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Standard Test Methods for Transverse Load Tests on Panels Used in Wall Construction[1]

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INTRODUCTION

Sound engineering design of structures using existing or new materials requires accurate technical data on the strength and rigidity of the basic elements employed in various construction systems. It is the purpose of these test methods to provide a systematic basis for obtaining engineering data on various construction elements and structural details of value to designers, builders, building officials, and others interested in this field. The results should closely approximate the performance in actual service.

1. Scope

1.1 These test methods cover transverse load testing to determine the structural properties of wall segments.

1.2 These test methods serve to evaluate the performance of wall panels subject to transverse bending loads applied perpendicular to the plane of the wall. The tests are conducted on horizontal or vertical specimens under two-point loading. It also shall be permitted to apply uniform load using an air bag or a vacuum chamber. Depending upon the configuration tested, these loads are intended to evaluate the transverse deflection, permanent set, and maximum flexural capacity or planar shear capacity, or both, of the wall segment. These test methods are not intended for the evaluation of individual structural framing or supporting members (floor joist, decking, etc.), or both. The connections between the vertical elements of the wall segment and the surrounding construction are excluded from the scope of these methods and shall be evaluated by alternative means.

1.3 Notes and footnotes in this standard provide explanatory material. These notes and footnotes, excluding those in tables and figures, shall not be considered as requirements of this standard.

1.4 The values stated in SI units are to be regarded as standard.

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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.6 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

E4 Practices for Force Verification of Testing Machines

E72 Test Methods of Conducting Strength Tests of Panels for Building Construction

E575 Practice for Reporting Data from Structural Tests of Building Constructions, Elements, Connections, and Assemblies

E631 Terminology of Building Constructions

E2309/E2309M Practices for Verification of Displacement Measuring Systems and Devices Used in Material Testing Machines

3. Terminology

3.1 *Definitions:*

3.1.1 For definitions of general terms related to building construction used in these test methods, refer to Terminology E631.

[1] These test methods are 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.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *asymmetrical assemblies, n*—panels having different configuration on exterior and interior exposed surface.

3.2.2 *wall panel configuration, n*—a wall panel of specific length, or height, and width representing one possible case of a wall system and consisting of a specific arrangement of wall panel components.

4. Significance and Use

4.1 The procedures outlined in these test methods serve to evaluate the performance of the wall segments for deflection, permanent set, and maximum load-carrying capacity under transverse loading. Performance criteria based on data collected using these procedures fall outside the scope of these test methods.

4.2 Transverse loads cannot be applied satisfactorily to some wall constructions, such as masonry, with the specimen in a horizontal position. For such constructions, the loads shall be applied to the specimen in a vertical position thus simulating service conditions.

4.3 Test results obtained from the two-point loading (8.2.1 and 9.2.1) and the uniform loading (8.2.2 and 9.2.2) are neither compatible nor interchangeable.

5. Test Specimens

5.1 *Minimum Number of Specimens*—There shall be at least three specimens tested for each wall panel configuration and loading direction. Asymmetrical assemblies shall be tested on each face (side) for which the results may be different.

5.2 *Specimen Construction*—Specimens shall be constructed to represent segments of the wall assembly. The specimens shall be representative as to material and workmanship and shall be of the practical size to predict the targeted structural performance attributes of the assembly (see 5.3).

5.3 *Length or Height*—The length, or height, of specimen for each wall panel configuration shall be chosen to conform to the length, or height, of that wall panel in actual use. The length(s) selected for testing shall be chosen to promote any potential flexural or shear failure modes, or both, that may occur (see Note 1).

NOTE 1— An example of an approach that may satisfy this requirement may be to test the shortest wall length that may occur in actual use to evaluate the potential for a shear failure and a longer representative length to achieve a bending failure

5.4 *Width*—The width of specimen shall be chosen, insofar as possible, to include several of the principal load-carrying members to ensure that the behavior under load will simulate that under service conditions. The nominal width of specimens shall be 1.2 m (48 in.). The actual width of specimens shall be a whole number multiple of the spacing of the principal load-carrying members, except for prefabricated panels for which the actual width shall be the width of panel used. If the structural properties of a particular construction are to be compared with another construction, the specimens shall be of comparable (similar) sizes.

5.5 *Age*—Constructions such as plaster, stucco, concrete, and masonry (brick, stone, structural clay tile, or concrete block) for which the structural properties depend upon the age of the specimen shall be aged not less than what is indicated by the manufacturer or national standard, or both. The age of the specimen shall be recorded in the report.

6. Apparatus

6.1 *Loading Apparatus*—For any of the horizontal and vertical test methods detailed in Sections 8 and 9, the testing machine and load-measuring apparatus shall comply with the requirements prescribed in Practices E4.

6.2 *Supports*—The supporting method of the specimen shall closely reflect the field application. If the supports cannot reflect the field applications, then the specimen shall be simply supported at the ends in accordance with 8.1.1.

6.3 *Deflection-Measuring Apparatus*—Deflection-measuring apparatus shall meet the requirements given in 8.1.4 for the tests on horizontal specimens and 9.1.4 for the tests on vertical specimens.

7. Procedure

7.1 *Procedure*—For any of the horizontal and vertical test methods detailed in Sections 8 and 9, the following load application and displacement measurement procedures shall be used:

7.2 *Application of Load*—Apply the load to the specimen in increments so chosen that a sufficient number of readings (4 to 10) will be obtained to definitely determine the load-deflection curve (see 7.3) using the following sequence:

7.2.1 Apply a pre-load not to exceed 5 % of the expected maximum load and hold for 5 min (±1 min). Release the load and allow a recovery period for stabilization of the test specimen. Then zero-out the deflection-measuring devices. The recovery period for stabilization shall not be less than 5 min (±1 min) at zero load.

7.2.2 Increase the load to the first increment, hold for 5 min (±1 min), and then release. Hold the specimen released for 5 min (±1 min).

7.2.3 Increase the load to the next increment, maintain the load level as constant as possible for the predetermined period (see 7.4) and unless otherwise specified, release it. Maintain the specimen in the unloaded state for 5 min (±1 min).

7.2.4 Repeat 7.2.3 sequence for each of the predetermined increments until the behavior of the specimen under load indicates that it might fail suddenly and damage the deflection-measuring apparatus. Then, remove this apparatus from the specimen and increase the load continuously until the maximum load is reached.

7.2.5 *Loading Rate*—Load shall be applied at a uniform rate of load or displacement. The loading rate shall be such that the target load or displacement at each increment is achieved in not less than 1 min. Report the loading rate used and the time from load initiation to maximum load for each test specimen.

7.3 *Measurements:*

7.3.1 At each load increment, take displacement 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. Maintain complete load-deflection-time records throughout the test until the deflection-measuring apparatus is removed.

7.3.2 If application of a given load is required for a longer period, take displacement readings at the beginning, at intervals during this period, and immediately at the end of the period, to allow the satisfactory plotting of a time-deflection curve for the complete period.

7.3.3 Calculate the deflection for each edge of the specimen under a given load as the difference between the readings when the load is applied and the initial reading. Calculate the deflection at mid-span as the average of the deflections obtained at both edges of the specimen. Calculate the sets under the initial load (or partially released load, if applicable) by using the same procedure

7.4 *Duration of Load Application*—At each load increment, maintain load level as constant as possible for a period of at least 5 min. If load duration has an important bearing on test results for certain wall constructions, a longer period of load application, such as 24 h, is required (see Note 2).

NOTE 2—Reasons 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 provide sufficient time for making all observations. Longer time intervals may be required under certain conditions.

(3) 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-deflection curves. This load level may, under certain conditions, have an important bearing on the design load.

(4) To be able to stop the test if initial results show that failure is likely.

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

7.5 *Direction of Load Application*—The specimens shall be tested with the transverse load applied to the outside face of the specimen. For asymmetrical assemblies, additional specimens shall be tested with the transverse load applied to the inside face.

8. Test on Horizontal Specimen

8.1 *Apparatus:*

8.1.1 *Loading Apparatus*—The apparatus shall be capable of applying two-point load or a uniform load (such as that applied by air bag or vacuum chamber) and shall conform to the requirements prescribed in 8.1.2 and 8.1.3, or the equivalent.

8.1.2 *Supports*—The specimen shall be supported at the ends of the span across the entire width using steel bearing plates on steel rollers (recommend 5-cm (2-in.) diameter). The size of the bearing plates shall be sufficient to prevent a localized bearing failure, but not more that 5 % of the test span.

8.1.3 *Loading Assembly*—The load shall be applied using two steel rollers with a steel plate between each loading roller and the specimen. The rollers and plates shall be sized in accordance with 8.1.2.

8.1.4 *Deflection-Measuring Device*—The deflection-measuring device shall be compatible with the test apparatus indicated in 8.1.1 and provide Class D or better accuracy in accordance with Practices E2309/E2309M. A frame shall be placed on the upper face of the specimen. To prevent stresses deforming the frame as the specimen deforms under load, this frame shall rest on three hardened steel balls each supported by a steel block on the face of the specimen. Two of the balls shall be placed in a line vertically above one support and the third ball vertically above the other support. Two deflection-measuring devices, one positioned near each longitudinal edge of the specimen, shall be attached to the frame at mid-span. The spindles shall rest on the upper face of the specimen (see X1.8 for additional information).

8.2 *Loading Procedure*—The test on the horizontal specimen shall be performed using either two-point loading (8.2.1) or uniform loading (8.2.2), such as that applied by air bag (8.2.2.1) or vacuum chamber (8.2.2.2).

8.2.1 *Two-Point Loading*—Apparatus for the two-point loading method is shown schematically in Fig. 1A. Test the specimen as a simple beam of a span 15 cm (6 in.) less than the specimen length. Apply two equal loads, each at a distance of one-quarter of the span from the supports.

8.2.2 *Uniform Loading*—Uniformly distributed load shall be applied by air pressure, either by means of an air bag or in a vacuum chamber having the specimen as one face.

NOTE 3—Uniformly distributed loading is a satisfactory test method. However, the transverse bending capacity for any span may be greater for some constructions under uniformly distributed load than under loads applied at the quarter-points of the span.

8.2.2.1 *Air Bag Loading*—Apparatus for the air bag method of loading is shown schematically in Fig. 2. A reaction platform wider than the specimen shall be connected to the supports by tie rods. An airtight bag of rubberized cloth as wide as the specimen and as long as the span shall be placed between the specimen and the reaction platform. Apply transverse load to the specimen by increasing the air pressure in the bag. Measure the pressure by means of a manometer. The specific gravity of the liquid in the manometer shall be such that the error in pressure readings does not exceed 1 %.

NOTE 4—Water is usually the liquid in the manometer.

8.2.2.2 *Vacuum Chamber Loading*—Apparatus for the vacuum chamber method of loading is shown schematically in Fig. 3. An airtight frame or curb shall surround the specimen closely and be about flush with the upper surface of the specimen, which shall be installed on supports opposite an airtight reaction floor. A rubber blanket or polyethylene sheet covers the specimen, overlaps the frame, and is sealed so that it is reasonably airtight. Use a small vacuum pump or positive action exhaust blower to reduce air pressure between the specimen and the reaction floor. Measure the difference in pressure outside and inside of the vacuum chamber by means of a manometer. If a specimen has an airtight cavity, vent each cavity to the low-pressure face by a hole in the face of the specimen not less than 5 mm (3⁄16 in.) in diameter located where it will least affect the transverse strength of the specimen.