centre of the specimen shall be obtained during loading by measuring the deflection of the bottom of the specimen at the centre by means of an indicating dial (Note 6) attached to the base of the testing jig, with the dial plunger in contact with the bottom of the specimen at the centre. The load and deflection at first failure and at maximum load shall be noted. Readings of deflection shall be taken at least to the nearest 0.005 inch. Fig. 2 shows a typical load-deflection curve.

Note 6: The range of standard 0.001 inch indicating dials is 1 inch. The total deflection of some thicknesses and types of fibreboard may exceed 1 inch at failure. When this happens, either a 2-inch total-travel indicating dial or a suitable 2 to 1 reducing lever in conjunction with a 1-in-travel dial should be used so that maximum deflections can be obtained.

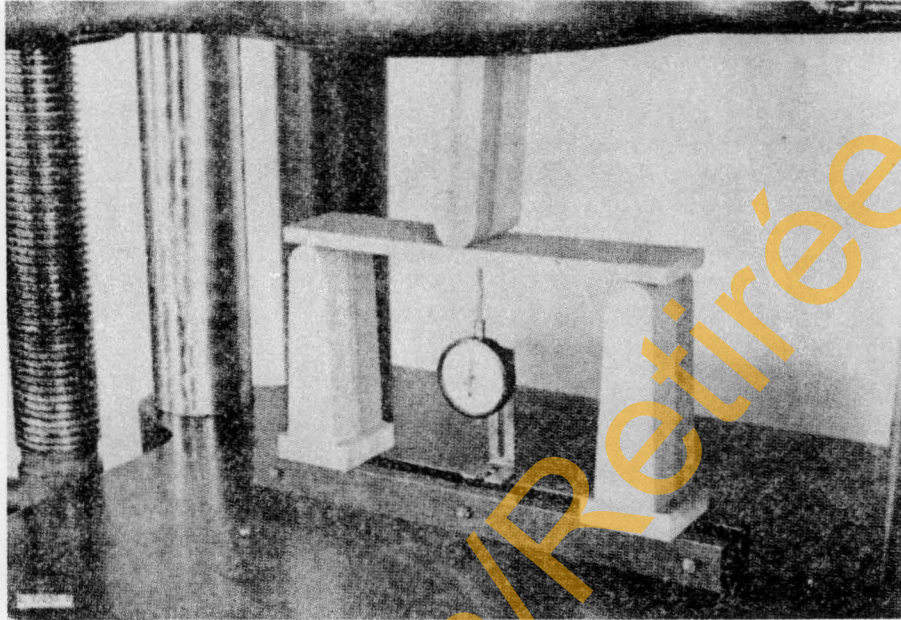


FIG. 1 - STATIC BENDING TEST ASSEMBLY

Description of Failure - The character of the failure shall be noted.

Moisture Content and Density - The moisture content and density of each specimen shall be determined in accordance with Method 12.1.

Calculations and Report - Results shall be reported in terms of modulus of rupture and apparent modulus of elasticity or in terms of load and deflection; as required by the specification being followed. The strength average of machine direction and across machine direction shall be reported, together with the average of both directions. Unless otherwise specified, the average of both directions shall be used to determine compliance with the specification requirement.

- (a) When modulus of rupture is to be reported, it shall be calculated for each specimen by the following formula, and the value determined shall be included in the report:

$$R = \frac{3PL_2}{2bd^2}$$

where:

P = actual maximum load in pounds

L = length of span in inches

b = width of specimen in inches

d = measured thickness (depth) of specimen in inches, taken at centre of specimen.

R = modulus of rupture in pounds per square inch.

- (b) When stiffness (apparent modulus of elasticity) is to be reported it shall be calculated for each specimen by the following formula, and the values determined shall be included in the report:

$$E = \frac{P_1 L^3}{4bd^3 y_1}$$

where:

P₁ = actual load in lb. at which deflection y₁ is taken (load in lb. within the proportional limit).

y₁ = centre deflection at load P₁, in inches.

L = length of span in inches

b = width of specimen in inches

d = measured thickness (depth) of specimen in inches taken at centre of specimen

E = stiffness (apparent modulus of elasticity) in pounds per square inch.

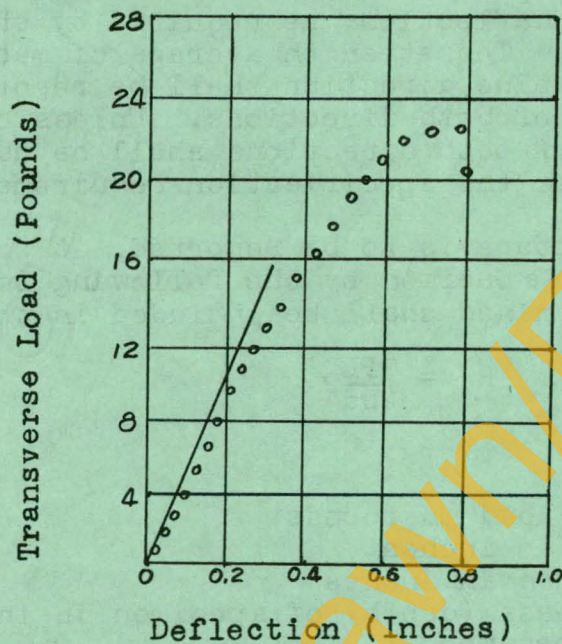


Fig. 2 - Typical Load-Deflection
Curve for Static Bending Test

TENSILE STRENGTH PARALLEL TO SURFACE

Scope - The test of tensile strength parallel to the surface shall be made on specimens conditioned according to Method 2.1 and/or on the soaked specimens. Four specimens from the long dimension of the board and four at right angles to the long dimension shall be tested.

Note 1: This test may be applied to material 1 inch or less in thickness. When the material exceeds 1 inch in thickness crushing at the grips during test is likely to affect adversely the test values obtained. It is recommended that for material greater than 1 inch in thickness, the material be resawed to 1/2-inch thickness. Test values obtained from resawed specimens may be only approximate because strengths of material near the surface may vary from the remainder.

Test Specimen - Each test specimen shall be prepared as shown in Fig. 1. The reduced section shall be cut to the size shown, with a band saw. A sharp saw shall be used to insure a smooth surface in the centre section. The thickness of the board in the net section shall be carefully measured to the nearest 0.001 inch. The minimum width of the reduced section shall be determined to at least the nearest 0.01 inch. These two dimensions shall be used to determine the net cross-sectional area for determining maximum stress.

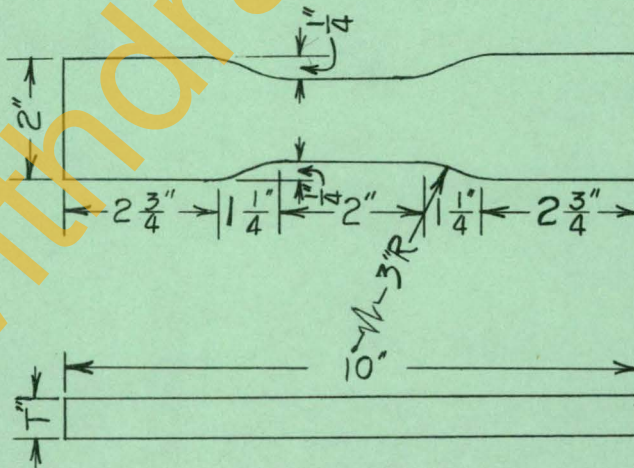


Fig. 1

Specimens Soaked before Test - Specimens to be tested in the soaked condition shall be prepared in accordance with the third paragraph of Method 5.1.

Method of Loading - Self-aligning, self-tightening grips with serrated gripping surfaces at least 2 inches in width and at least 2 inches in length shall be used to transmit the load from the testing machine to the specimen. The specimen shall be placed in the grips so that approximately 1/2 inch of the wide parallel portion lies between the grips and the tapering portion.

Speed of Testing - 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 inch per minute.

Calculation and Report - Tensile strength values shall be obtained in psi. by dividing the breaking load by the cross-section area of the specimen at the place of failure. If the failure is within $\frac{1}{8}$ inch of either grip, the test value shall be disregarded. The report shall include the average tensile strength value of all the specimens tested and the location and description of the failures.

Moisture Content and Density - The moisture content and density of each specimen shall be determined as specified in Method 12.1.

TENSILE STRENGTH PERPENDICULAR TO SURFACE

Scope - The test of tensile strength perpendicular to surface shall be made on conditioned (Method 2.1) specimens when the strength of the material under test is less than the bond between the material and the blocks that are used to apply the load.

Note 1: This test is included because of the increased use of fibreboards of lower density as core stock for constructions where wood, plywood, or other more dense materials are glued to the faces of the fibreboard. Tests in the soaked condition shall be made if the material is to be used under severe weather conditions.

Test Specimens - The test specimens shall be 2 inches square by the thickness of the finished board. Loading blocks of steel or aluminum alloy 2 inches square and 1 inch in thickness shall be bonded with a steam-refined roofing pitch or other suitable adhesive (Note 2) to the 2-inch square faces of the specimen as shown in Fig. 1. Cross-sectional dimensions of the specimens shall be measured to the nearest 0.01 inch. Four specimens shall be tested.

Note 2: A suitable technique for applying the blocks to the specimen is as follows:

- (1) The specimen is cut to size with a sharp, circular woodworking saw.
- (2) The pitch is melted, with care being taken that it will not ignite.
- (3) The metal blocks are heated to approximately the same temperature as the pitch.
- (4) The surface of the block that is to be in contact with the specimen is coated with pitch.
- (5) The blocks and specimen are assembled in a jig, and a pressure of approximately 20 psi. is applied until the blocks have cooled. If this pressure is likely to damage appreciably boards of low density, lower pressure may be used. The residual heat in the blocks keeps the pitch fluid until a satisfactory bond with a good squeeze-out is effected. The load blocks may be cleaned after test and reused.

Procedure - Steel hooks or eyelets threaded into the loading blocks as illustrated in Fig. 1 are attached to the heads of the testing machine. The specimen shall be stressed 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 fibreboard as possible, and the centre of load shall pass through the centre of the specimen.

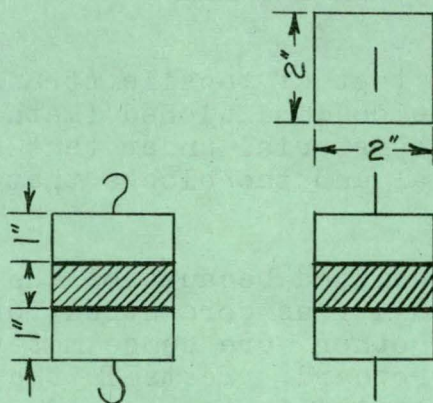


Fig. 1 - DETAIL OF SPECIMEN FOR TENSION
TEST PERPENDICULAR TO SURFACE

Speed of Testing - The load shall be applied continuously throughout the test at a uniform rate of motion of the movable crosshead of the testing machine of 0.035 inch per minute.

Test Data and Report - Maximum loads shall be obtained from which the stress at failure shall be calculated. Strength values shall be calculated in pounds per square inch, for which the measured dimensions of the specimen shall be used. The average of results obtained from the four specimens shall be reported, together with the location of the line of failure.

Moisture Content and Density - The moisture content and density of each specimen shall be determined as specified in Method 2.1.

CANADIAN GOVERNMENT SPECIFICATIONS BOARD

Ottawa, Canada

WATER ABSORPTION AND THICKNESS EXPANSION

Scope - This test determines the percentage water absorption and the percentage thickness expansion of conditioned fibreboard specimens after immersion in distilled water at $70 \pm 1^\circ\text{F}$ for the specified time.

Test Specimen - The test specimen should be 12 x 12 inches in area with all four edges trimmed square. When a board is less than 12 inches in one or both dimensions, the largest piece with edges trimmed square approaching 12 x 12 inches should be used as the specimen, but this shall be at least 6 x 6 inches.

Weight and Volume of Test Specimen - After conditioning in accordance with Method 2.1, the specimen shall be weighed, the length and width shall be measured to the nearest 0.01 inch, and the specimen shall be calipered to the nearest 0.001 inch at five points - near each corner and near the centre. The calipered points shall be marked on hard pressed fibreboard having a density equal to or greater than 50 lb. per cubic foot. The volume of the specimen shall be computed from these measurements.

Submersion in Water - The specimen shall be submerged horizontally with top surface of specimen one inch under surface of distilled water maintained at a temperature of $70^\circ \pm 1^\circ\text{F}$. After a 2-hour submersion (Note), the specimen shall be placed on end to drain for 10 minutes at the end of which time excess surface water shall be removed by hand with a blotting paper or paper towel and the specimen shall be immediately weighed and calipered.

Note: - The 2-hour immersion period is for fibreboard of density less than 50 lb. per cubic foot, (conditioned volume, oven-dry weight basis). For hard fibreboard with density equal to or greater than 50 lbs. per cubic foot, the immersion time shall be 24 hours, and the specimen shall be recalipered at the marked points in order to allow calculation of thickness expansion.

Calculation and Report - The volume of water absorbed shall be calculated from the increase in weight of the specimen during submersion, and the water absorption shall be expressed as a percentage of volume based on the volume after conditioning. The specific gravity of the water shall be assumed to be 1.00 for this purpose.

The increase in thickness shall be calculated from the average increase in caliper of the specimen during submersion and this thickness expansion shall be expressed as a percentage of the average caliper of the specimen after conditioning.

CANADIAN GOVERNMENT SPECIFICATIONS BOARD

Ottawa, Canada.

WATER PERMEABILITY

Scope - This test determines the length of time required for water to penetrate conditioned fibreboard specimens that are floated on water at $70^{\circ}\text{F} \pm 1^{\circ}\text{F}$.

Test Specimens - The test specimens should be 4 x 4 inches in area, conditioned according to Method 2.1. A total of eight specimens shall be tested.

Procedure - An indicator consisting of a mixture of eosin dye, powdered sugar and starch is sprinkled on one surface of each of the specimens, a glass cover is sealed over the indicator, and the edges of the specimen are sealed with wax to prevent water from reaching the indicator except by penetration through the board and to prevent evaporation of the transuded moisture. The specimens are then floated on water at $70^{\circ} \pm 1^{\circ}\text{F}$, and the time of transudation of water in an amount sufficient to develop color in the indicator is a measure of the permeability. Four specimens are tested with the finished face next to the water and four specimens with the unfinished face next to the water.

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WATER VAPOR PERMEABILITY *

Scope - This method is for the determination of the water vapor permeability of paper and paperboard under normal atmospheric conditions. It is considered generally suitable also for other sheet materials up to 1 inch in thickness.

Water vapor permeability is defined for this test as the weight of water transmitted per unit of time, per unit area, measured while the specimen separates an atmosphere below 5% R.H. on one face from the standard atmosphere of 50% R.H. and 73°F. on the other face.

Apparatus -

1. Test Dish - An open-mouthed cup or dish of such size and shape that it can be accommodated readily on the pan of an analytical balance. The opening should be as large as practical, an area of at least 50 sq. cm. being preferred. (This is equivalent to a circle about 3 inches in diameter). The test dish shall be of such design that a wax seal can be made which will be impervious to leakage of water vapor and will define clearly the test area. Suitable designs for the dish with supporting rings and flanges are shown in Fig. 1. Other modifications of these designs may be made, provided the principle of preventing edge leakage by means of a complete wax seal is retained.
2. Template - for use in defining the test area and effecting the wax seal, consisting of a circular metal disk 1/8 to 1/4 inch thick, with the edge bevelled to an angle of about 45°. The diameter of the bottom (smaller) face of the template shall be approximately equal to and not greater than the diameter of the effective opening of the cell in contact with the specimen. A small hole through the template to admit air will facilitate its removal after the wax solidifies.
3. Analytical Balance - of 200-gram capacity, sensitive to 0.001 gram, with pans large enough to hold the test dishes.
4. Testing Room or Cabinet - provided with conditioned air maintained at $50 \pm 2\%$ R.H. and 73°F. and continuously circulated at a rate not less than 500 feet per minute over the exposed surfaces of the specimens under test.
5. Grill or Reticulated Rack - in the testing room or cabinet, capable of supporting the inverted specimens in a manner to afford free access of the circulating air.

Materials -

- A. Desiccant - with a powerful affinity for water vapor and a high drying efficiency - that is, a low vapor pressure after absorbing a large amount of water. The desiccant shall remain essentially unchanged in physical condition and exert, while dry, no chemical or physical action other than dehydration effects on membrane materials with which it is in contact. The desiccant used shall be in the form of small lumps, free from fines that will pass a No. 30 sieve.
- B. Wax - for sealing the specimen to the testing dish, made of a mixture of 60% of a suitable refined amorphous wax, and 40% of refined crystalline paraffin wax. The wax mixture shall cling tenaciously to the surfaces and not be brittle at ordinary room temperatures. Care shall be taken to prevent contamination of the wax with particles of calcium chloride

* Based on Method T448m.49 of the Technical Association of the Pulp and Paper Industry

or other salts when it is salvaged for reuse. The wax in use should be replaced frequently with new material. The stability and water absorption of the mixture shall be tested by applying a heavy film of the wax, about 10 square inches in area to a glass plate, exposing to an atmosphere of high temperature and humidity (about 90% R.H. at 100°F.) and determining whether any significant change occurs in the weight of the film and plate - for example, more than 0.001 gram per day. Ordinary rosin as used in beeswax-resin mixtures will absorb a significant amount of moisture when so tested.

C. Petrolatum - for application to the bevelled edge of the template in order to facilitate removal of the latter after sealing the test sheet to the dish. The petroleum jelly commonly used by druggists is suitable.

Test Specimen - Eight specimens shall be tested, four with the finished face next to the desiccant and the remaining four with the unfinished face next to the desiccant during the test. Samples shall be conditioned before test, according to Method 2.1.

Procedure - Sufficient desiccant shall be placed inside the dish to cover the sheet area evenly to a depth of about 15 mm.

For paperboards over 1/8 inch thick, the method of preparing the test assembly is as follows: To prevent edge leakage, the edge of the test specimen shall be rotated in molten wax of such fluidity that it does not penetrate into the edge more than 1/16 inch, the specimen shall be suspended inside the dish to a distance of about half the thickness of the specimen and molten wax shall be run around the edge of the specimen to seal it to the dish.

The assembly shall be weighed on the analytical balance to 0.001 gram. The dish shall be placed on the rack inside the testing room or cabinet in an inverted position so that the layer of desiccant is in direct contact and evenly distributed over the inner face of the test sheet and so that free access of the conditioned circulating air is provided on the exposed surface of the sheet.

Successive weighings of the assembly shall be made at suitable intervals until a constant rate of gain is attained. For papers that are relatively pervious, the weighings should be frequent enough to complete the test before drops of liquid agglomerate are formed in the desiccant or caking of the desiccant occurs. These conditions will be indicated by a drift from the constant rate of gain, after which no readings should be recorded. The weight gain against time shall be plotted. The slope of the resulting curve will furnish a measure of the water vapor permeability.

Report - The water vapor permeability shall be reported to two significant figures as grains per square foot per hour per vapor pressure differential of 1 inch of mercury (perms). The calculation should be made for the period of constant weight increase.

Example - Conditions for test

Temperature	72°F
External Relative Humidity	50%
Internal Relative Humidity	0%
(Desiccant - anhydrous calcium chloride)	
Vapor Pressure Differential	0.415 inch
Area under Test	0.05 square foot
Weight Increase (at constant rate)	450 grains
Time of Increase (at constant rate)	240 hours

$$\text{Water Vapor Permeability} = \frac{450 \text{ grains}}{0.05 \text{ sq.ft.}} \times \frac{1}{240 \text{ hours}} \times \frac{1}{0.415 \text{ inches}} = 0.090 \text{ perms.}$$

The average, maximum and minimum values for each test made shall be reported.

The report shall state what desiccant was used.

Reproducibility of Results - Duplicate determinations should check within 10%, depending largely on the variation in the sheet material itself. As the spread between very permeable sheets and those having a low permeability is at least a thousand fold, a precision of 10% on a given material will establish it quite definitely in the scale of permeabilities normally encountered in sheet materials.

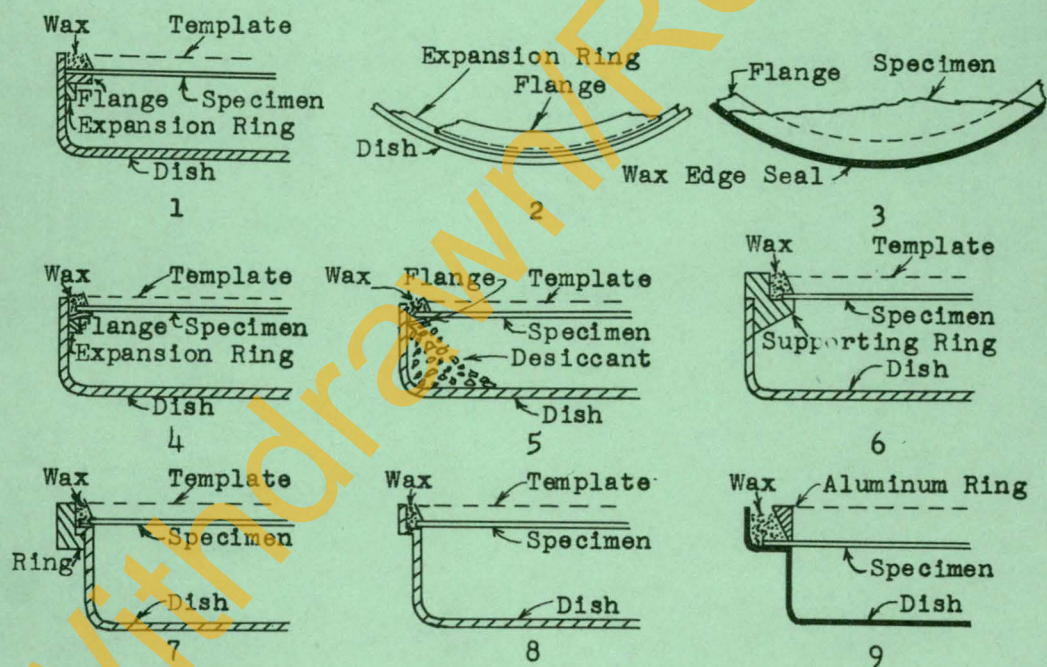


FIGURE 1 - TEST DISHES

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LINEAR EXPANSION

Scope - Tests for linear expansion measure the dimensional stability of fibreboard with change in moisture content.

Test Specimen - Where possible, the test specimen shall be 3 inches in width and 10 inches in length, the sides and ends of the specimen being square and smoothly cut. Four specimens shall be provided, two cut parallel with and two cut perpendicular to the long dimension of each sample board. When the board does not permit obtaining a 10-inch specimen, the maximum length possible shall be used, but it shall be at least six inches.

Procedure - The specimens shall be conditioned for 24 hours or until practical equilibrium is obtained, at a relative humidity of 50 ± 5 percent and a temperature of $70^\circ \pm 2^\circ\text{F}$. The specimen length is measured by means of a dial comparator. Care must be exercised when measuring to hold the specimen flat and to orient it in the dial gauge comparator the same way each time a measurement is made.

The specimens shall next be conditioned for at least 24 hours or until practical equilibrium is obtained at a relative humidity of 97 ± 3 percent and a temperature of $70^\circ \pm 2^\circ\text{F}$. The length of the specimen is measured again, by means of the dial comparator. The measurement should be made in the conditioned atmosphere, or as quickly as possible after the specimen is removed therefrom.

Note: In the absence of other facilities, a convenient means of conditioning the specimens at the specified humidity conditions is to expose them in an enclosed space immediately above saturated solutions of suitable salts; sodium dichromate ($\text{Na}_2\text{Cr}_2\text{O}_7 \cdot 2\text{H}_2\text{O}$) for a relative humidity of 50 percent and potassium sulphate (K_2SO_4) for a relative humidity of 97 percent.

Calculation and Report - The linear variation with change in moisture content shall be reported as the percentage change in length of the specimen, based on the length at 50 percent relative humidity. The average of the specimens tested shall be reported for compliance with the specification requirement.

MOISTURE CONTENT AND DENSITY

Procedure - The moisture content and density at time of test shall be determined because of their relation to the strength properties. Values of density calculated from the volume and weight are satisfactory for these materials.

The specimens shall be weighed and measured immediately before test. The weighing should be done on balances accurate to 0.01 gram. The length and width shall be measured to the nearest 0.01 inch and the thickness shall be measured to the nearest 0.001 inch. When, as in the case of tension-parallel-to-surface specimens, it is impossible to measure the width of the specimen after shaping, the dimensions and weight shall be taken after conditioning and before shaping and the specimen shall then be returned to the conditioning chamber until the test is made.

After testing, if the specimen is not too large, a coupon not smaller than 3 inches long x width of specimen shall be cut from the test specimen as near to the failure as possible and weighed to the nearest 0.01 gram, then dried to constant weight in an oven at 100°C. and weighed again. If the test specimens themselves are reasonably small, the whole specimen or half a specimen may be weighed and oven-dried.

Calculation

- (a) The moisture content shall be calculated as follows:

$$M = 100 \frac{W - F}{F}$$

where:

M = moisture content in percent

W = initial weight, and

F = final weight when oven-dry.

Note: When reporting moisture content of specimens, it shall be definitely stated that it is a percentage of the oven-dry weight of the specimen.

- (b) The density shall be calculated as follows (Note)

$$\text{Density} = \frac{3.81F}{Lwt}$$

where:

F = final weight, when oven-dry, in grams

L = length of coupon in inches

w = width of coupon in inches, and

t = thickness of coupon in inches.

Note: The density as determined by this equation is based on volume at test and weight when oven-dry.

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NAIL WITHDRAWAL TEST

Scope - Nail-holding tests shall be made on nails driven through the fibreboard from face to face to measure the resistance to withdrawal in a plane normal to the face.

Test Specimen - The test specimen shall be of convenient size (at least 3 inches in width and 6 inches in length). Four specimens shall be tested. The nails shall have a diameter of approximately 0.116 inch and shall be driven through the boards at right angles to the face, leaving at least 1/2 inch of the shank portion projecting above the surface of the material (Note).

Note: 2-1/4 inch common wire nails, 2-3/4 inch or 3-inch bright box or 3-inch finishing nails may be used.

Specimens Tested in the Dry Condition - When the tests are made in the dry state, the specimens shall be conditioned according to Method 2.1 and the withdrawals shall be made immediately after the nails have been driven.

Specimens Soaked Before Test - Specimens to be tested in the soaked condition shall be prepared in accordance with the third paragraph of Method 5.1 and the nails shall be driven before the specimens are soaked.

Method of Loading - The assembly is shown in Figure 1 following. The specimen-holding fixture shall be attached to the lower platen of the testing machine. The specimen shall be inserted in the fixture with the heads of the nails up. The heads of the nails shall be engaged 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.

Speed of Testing - Load shall be applied to the specimen throughout the test by a uniform motion of the movable head of the testing machine at a rate of 0.06 inch per minute. (See Note 4, Method 5.1).

Test Data and Report - The maximum load required to withdraw the nail shall be the measure of resistance of the material to direct nail withdrawal. The average of results from the four specimens shall be reported.

Moisture Content and Density - The moisture content and density shall be determined according to the procedure in Method 12.1 and reported.

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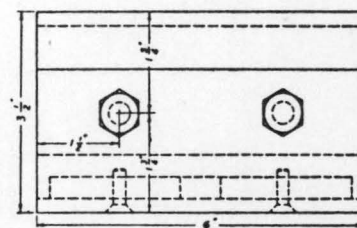
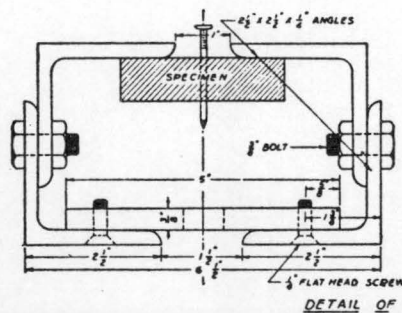
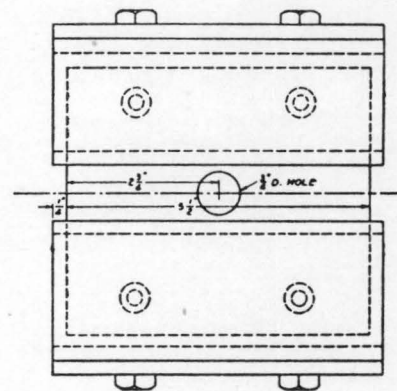
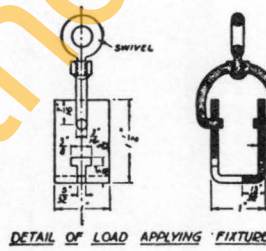
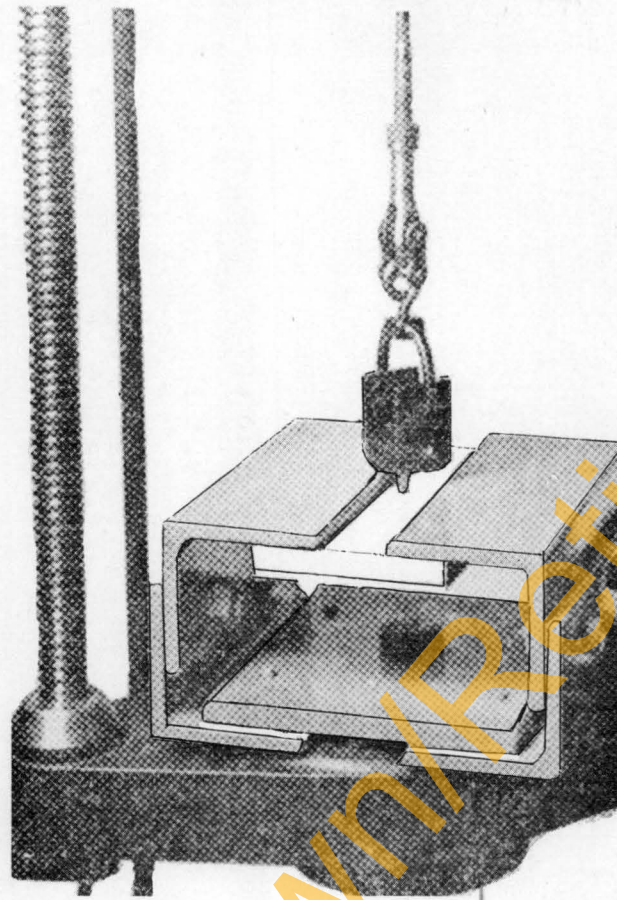


FIG. 1—Detail of Testing Equipment for Measuring the Resistance of Nails to Direct Withdrawal.

LATERAL NAIL RESISTANCE TEST

Scope - Nail holding tests shall be made to measure the resistance of a nail to lateral movement through a fibreboard. One-half of the specimens shall be selected and positioned in test so that the movement of the nail shall be parallel, and one-half so that the movement of the nail will be at right angles to the long dimension of the board, for evaluation of directional properties.

Note 1: If this test is performed on some hardboards, the nail may bend and pull out of the stirrup. If this happens, the maximum load will be 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 2: 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.

Test Specimen - Each specimen shall be 3 inches in width and of convenient length, and shall have a nail approximately 0.116 inch in diameter driven at right angles to the face of the board so that about an equal length of nail projects from each face. (Note 3) The nail shall be centred on the width and located $1/4$, $1/2$ or $3/4$ inch from one end. Four specimens shall be tested for each of the three end clearances for each material tested. Specimens shall be conditioned before test according to Method 2.1.

Note 3: 2- $1/4$ inch common wire nails or 3 inch bright box or finishing nails may be used.

Specimens Soaked before Test - Specimens to be tested in the soaked condition shall be prepared in accordance with the third paragraph of Method 5.1 and the nails shall be driven before the specimens are soaked.

Method of Loading - The end of the specimen opposite to the end with the nail shall be clamped in a position parallel to the movement of the testing machine. Grips such as are suitable for tension tests parallel to the plane of the fibreboard are suitable. The nail is engaged by the stirrup, which is in turn connected to one platen of the testing machine by a rod. A typical test assembly is shown in Figure 1 following.

Speed of Testing - 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 inch per min. (See Note 4, Method 5.1).

Test Data and Report - The load required to move the nail to the edge of the specimen shall be the measure of the lateral resistance. The average of results from the four specimens and the nature of failure shall be reported.

Moisture Content and Density - The moisture content and density shall be determined according to the procedure in Method 12.1 and reported.

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