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Standard Guide for Conducting Flexural Tests on Beams and Girders for Building Construction[1]

This standard is issued under the fixed designation E529; 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 guide covers the flexural testing of beams and girders under simulated service conditions to determine their structural performance characteristics. Methods following this guide are intended primarily for constructions that may not conform with the relatively simple assumptions upon which well-known flexural theories are based. In some cases, they are also suitable for determining the structural adequacy of the design, materials, connections, and fabrication techniques. The methods are not intended for use in routine quality control tests.

1.2 *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.* For specific precautionary statement, see 7.1.

2. Referenced Document

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 used in this standard, refer to Terminology E631.

4. Significance

4.1 This guide provides a general procedure for conducting flexural load tests on beams and girders of all types. Strength, stiffness, creep, or other useful properties may be obtained. When round-robin tests are to be conducted, a standardized set of procedures conforming to this guide should be agreed upon by the participants prior to testing to ensure a uniform basis for comparison.

5. Types of Tests

5.1 The flexural test is categorized as either a proof test or an ultimate load test. A proof test is intended to give assurance that the member will support a certain minimum short-term load, or to determine the deflection and recovery resulting from the application and removal of such a load. In carrying on a test to failure (ultimate load), more detailed information can be obtained, such as the proportional limit, yield point, ultimate capacity, mode of failure, load-deflection characteristics, and the adequacy of connectors and connections.

5.2 Both laboratory and field tests are acceptable.

5.3 The types of tests described above apply to beams subjected to short-term static loads. If cyclic, dynamic, or long-term sustained load tests are undertaken, care should be taken to ensure that procedures are consistent, that the test setup is reliable, and that load points cannot shift between cycles or impacts.

6. Apparatus

6.1 Loading method, type of test equipment, type of instrumentation, and so forth, are not specified, but are discussed in general terms, with the final choices being left to the discretion of the testing agency or controlling regulatory body.

7. Safety Precautions

7.1 Tests of this type can be dangerous. Equipment and facilities must be designed with ample safety factors to assure that it is the specimen that fails and not the test apparatus or facilities. Observers and sensitive instrumentation must be kept away from beams when loading to failure or in a range where performance is unknown. Gravity loading with concrete blocks, metal bars, sand, or similar materials can be very hazardous at failure as collapse may be sudden and complete.

[1] This guide 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.

8. Number of Tests

8.1 The number of like beams required for the tests will vary with the desired accuracy and reliability of the information to be obtained and with the purpose of the tests. The number chosen should be compatible with the purpose of the tests and agreeable to all parties concerned regarding the significance of the results. However, no fewer than two identical tests should be performed.

9. Test Specimen

9.1 Specimens shall be typical of those anticipated in service or as required for the purpose of the tests. Materials, fabrication, fasteners, connections, and so forth shall be representative. If the materials used require time to come to full strength, sufficient time shall be allowed between fabrication and testing for proper curing. This period of time will vary between materials but should be no less than that specified by applicable building codes or in the manufacturer's recommendations.

10. Preparation of Apparatus

10.1 *Test Set-up:*

10.1.1 Loads are applied using a testing machine, hydraulic rams, dead weights, or by other appropriate means. Set-ups may be designed to test the specimens either horizontally or vertically. It is recommended that the specimens be tested in the same position as assumed in the design. Regardless of the position of the member in the test fixture, the loading apparatus must be capable of applying the same forces, shears, and moments that the actual member in its proposed usage is intended to resist.

10.1.2 Provide supports that are capable of carrying the reactions without significant deformation or lateral movement. They are to be typical of those anticipated in service, or as required to satisfy the purpose of the tests. If the expected service conditions are unknown, provide supports that simulate the most stringent conditions likely to occur, or that would induce the most critical effects on the specimens.

10.1.3 Weigh materials used for gravity loading to an accuracy of ±1 %. Other types of loading equipment shall be capable of applying loads with similar accuracy.

10.2 *Instrumentation and Measurement:*

10.2.1 Calibrate instrumentation and load-measuring devices to ±1 % accuracy. In some indirect methods of load measurement, the load on the beam and that indicated may not be quite the same. Better accuracy in load determination is obtained when the magnitude is directly indicated. This can be done by the use of proving rings or load cells at the reactions or at the points of loading, or by adequate mechanical or electronic devices.

10.2.2 *Deformation Readings:*

10.2.2.1 Deformation readings can be obtained in a number of ways. One of the simplest methods is by use of a taut wire placed along the length of the beam. When a taut wire is used, the mountings for the wire should be above the two end supports on the beam at or close to the neutral axis. Maintain a reasonably constant tension on the wire by means of pulleys and weights, springs, or by other suitable means. Take readings from a scale and mirror attached to the beam at the measurement points. Read the scale by lining up the taut wire with its reflection in the mirror.

10.2.2.2 Other common methods of measuring deformations involve the use of micrometer dial gages or linear variable differential transformers attached to a suitable reference bar and bearing at the desired points on the beam. Mount the reference bar for supporting the deflection-measuring apparatus on the beam above the two end supports at or close to the neutral axis. Deformations can also be determined by using a surveyor's level and reading scales attached to the beam. In all cases, the method used shall compensate for any settlement of the reaction supports.

10.2.3 Strain readings can be taken by any of the many strain indicators and gaging systems commercially available. Follow a consistent procedure in taking strain readings to ensure results that will produce reliable stress-strain data.

NOTE 1—The use of strain gages on wood beams should be approached with great caution. Local variation in the stiffness of wood can cause a significant difference between the strain measured on the surface of the beam and the true strain through the entire beam depth.

11. Loading Procedure

11.1 Support, brace laterally, and load the beam in a manner that closely simulates service conditions or satisfies the intent of the test.

11.2 Before the test is begun, document any defects or other existing characteristics that could be confused as being caused by the test.

11.3 Apply and remove the load or loads in equal increments or continuously and at as uniform a rate a possible. Record the load, load rate, deformations, and other desired data at each increment or decrement. Choose the load intervals so that sufficient measurements can be made to develop a satisfactory load-deformation or stress-strain curve. Usually this can be achieved when each of the increments of load does not exceed 20 % of the service dead plus live load. This should provide approximately ten or more points on the load versus deformation curve at failure. Select a rate of load application that is consistent with the purpose of the tests. When loads are applied by a testing machine, either a constant rate of loading or constant rate of straining is used.

11.4 Except in the instance of impact tests, after each increment of load is applied, maintain the load level at as constant a level as possible for a period of 5 min (see Note 2).

11.4.1 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.

11.4.2 If application of a given load is required for a certain period, such as 24 h, take deformation readings at the beginning, and at equal intervals during this period, to allow the satisfactory plotting of a time-deformation curve for the complete period.

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 upon 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 may, 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 or after initial failure has been anticipated as a result of the observations.

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

11.5 Note and record visual and audible signs of distress in the beam, any deformation at connections and joints, and the mode of failure. Make a photographic record of the failure made and other noteworthy events.

11.6 *Auxiliary Tests*—To aid in the interpretation of the results, it is generally desirable and in many cases mandatory to determine the inherent properties of the materials, fastenings, and connectors used in the specimens. Perform all auxiliary tests in accordance with applicable ASTM standards.

12. Report

12.1 The report shall conform to Practice E575.

13. Precision and Bias

13.1 No statement is made on the precision or on the bias of test methods based on this guide, since no standard set of procedures is specified.

14. Keywords

14.1 beams; flexural test; girders