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# Standard Methods of Testing Structural Insulating Roof Deck[1]

This standard is issued under the fixed designation D 2164; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

## INTRODUCTION

The test methods presented herein relating to structural properties were developed to measure the resistance of insulating roof deck to forces expected or possible when the product is used as roof decking, usually in exposed beam construction.

Insulating roof deck is a laminated composite of interior and weather-resistant grades of insulating board where the interior, factory-finished board provides the finished ceiling and the glued-laminated composite provides the structural deck, the base for built-up or other roofing and the thermal insulation. Vapor barriers are provided where use conditions require. While these test methods were developed specifically for measuring the deflection and strength characteristics of roof deck of insulating board, the concept is based on loads and forces applicable to any structural deck. Results of test are presented in terms usually used by architects and structural engineers.

Presented here are methods of test only. The criteria to be applied to the results of test are a matter that must be considered when these methods are used to determine limiting values for a procurement specification or for any purpose. A case in point is the accelerated aging exposure detailed in Sections 25 and 29. That exposure cycling was developed many years ago to obtain a measure of the resistance of a material to deterioration under exterior exposure conditions. It was selected for inclusion in this compilation of structural test methods for insulating roof deck, fully realizing that roof deck usually would not be subjected to a combination of exposures as severe as for materials exposed directly to the elements. It was the considered opinion, however, that the procedure would ensure adequate performance of insulating roof deck in use.

The methods presented herein are only for structural properties. For physical properties such as thermal conductivity and vapor permeability, which are important to the use of these materials, the appropriate ASTM methods for determining those properties of any engineering material are referenced and should be used. Instructions are included in these methods for specimen preparation and presentation of the results.

## 1. Scope

1.1 These methods cover determination of the following properties of structural insulating roof deck. In all structural tests the specimens are loaded as beams with the finished (ceiling) face in tension.

| | Sections |
|---|---|
| Equivalent Uniform Load | 8-12 |
| Concentrated Load | 13-16 |
| Sustained Uniform Load (Sag) | 18-20 |
| Impact Load | 21-24 |
| Resistance to Cyclic Exposure | 25-29 |
| Thermal Conductance (Test Method C 177) | 30-32 |
| Water Vapor Permeance (Test Method C 355) | 33-37 |

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

1.3 *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:*

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

Current edition approved Dec. 30, 1983. Published February 1984. Originally published as D 2164 – 63 T. Last previous edition D 2164 – 65 (1977).

C 177 Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded Hot Plate Apparatus[2]

C 355 Test Methods for Water Vapor Transmission of Thick Materials[3]

D 1037 Test Methods for Evaluating Properties of Wood-Base Fiber and Particle Panel Materials[4]

E 72 Methods for Conducting Strength Tests of Panels for Building Construction[5]

## 3. Significance and Use

3.1 Insulating roof panels need to comply with bending strength and deflection criteria found in applicable building codes. This standard establishes procedures for determining the load-carrying properties of such panels under uniform, concentrated, and impact load; and for evaluating durabilities.

3.2 The test procedures outlined consider the effects of long- and short-term load applications on roof deck samples. The procedures outlined parallel similar ASTM procedures for traditional decking systems. Test results are appropriate for the determination of conformance to establish criteria. This standard does not establish or identify performance requirements.

## 4. Descriptions of Terms Specific to This Standard

4.1 *structural insulating roof deck*—Refers to a structural insulating board product designed for use in open-beam ceiling roof construction. It is designed for applications to flat, pitched, or mono-sloped roofs for providing (*1*) the structural roof deck, (*2*) efficient insulation, and (*3*) the interior ceiling finish. The underside of the deck, which remains exposed to the room, is usually factory-finished and, in addition, may be obtained with varying degrees of acoustical treatment. The structural insulating roof deck shall be composed of multiple layers of structural insulating board, either plain or asphalt-impregnated, laminated together with a water-resistant adhesive. The composite will normally consist of approximately ½ in. (12.7 mm) of factory-finished interior-grade insulating board which is laminated to several layers of structural-grade insulating board, giving a product of nominal thicknesses of 1½, 2, or 3 in. (38, 51, 76 mm), a width of 2 ft (61 cm) and a length 8 ft (244 cm) with the long edges fabricated to form an interlocking joint when applied. Short edges are normally either interlocking or square. A vapor barrier may be present in the product, and provision may be made for sealing of joints against vapor passage under cold-weather use.

4.2 *slab*—refers to the material, normally in commercial sizes, as received.

4.3 *sample*—refers to the collection of slabs selected in accordance with Section 5.

4.4 *specimen*—refers to the test piece cut from a slab, unless otherwise specified in the test method.

## 5. Sampling

5.1 Slabs shall be selected at random so as to give a fair representation of the entire shipment. The number of slabs to be selected shall be as follows:

5.1.1 *Less-than-Carload Shipments*—Five-tenths percent of the number of slabs in shipment, but not less than three nor more than five slabs of any shipment.

5.1.2 *Carload Shipments*—Five slabs.

5.1.3 *More than One Car or Carrier Load*—Five slabs from each car or carrier load.

## 6. Test Specimens

6.1 For the strength tests, namely, equivalent uniform load, concentrated load, sustained uniform load (sag), impact load, and durability, three test specimens shall be cut from each five slab sample (two test specimens from each three slab sample) for each type of test. These specimens shall be 10 in. (254 mm) wide by 4 in. (101.6 mm) longer (Note 1) than the distance between the supports of the testing device and shall be cut with their long dimensions parallel to the long dimension of the slab. The width, length, and thickness of each specimen shall be measured to an accuracy of not less than ±0.3 %.

NOTE 1—For the 1½-in. (38-mm) nominal thickness material the total length of specimen shall be 28 in. (71 cm). For the 2-in. (51-mm) nominal thickness material the total length of specimen shall be 40 in. The total length for 3-in. (76-mm) nominal thickness material shall be 48 in. (122 cm) and the span shall be shortened from 16 times the thickness to 44 in. (111.7 cm) to permit two specimens to be cut from the 8-ft (244-cm) length of the material as manufactured.

6.2 For the thermal conductance test and the vapor permeance test, specimens shall be as prescribed in Test Method C 177, and Test Methods C 355, respectively. For each sample as defined in 4.3 there shall be two thermal conductance tests for each five-slab sample (one for a three-slab sample) and three vapor permeance tests for each five-slab sample (two for a three-slab sample).

## 7. Conditioning

7.1 *Specimens Tested for Strength*—All strength tests should be made on test specimens conditioned until practical equilibrium is obtained, not less than 24 h at a relative humidity of 50 ± 2 % and a temperature of 70 ± 5°F (21 ± 3°C). When there is any digression from this conditioning prior to test, specimens shall not be changing in moisture at the time of test, and moisture content of each specimen based on oven-dry weight shall be determined and reported as described in Test Methods D 1037.

7.2 Conditions for thermal conductance and vapor permeance shall be as described in Test Method C 177 and the Desiccant Method of Test Methods C 355, respectively.

# EQUIVALENT UNIFORM LOAD

## 8. Scope

8.1 This method covers measurement of the deflection and strength characteristics of the roof deck when loaded as a beam as it will normally be loaded in use. Spans required for the different thicknesses of deck are those usually recommended in actual construction.

[2] *Annual Book of ASTM Standards*, Vol 04.06.
[3] Discontinued, see *1981 Annual Book of ASTM Standards*, Part 18.
[4] *Annual Book of ASTM Standards*, Vol 04.10.
[5] *Annual Book of ASTM Standards*, Vol 04.07.

## 9. Apparatus

9.1 *Testing Machine*—Any standard mechanical or hydraulic testing machine capable of applying and measuring the required load within an accuracy of ±2 %.

9.2 *Other Equipment*—Loading blocks, supports, and dial gage as prescribed in Section 10 and shown in Fig. 1.

## 10. Procedure

10.1 *Span and Supports*—The span for each test shall be 24, 32, or 44 in. (61, 81, 112 cm) for the nominal 1½, 2, and 3-in. (38, 51, 76-mm) thicknesses, respectively. The supports, at least 10 in. (254 mm) long, shall be rounded to a radius of 1½ times the nominal thickness being tested. The radius used shall not vary by more than ± 50 % from that specified. The supports shall be straight and shall maintain full contact with the specimen throughout the test.

10.2 *Loading*—Load the specimens through two rounded bearing blocks, at least 10 in. long, at the quarter-points of the span. The bearing blocks shall be rounded to a radius of 1½ times the nominal thickness being tested, and the radius shall not vary by more than ±50 %.

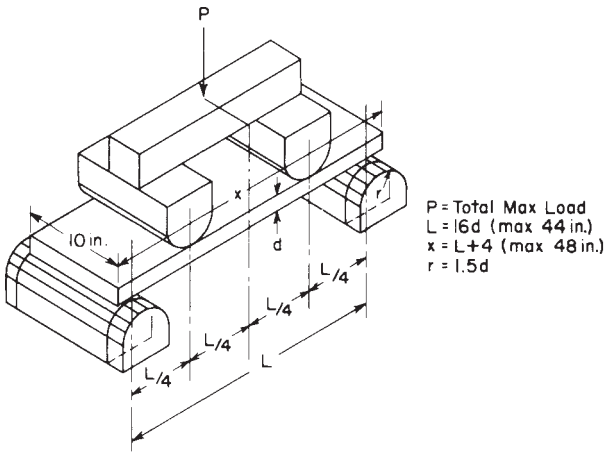
10.3 *Speed of Testing*—Apply the load continuously throughout the test at a uniform rate of motion of the crosshead of the testing machine of 0.30, 0.45, and 0.60 in. (7.6, 11, and 15 mm)/min for the 1½, 2, and 3-in. thicknesses, respectively. The speed used shall not vary by more than ±50 % from that specified.

10.4 *Load-Deflection Curves*—Obtain load-deflection curves to maximum load for all tests. Obtain the deflection of the center of the lower surface of the specimen by means of a suitable indicating dial gage. Read the deflection to the nearest 0.01 in. (0.25 mm).

## 11. Calculation

11.1 *Modulus of Rupture*—Calculate the modulus of rupture for each specimen as follows:

$$R = (3\,PL)/(4bd^2) \tag{1}$$




| Metric Equivalents | | | |
|---|---|---|---|
| in. | 10 | 44 | 48 |
| cm | 25.4 | 111.7 | 122 |

**FIG. 1 Apparatus for Equivalent Uniform Load**

where:

$R$ = modulus of rupture, psi (MPa),
$P$ = total maximum load, lbf (kN).
$L$ = span, in. (mm),
$b$ = width of specimen, in. (mm), and
$d$ = depth or thickness of specimen, in. (mm) (average of six measurements; at each edge and center of specimen along quarter point)

11.2 *Modulus of Elasticity*—Calculate the modulus of elasticity for each specimen as follows:

$$E = (11\,P_1L^3)/(64\,bd^3y) \tag{2}$$

where:

$L$ , $b$, and $d$ are previously identified,
$E$ = modulus of elasticity, psi (MPa),
$P_1$ = some load lbf (kN) on the straight-line position of the load-deflection curve, and
$y$ = deflection for load $P_1$, in. (mm)

11.3 *Equivalent Pounds-force per Square Foot of Uniform Live Load*—Calculate the equivalent uniform load for each specimen as follows:

$$W_{LL} = (192\,Rd^2)/L2 \tag{3}$$

where:

$R$, $d$ , and $L$ are previously identified, and
$W_{L\,L}$ = equivalent uniform load at failure, lbf/ft$^2$

11.4 *Deflection-Span Ratio*—Calculate the deflection-span ratio for a uniform applied live load of 30 lbf/ft$^2$ for each specimen as follows:

$$\text{Deflection}-\text{span ratio} = (25\,L^3)/(768\,Ed^3) \tag{4}$$

where the terms are as previously identified. The deflection-span ratio should be expressed in the form 1/$x$.

## 12. Report

12.1 The report shall include the individual values of modulus of rupture ($R$), modulus of elasticity ($E$), equivalent pounds-force per square foot of live load ($W_{LL}$) at failure, and deflection-span ratio calculated as outlined in Section 11. For the equivalent pounds-force per square foot of live load and the deflection-span ratio, the over-all property values for a given thickness shall be taken as the averages for all the specimens of that thickness tested. The type of failure of each specimen shall be described.

## CONCENTRATED LOAD

## 13. Scope

13.1 This method covers measurement of the minimum resistance of the decking to a concentrated force. Loading is at midspan along the unsupported edge. The decking will be able to sustain loads of greater magnitude at any other location than the one obtained from this test. Spans required are the same as for the equivalent uniform load test.

## 14. Apparatus

14.1 *Testing Machine*—The testing machine described in 9.1 is suitable.