Designation: E 2322 – 03

An American National Standard

Standard Test Method for Conducting Transverse and Concentrated Load Tests on Panels used in Floor and Roof Construction[1]

This standard is issued under the fixed designation E 2322; 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.

1. Scope

1.1 These test methods cover the following procedures for determining the structural properties of segments of floor and roof constructions:

	Section
Test Specimens	5
Loading	6
Deformation Measurements	7
Report	8
Precision and Bias	9
Testing Floors	
Transverse Load	10
Concentrated Load	11
Testing Roofs	
Transverse Load	12
Concentrated Load	13

1.2 Metric units (SI) are to be considered as the primary standard units.

1.3 These test methods serve to evaluate the performance of floors and roofs panels subjected to (*1*) Uniform loading, and (*2*) Concentrated static loading, which represent conditions sustained in the actual performance of the element. The standard is not intended for the evaluation of individual structural framing and/or supporting members (floor joist, rafters and trusses).

1.4 The text of this standard references notes and footnotes which provide explanatory material. These notes and footnotes, excluding those in tables and figures, shall not be considered as requirements of the standard.

1.5 This standard is not intended to cover concrete floor slabs.

1.6 *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]

C 109 Test Method for Compressive Strength of Hydraulic Cement Mortars

E 4 Practices for Force Verification of Testing Machines

E 72 Method of Conducting Strength Tests of Panels for Building Construction

E 73 Method of Testing Truss Assemblies

E 196 Practice for Gravity Load Testing of Floors and Low Slope Roofs

E 455 Method for Static Load Testing of Framed Floor or Roof Diaphragm Constructions for Buildings

E 575 Practice for Reporting Data from Structural Tests of Building Constructions, Elements, Connections, and Assemblies

E 631 Terminology of Building Constructions

E 661 Test Method for Performance of Wood and Wood-Based Floor and Roof Sheathing Under Concentrated Static and Impact Loads

E 695 Test Method of Measuring Relative Resistance of Wall, Floor, and Roof Constructions to Impact Loads

E 1592 Test Method for Structural Performance of Sheet Metal Roof and Siding Systems by Uniform Static Air Pressure Difference

3. Terminology

3.1 *Definitions*—Refer to E 631 for definitions of terms used in these test methods.

4. Significance and Use

4.1 *Transverse Load*—The procedures outlined will serve to evaluate the performance of floor and roof segments for deflection, permanent set and ultimate capacity. Performance criteria based on data from these procedures can ensure structural adequacy and effective service.

[1] This test method is under the jurisdiction of ASTM Committee E06 on Performance of Buildings and is the direct responsibility of Subcommittee E06.11 on Horizontal and Vertical Structures/Structural Performance of Completed Structures.

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[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.

4.2 *Concentrated Load*—This concentrated load test shall be used to evaluate surface indentation of structural framing members.

4.3 These procedures will serve to evaluate performance of roof and floor segments under simulated service conditions. Diaphragm shear loading of roof and floor segments shall be evaluated under Method E 455. Impact loading shall be evaluated under Test Methods E 661 or E 695.

5. Test Specimens

5.1 *Specimens*—There shall be at least three replicate specimens for each test. Specimens shall be constructed to represent sections of the floor, or roof assembly including the means of the attachment when the load direction is away from the supports. The specimens shall be representative in width and length as to the material and workmanship. The test specimen shall not be less than the width and length of the tributary load area under actual conditions. If the tributary load area for the test specimen exceeds the test equipment, a reduced specimen that is representative in proportional width and length shall be tested. Unsymmetrical assemblies shall be tested in each axis. If the structural properties of a particular construction are to be compared with another construction, widths of the specimens shall be of comparable size.

5.2 *Age*—Constructions, which include concrete and masonry for which the structural properties depend upon the age of the specimen, shall be aged not less than what is indicated by the manufacturer and/or national standard. The age of the specimen shall be recorded in the report.

6. Loading

6.1 *Apparatus*—The testing machine or load-measuring apparatus shall comply with the requirements prescribed in Practices E 4.

6.2 *Application of Load*—Apply the load to each individual specimen in increments so that a sufficient number of readings will be obtained to determine definitely the load-deformation curve (see 6.3) using the following sequence:

6.2.1 Prior to testing, apply a small initial load not greater than 5 % of the ultimate capacity load expected and hold for 5 min (± 1 min) and then release. Zero all measuring devices and begin the test.

6.2.2 Record the initial load and deformation reading of the specimen and then increase the load on the specimen to the first predetermined increment.

6.2.3 Record the load and deformation reading and release the load back to the initial load and then record the set of the specimen.

6.2.4 Increase the load to the next predetermined increment and record the information as indicated in the first load increment above. Follow this sequence of loading and reading for all predetermined load increment(s).

6.3 *Duration of Load Application*—After each increment of load is applied, maintain the load level as constant as possible for a period of 5 min (see Note 1). Take deformation readings as soon as practical after load application, at the end of the 5-min period under constant load, and immediately and at the end of the 5-min period after any partial or complete load release. Plot initial and 5-min readings in the form of load-deformation curves. Maintain complete load-deformation time records throughout the test. If application of a given load is required for a certain period, such as 24 h, take deformation readings at the end of this period, to allow the satisfactory plotting of a time-deformation curve for the complete period.

NOTE 1—Reason for the 5-min application of constant-level increment loads are as follows:

(1) To permit the assembly to come to a substantial rest prior to taking the second set of readings. (Depending on the method employed for applying the test load, it may be necessary to continue, at a reduced rate, the motion of the loading device in order to maintain the constant load level during the 5-min period.)

(2) To observe any time-dependent deformation or load redistribution, or both, and to record accurately the load level when time-dependent deformation starts, that is, at the divergence of the immediate and delayed load-deformation curves. This load level may, under certain conditions, have an important bearing on the design load.

(3) To be able to stop the test, if this should be desirable, prior to total failure, after initial failure has been anticipated as a result of the observations.

(4) To assure uniformity in test performance and consistency in test results.

7. Deformation Measurements

7.1 Measure the deformations with sufficient precision to define the load-deformation relationship, and report at least to the nearest 0.25 mm (0.01 in.).

8. Report

8.1 Prepare the report in accordance with Recommended Practice E 575.

9. Precision and Bias

9.1 It is not possible to specify the precision of the procedure in Test Method E 2322 for measuring these test methods because of the variety of materials and combinations of materials involved.

TESTING FLOORS

10. Transverse Load—Floor

10.1 *Test Specimen(s)*—Test specimen(s) shall be constructed in accordance with Section 5.

10.2 *Apparatus*—The apparatus shall be capable of applying a uniform load (such as air bag load or vacuum load), gravity load or two point load and shall conform to the requirements prescribed in 10.2.1 through 10.2.3 or the equivalent.

10.2.1 *Uniform Load*—Uniformly distributed loading is a satisfactory test method. Uniformly distributed load shall be applied by air pressure, either in a bag or in a vacuum chamber.

10.2.1.1 The bag method of loading is schematically shown in Fig. 1. Connect a reaction platform parallel to the face to be loaded and wider than the specimen to the supports by tie rods. Place an airtight bag as wide as the specimen and as long as the span between the specimen and the reaction platform. Apply transverse load to the specimen by increasing the air pressure in the bag. Measure the difference in pressure by means of a manometer or other pressure measuring device. The error of

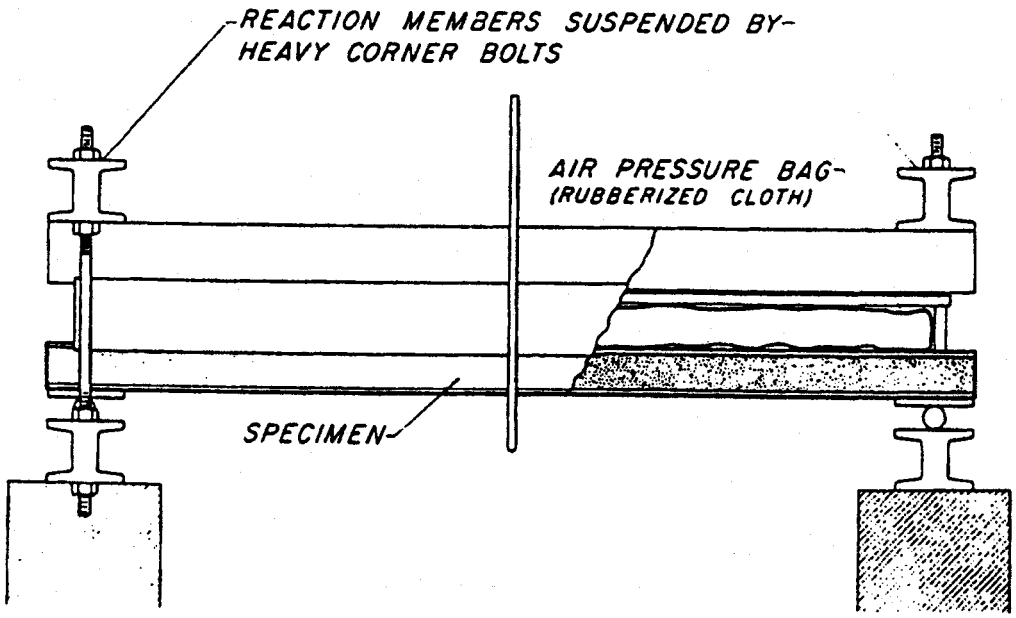

FIG. 1 Apparatus for Uniformly Distributed Transverse Load (Bag Method)

the pressure reading shall not exceed 1 % of the full-scale reading. Deflection measurement shall be measured following 10.4. See Fig. 1.

10.2.1.2 When the vacuum chamber method of loading is used, place the specimen near the test frame to create an airtight vacuum chamber. An airtight frame or curb shall surround the specimen closely and be flush with the upper surface of the specimen. An air resistant blanket covers the specimen, overlaps the frame, and is sealed so that it is reasonably airtight. Use a vacuum pump or positive action exhaust blower to reduce air pressure between the specimen and floor/wall. Measure the difference in pressure by means of a manometer or other pressure measuring device. The error of the pressure reading shall not exceed 1 % of the full scale reading. Deflection measurement shall be conducted following 10.4. See Fig. 2.

10.2.2 *Gravity Load*—Gravity load testing shall be conducted in accordance with Practice E 196.

10.2.3 *Two Point Load*—The two point (quarter-point) loading method is used for transverse load tests. Test the specimen as a simple beam (Fig. 3) on a span 150 mm (approximately 6 in.) less than the specimen length. Apply two equal loads, each at a distance of one-quarter of the span from the supports, toward the middle of the span. For floor specimens tested horizontally (Fig. 1), the load on the specimen shall include the weight of the specimen between the supports. Apply the transverse loads to the upper (finish floor) face for three of the symmetrical specimens. For asymmetrical assemblies, the bottom face for three of the specimens must also be tested. Deflection measurements shall be measured following 10.4. See Fig. 3.

10.3 *Loading Application*—The application of load is found in 6.2. The application of load shall be compatible with the test apparatus indicated in 10.2.

10.4 *Deflection Measurement Device*—The deflection measurement device shall be compatible with the test apparatus indicated in 10.2. A frame shall be placed on the upper face of the specimen in a manner such that the frame shall not deform as the specimen deforms under load. Two deflection measuring devices, one near each longitudinal edge of the specimen, shall be attached to the frame at the mid span.

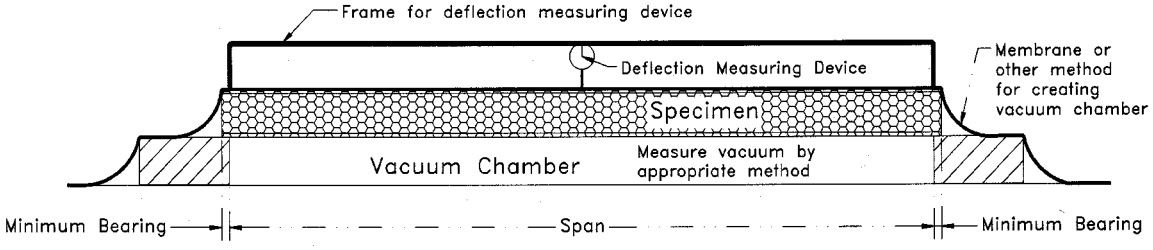

FIG. 2 Apparatus for Uniformly Distributed Transverse Load (Vacuum Bag)

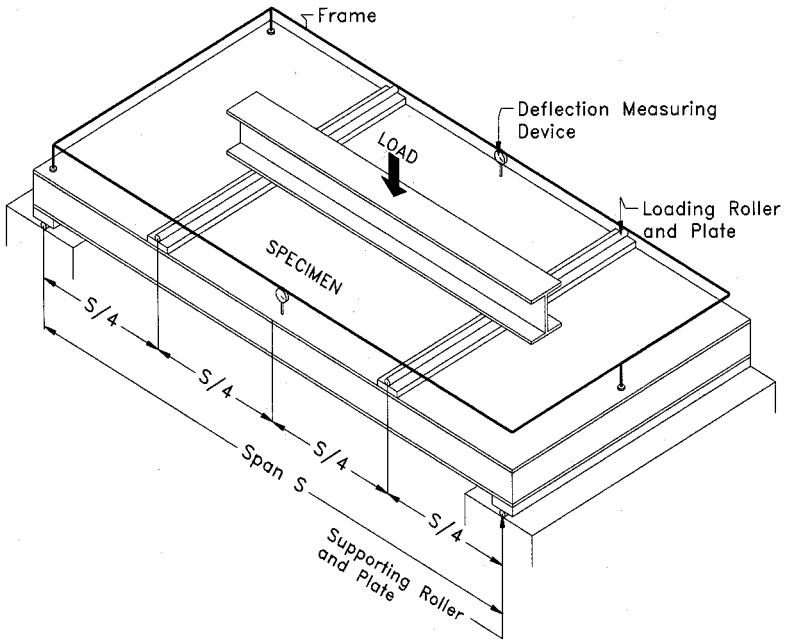

FIG. 3 Quarter Point Loading

10.4.1 *Method A—Deflection Measuring Device Top of Panel*—Mid span deflection shall be measured on the top of the panel. The deflection measurement should be referenced to the panel deflection at the end supports.

10.4.2 *Method B—Deflection Measuring Device Bottom of Panel*—Mid span deflection shall be measured on the bottom of the panel. The deflection measurement should be referenced to the panel deflection at the end supports.

10.5 *Calculations and Report*:

10.5.1 *Load-Deflection Data*—For each deflection measuring device, calculate the deflection under a given load as the difference between the reading when the load is applied and the initial reading. Calculate the deflection of the specimen for the span as the average of the deflections obtained from each of the measuring devices. Calculate the sets under the initial load by using a similar method. Record the maximum load for each specimen.

10.5.2 *Data Presentation*—Report the results in the form of a graph in accordance with Section 8.

11. Concentrated Load—Floor

11.1 *Test Specimens*—Tests shall be made on each of the transverse specimens after the transverse tests are completed.

11.2 *Apparatus*—The apparatus shall be assembled as shown in Fig. 4 and shall conform to the requirements for component parts prescribed in 11.2.1 through 11.2.3 or the equivalent.

11.2.1 *Steel Bar*—Steel bar having a diameter of 25.4 mm (1 in.) and the edge of the face contacting the specimen rounded to a radius of 1.3 mm (0.05 in.). When testing for decking deflection, place a 25.4 mm (1 in.) diameter flat disk between the steel load bar and the decking surface.

11.2.2 *Depth Gage*—The depth gage shall consist of a measuring device that is capable of indicating displacement to 0.025 mm (0.001 in.) and is mounted on a support. The support shall be notched to permit placing the measuring device directly adjacent to the bar and shall be long enough to permit placing the supporting elements on undisturbed areas of the face of the specimen.

11.2.3 *Loading Device*—Any convenient means for applying a compressive load up to 5 kN (1100 lbf) and means for measuring the load within 1 %. See Fig. 4.

11.3 *Procedure*:

11.3.1 *Loading*—Place the entire specimen or portion of the specimen on a horizontal support and level the specimen. Apply the loads on the face of the specimen. Place the steel bar on the surface of the specimen at what is judged to be the weakest place and, also, at what is judged to be the strongest place. Apply a load vertically downward to the upper surface of the bar. Continue loading until maximum load or 4.45 kN (1000 lbf) is attained on the steel bar. Application of load is found in 5.2.

11.3.2 *Depth of Indentation*—Measure the depth of indentation, by means of the depth gage, and record the reading of the gage to the nearest 0.025 mm (0.001 in.).

11.4 *Calculations and Report*:

11.4.1 *Depth of Indentation*—Calculate the depth of indentation (set) after a given load has been applied and the bar removed to the nearest 0.025 mm (0.001 in.) as the difference between the depth for that load and the initial reading of the deflection measurement device before a load has been applied to the specimen.

11.4.2 *Deflection*—Calculate the amount of deflection at a given load to the nearest 0.025 mm (0.001 in.) as the difference between the displacement for the load and the initial reading of the deflection measuring device before a load has been applied to the specimen.

11.4.3 *Data Presentation*—Report the results in the form of a graph in accordance with Section 7.

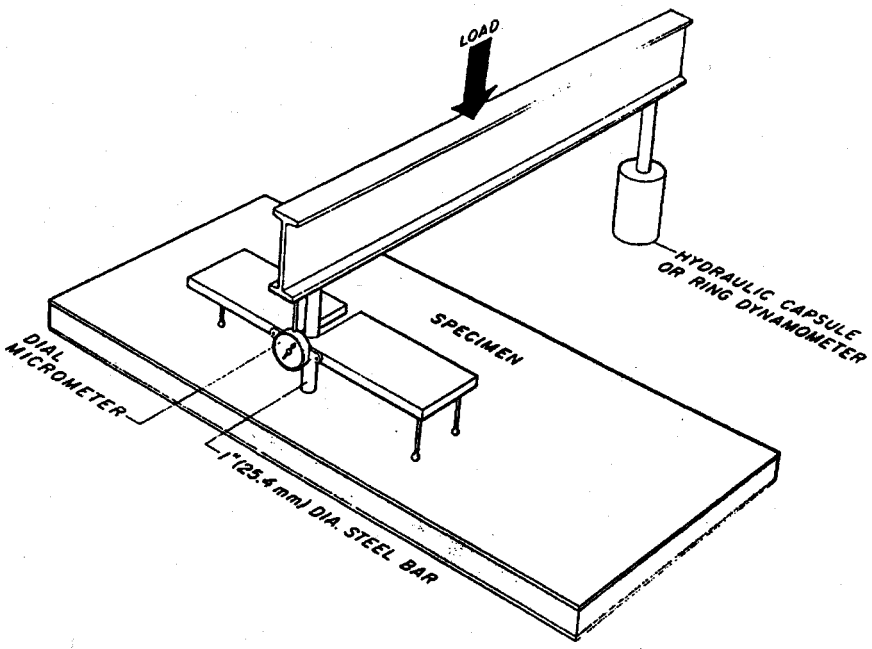

FIG. 4 Typical Concentrated Load Apparatus

TESTING ROOFS

12. Transverse Load—Roof

12.1 *Test Specimens*—Test specimen(s) shall be constructed in accordance with Section 5.

12.2 *Apparatus*—The test apparatus shall conform to the requirements of 10.2.

12.3 *Procedure*—Conduct the test in accordance with 10.2.1 through 10.2.3 for the transverse load tests of the roof. Apply the load to the upper roof surface when testing for inward loading. Apply the load to the inner roof surface when testing for outward loading. Application of load is found in 6.2.

12.4 *Calculations and Report*—Report the results as indicated in Section 8 and 10.5.

13. Concentrated Load—Roof

13.1 *Test Specimens*—Tests shall be made on each of the transverse specimens after the transverse tests are completed.

13.2 *Apparatus*—The apparatus shall conform to the requirements of 11.2.

13.3 *Procedure*—Conduct the test in accordance with 11.3 on concentrated load tests of floors, except apply the loads only to the upper face of the specimen. Application of load can be found in 6.2.

13.4 *Calculations and Report*—Report the results as indicated in Section 8 and 10.5.

14. Keywords

14.1 concentrated loads; deformation; floors; load duration; roofs; sheathing; strength tests; transverse loads

APPENDIXES

(Nonmandatory Information)

X1. COMMENTARY ON TEST METHOD

X1.1 This standard was originally part of a larger standard test method, Method E 72. Due to difficulties in maintaining the large and cumbersome test method, the floor and roof sections of Method E 72 were modified and placed in this new standard to help aid in maintaining an up-to-date standard test method.

X1.2 *Estimating Ultimate Load Carrying Capacity of Specimen*—The loading schedule of 6.2 is based on the estimated ultimate load carrying capacity of the specimen. This load can be estimated via calculations or previous experience based on historical tests or analysis.

X1.3 Estimate the number of increments for application of load. This number of increments when applying load can be estimated via calculation or previous experience based on historical test or analysis. The minimum number should be between 3–10.

X2. TECHNICAL INTERPRETATION

X2.1 It is the purpose of these test methods to provide a systematic basis for obtaining comparable engineering data on various construction elements and structural details of value to professionals, designers, builders, building officials, and others interested in this field.

X2.2 Subjecting complete structures to known loads is very expensive and requires much time; therefore, that method of carrying out investigations to establish structural properties is not likely to be used to any great extent. Such tests have the further disadvantage that only the strength of the weakest elements of a particular structure could be measured.

X2.3 For these reasons, it seems more practicable to apply loads to specimens that accurately reproduce a structural portion of a finished building. These portions of a building have been designated as "elements;" for example, floor, roof, etc. For the procedure described in these test methods, the elements have been restricted to those most important structurally. For each element, methods of loading are described that simulate the loads to which the element would be subjected under service conditions. It is believed that the results of these measurements on the structural elements will be more useful to architects and engineers than the results of tests of the individual structural members. Although it may be impractical to determine all of the structural properties of each element of a building, it is believed that the more important properties may be determined by tests described in these test methods.

X2.4 The test method, involving the application of the loads in increments and the concurrent measurement of deformation and set, simulated, to some extent, the conditions of repeated loading under service conditions. Therefore, results by such a method of loading may be more useful than those obtained by increasing the load continuously throughout the test. The results from increment loading tests may show whether different portions of a construction act as a unit under load, whether the fastening or bonds have adequate strength, or whether they rupture under repeated loads. For any engineering structure, including small house, it is necessary not only that the strength be adequate, but also that the deformation under load shall not appreciably decrease the usefulness of the structure. If the working load and the allowable deformation for an element for a structure are known, constructions complying with these requirements may be selected by inspection of the graphs from tests of such constructions.

X2.5 A structure is elastic if, after a load has been applied and then removed, the set is inappreciable. If the set is small for an element of a building, it may be assumed that the construction has neither been damaged nor appreciably deformed by the load. The set, therefore, is another property that may be used when comparing different constructions and may be useful when selecting construction for a particular purpose.

X2.6 The variations in the properties of a construction as used commercially for buildings, in all probability, will be greater than the variations for the three specimens tested as directed in these test methods. Reason being, these specimens will be all fabricated at the same time by the same workers and from the same lot of material. This fact should be clearly indicated in any general report based on these test procedures.