Designation: E196 – 06 (Reapproved 2012)

Standard Practice for Gravity Load Testing of Floors and Low Slope Roofs[1]

This standard is issued under the fixed designation E196; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the Department of Defense.

1. Scope

1.1 This practice covers static load testing of floors and low slope roofs (roofs having a slope of less than 1 in 12) under actual or simulated service conditions, and is applicable to typical elements or sections of structures fabricated for test or to actual existing building components. This practice is intended for use in determining the strength and stiffness of elements or sections of floors and roofs of buildings under gravity loads, as well as in checking the design, materials, connections, and the quality of the fabrication of such building constructions.

1.2 The values stated in SI units are to be regarded as standard. The values given in parentheses are mathematical conversions to inch-pound units that are provided for information only and are not considered standard.

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:*[2]

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

E631 Terminology of Building Constructions

3. Terminology

3.1 For definitions of terms in this practice, see Terminology E631.

4. Significance and Use

4.1 This practice is intended to be used by parties involved in the testing of floors and roofs of structures either in the field or the laboratory. Tests are either proof tests or tests to failure, and are applicable to all construction materials. The practice is not intended for use in routine quality control testing of individual building elements or constructions.

5. Types of Tests

5.1 *Proof Tests*—Proof tests are intended to give assurance that the construction will support a specified load or will not exceed a given deflection under this load, or both. If the floor or roof is to be placed in service after the proof test, or is part of an existing structure which must remain in service after the test, great care must be exercised to determine that structural damage has not occurred, or that if failure did occur, damage is minimal and the safety of personnel is not jeopardized.

5.2 *Failure Tests*—Failure tests are carried out to obtain more detailed information on the performance, ultimate load carrying capacity, the mode of failure, the adequacy of the connections, and to develop the complete load-deflection curve for the construction(s).

6. Test Specimens

6.1 The area or size of the test specimen shall be a representative section, taken to duplicate the structural performance of the actual floor or roof, or shall be a typical element or bay of an existing structure. When a loading test is performed on a particular floor or roof composed of many identical segments, the selection of a representative test section shall be approved by the building official or party for whom the test is being performed. Normally only one representative portion of the structure need be tested, except where various areas of a floor or roof are subject to differing types of loading, or where a number of structural elements or sections in a building are suspect and to be proof loaded.

6.2 The condition of the materials in the assembly to be tested shall be reasonably equivalent, at the time of test, to the conditions assumed in the design or representative of the actual in-service conditions.

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[1] This practice 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.

7. Simulated Structures

7.1 When a loading test is carried out on a simulated structure, the support conditions and the fixity of the edges of the floor or roof developed in the actual structure shall be reproduced as closely as possible in the test specimen.

7.2 The materials, structural shapes, connections, connectors, and construction used in the simulated structure shall duplicate as closely as practical those used or intended for use in the actual structure.

8. General Testing Arrangement

8.1 *Verification of Design Assumptions*—Floors or roofs shall be loaded in a manner satisfying the original design assumptions. Floors or roofs designed for uniform loading shall be tested under uniform loading or by a method that will simulate the forces and moments generated by a uniformly distributed load. When structures with protrusions or structural elements that are located above the surface to be loaded are tested, care shall be taken to ensure that the loading procedure used does not inadvertently restrain lateral buckling of these elements.

8.2 *Uniform Live Load*—An actual uniform live load is applied to the test specimen(s). This shall be achieved using an air bag, a vacuum chamber, water, or other suitable materials. If water is used as a loading medium, care must be taken to minimize the effects of ponding which will produce a nonuniform load. One means of minimizing the ponding is by dividing the area to be loaded by water into a series of separate compartments that are filled individually.

NOTE 1—The unintentional failure of a test structure loaded by water can be extremely messy and can create unanticipated problems.

8.3 *Simulated Uniform Live Load*—A simulated uniform live load shall be applied by dead weights, jacks, cables and pulleys, or any other method that will simulate a uniformly distributed load by concentrated loads. If the loads are applied by jacks, distribute the bearing forces over a sufficient area to preclude local damage. Where a uniformly distributed load is represented by dead weights such as masonry units, metal ingots, or other materials of known weight, they shall be placed so as to preclude any arch action or bridging effect in the loading material which can affect the induced bending stresses.

8.4 *Concentrated Load*—When a floor or roof is designed for a concentrated load or loads in addition to a uniform load, a concentrated load test shall also be performed that simulates the actual condition of loading. If the bearing area is not otherwise specified, the concentrated load shall be distributed over an area of 460 by 460 mm (18 by 18 in.) and placed at the points anticipated in service or where such a load or loads will produce maximum bending moments or shears, depending on the purpose of the test. The uniform load, if any, shall be applied as specified in 8.2 or 8.3.

8.5 *Safety Considerations*—Adequate precautions shall be taken to prevent injury to personnel during loading tests, by avoiding the danger of a complete collapse of the floor or roof in case of a failure. This shall be done by providing, when necessary, adjustable shoring or supports on the underside of the floor or roof to support the construction in case of failure, and shall be arranged to catch the main load-carrying members of the floor or roof construction and not merely the covering surface such as the roof sheathing or a false ceiling. This shoring system shall be capable of taking the full dead weight of the floor or roof plus the full test load and shall be adjusted during the test to leave a gap for deflection and observation. To minimize the damage to a structure in the event of a failure during a proof-load test, the loading medium shall have back-up restraint to keep it from becoming a following-type load. The load shall be located so as to facilitate quick removal and limit the damage in the event that structural problems become evident.

9. Measurements

9.1 *Deflections*—Deflection measurements shall be taken during the loading tests on the floor or roof at the center line and quarter points of the two main axes of the loaded area and at other specified locations. Where the deformation of supporting members affects the rigidity of the unit being tested, the deflection of the supporting members shall also be measured. Deflections are permitted to be measured using dial gages, a surveyor's level, or other methods that will limit the error to ±2 % of the total deflection. The deflection gages shall be supported so as to be unaffected by the application of the load or by local deformations caused by the load. A means of monitoring deflections and test assembly performance from remote locations is the use of video tape equipment.

9.2 *Accuracy of Loading*—The loading medium or applied loads shall be measured by a method that will limit the error to ±5 % of the specified design live load. Loading methods that do not allow such accuracy shall not be used.

9.3 *Load Sharing*—Where several structural elements are in the section being tested or the load test is conducted on an existing structure, deformation readings shall be taken on the main element being evaluated and on the adjacent elements, as required, to determine the effects of load sharing. The sharing of loads shall be accounted for in the analysis of the test data.

10. Procedure

10.1 *Determination of Load Magnitudes:*

10.1.1 *Proof Tests*—In the case of proof tests of elements or sections of buildings not in an actual structure, the magnitude of load shall be the basic loads with appropriate applicable code specified adjustments. In the case where an element or section of an existing building is to be proof loaded, the magnitude of load shall be the rated live load adjusted, where appropriate, for duration of load, tributary area, etc.

10.1.2 *Ultimate Load Tests*—The magnitudes of loads shall be determined in the same manner as for proof tests. An approximation of the minimum target ultimate load is obtained by multiplying the design load by the appropriate load factors for the materials involved. Anticipated average ultimate load values are then determined by statistically adjusting the minimum target values to mean values using the coefficient of variation for the materials involved or other adjustment factors where known.

10.2 *Duration of Load Application:*

10.2.1 *Elements in Simulated Structures and Less than Five Members in Existing Structures*—Except in the instances of impact tests, after each increment of load is applied, maintain the load level as constant as possible for a period of 5 min (see Note 2). 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 beginning, at intervals during this period, and at the end of this period, to allow the satisfactory plotting of a time-deformation curve for the complete period. Note and describe in detail the performance of the floor or roof portion and any signs of distress or failures in members and connections and, whenever possible, illustrate by photographs or sketches.

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-deformation curves). This load level can, under certain conditions, have an important bearing on the design load.

(*4*) 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.

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

10.2.2 *Multiple Member Tests in Existing Structures*—Where five or more identical or nearly identical members are to be proof loaded in the same existing structure to determine their ability to carry a specified live load, and economics and time limitations dictate that the duration of load requirements of 10.2.1 not be followed, a higher predetermined proof load shall be slowly applied over a 5-min period in one step and then remove it after a 5-min hold under full live load. Deflection readings shall be taken initially after application of the proof load, at the end of the 5-min hold, immediately after removal of the load, and 5 min after removal of the load.

10.3 *Maintenance of Full Design Load*—After reaching the full design load, or other specified load level, except for the loading specified in 10.2.2, maintain the loading constant for a period of at least 6 h and take readings every hour during the 6-h period to allow the determination of additional time-dependent deflection. At the end of the constant load period, the floor or roof portion:

10.3.1 Shall be subject to additional loading to a specified test load or to failure in accordance with 10.1.2 or

10.3.2 When required by the building official or party for whom the test is being performed, the test load shall be removed and the recovery or permanent set measured immediately and not longer than 24 h after the removal of the load.

10.4 *Additional or Repeat Loadings*—The floor or roof portion tested in accordance with 10.3.2 shall be reloaded, using the testing procedure of 10.1, up to the specified test load for a proof test, or up to ultimate load for a failure test.

11. Auxiliary Tests

11.1 When required to aid in the interpretation of test results, the quality of the materials connections, connectors, and other parts of the systems shall be determined. Such determinations shall be made on the same or duplicate specimens and shall be made in accordance with the relevant ASTM standards.

12. Report

12.1 The test report shall be prepared in accordance with Practice E575.

12.2 The report shall include the justification for the choice of the condition or the specimens at the time of test and testing environment.

13. Precision and Bias

13.1 No statement is made on the precision or on the bias of this practice because the general guidelines on specimen size, instrumentation, and procedures provided herein make the results difficult or impossible to analyze statistically and compare with other tests.

14. Keywords

14.1 concentrated load; failure tests; flat roofs; floors; gravity loads; proof tests; stiffness; strength; uniform load