Designation: E 73 – 83 (Reapproved 2002)

An American National Standard

Standard Practice for Static Load Testing of Truss Assemblies[1]

This standard is issued under the fixed designation E 73; 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 This practice is intended as a guide for use in the testing of truss assemblies fabricated from all types of construction materials. While the practice may be used for the testing of a variety of assemblies, it is primarily intended to be used in the testing of those trusses designed to be spaced at 1.2 m (48 in.) centers or greater. It can be used, but it is not normally intended, for the testing of wood residential trussed rafters. Either proof tests or tests to destruction may be run.

1.2 *Limitations*—It is not intended that this practice be used for routine quality control testing.

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.* For specific hazard statements, see Section 7.

2. Referenced Documents

2.1 *ASTM Standards:*

E 196 Practice for Gravity Load Testing of Floors And Flat Roofs[2]

E 575 Practice for Reporting Data from Structural Tests of Building Constructions, Elements, Connections, and Assemblies[2]

E 631 Terminology of Building Constructions[2]

3. Terminology

3.1 *truss*—a coplanar system of structural elements joined together at their ends usually to construct a series of triangles that form a stable beam-like framework.

3.2 *static load*—a load or series of loads that are supported by or are applied to a structure so gradually that forces caused by change in momentum of the load and structural elements can be neglected and all parts of the system at any instant are essentially in equilibrium.

3.3 For other definitions in this practice, see Terminology E 631.

4. Summary of Practice

4.1 This practice outlines the procedures to be followed in the static load testing of major load carrying truss assemblies. While the procedure tells what to do, it does not tell the testing agency how to do it. This leaves the selection of the test fixture and loading medium to the discretion of the testing agency. Materials selection, sampling, conditioning, fabrication, test procedures, and report requirements are covered.

4.2 Two types of tests may be conducted using this practice:

4.2.1 *Proof Tests*—A proof test is frequently made to provide assurance that the truss will support a stated load or to determine the deformations and structural response under a specified loading.

4.2.2 *Test to Failure*—In testing to failure, more detailed information is generally desired such as ultimate load carrying capacity, total load-deflection history, yield point, connection performance, factor of safety, etc.

4.2.3 If desired, either type of test may be extended to include a determination of the magnitude and distribution of the stresses in the members and connections in order to permit a more comprehensive analysis of the truss performance.

5. Significance and Use

5.1 This practice provides a guide to any individual, group, agency, or code body on the methods of test for truss assemblies fabricated from all types of construction materials. Sample size is generally kept to a minimum to reduce costs. The methods may be used to apply proof loads to an assembly or to test it to failure. Information obtained includes strength and stiffness data, and if assemblies are tested to their ultimate load carrying capacity, the failure method or mechanism can be observed.

6. Test Apparatus

6.1 *General*—While the methods described in this procedure are best suited to tests of trusses before installation in a structure, they can also be applied to the testing of trusses after installation. In the former case, the truss may be tested in either a vertical position (normal or inverted) or in a horizontal position. Additional loadings must be applied to trusses tested

---

[1] This practice is under the jurisdiction of ASTM Committee E-6 on Performance of Buildings and is the direct responsibility of Subcommittee E06.11 on Horizontal and Vertical Structures/Structural Performance of Completed Structures.

Current edition approved March 10, 1996. Published May 1996. Originally published as E 73 – 48 T. Last previous edition E 73 - 83 (1991).

[2] *Annual Book of ASTM Standards,* Vol 04.11.

in an inverted or horizontal position to compensate for the effect of dead loads and gravity. Regardless of the orientation of the truss in the test fixture, the fixture and load application means shall be designed with an ample margin of safety to ensure that it is the test specimen that is being tested and not the test fixture. More information on the testing of components in existing structures is contained in Practice E 196.

6.2 *Supports and Reactions*:

6.2.1 The reaction supports shall provide sufficient clearance above the ground or restraint frame to allow for normal displacements, ease of loading, instrumentation, and provide room for observations and measurements. Supports shall have adequate strength and stiffness to resist deformations during tests.

6.2.2 Support reaction hardware shall be typical of that planned for use in the completed structure or as required to satisfy the intent of the tests. In a single truss test, frequently the support at one end will allow rotation but not translation (a rocker) and the other will allow both rotation and translation (a roller) so as not to induce additional unintentional secondary stresses into the test truss as it deforms under load.

6.2.3 Where lateral support is used, it shall not interfere with the free in-plane displacement of the truss assembly. The test trusses shall not be laterally supported in a manner that will exceed that intended in a typical installation. Trusses tested in pairs shall be laterally braced and sheathed in a typical manner. Lateral bracing between trusses tested in pairs shall be installed in a manner to prevent both trusses from buckling together. Care shall be taken when testing trusses horizontally to keep the test truss flat to minimize any adverse lateral displacement caused by gravity.

6.3 *Loading Devices*:

6.3.1 The loading devices shall result in the desired truss loading situation regardless of whether uniform, concentrated, or a combination of both. The system shall be such as to allow the application of loads during the test to approximate the overall intended in-service load distribution. Care should be taken to avoid eccentrically applied loads unless this type of loading is desired.

6.3.2 Vertical loads may be applied in the form of dead weight through bearing, suspension, or jacking arrangements. Horizontal loads are usually applied by some form of jacking arrangement directly in-plane or by using a system of cables and pulleys with dead weights or hydraulic cylinders. The loading system should have provisions for applying unbalanced loads when this type of loading can be critical to truss performance (see 9.4). Uplift forces such as those caused by wind loads may be simulated by reversing the direction of the applied gravity loads; or if the fixture will permit it, testing the truss upside down. It is preferable to test the truss in its normally installed orientation in order to more typically allow for the uplift forces working against gravity forces.

6.3.3 When loads are to be applied using dead weight, such items as sand, masonry units, iron or lead ingots, boxed nails, roll roofing, water or boxed fireplace logs have been successfully employed as a loading medium. The arrangement of dead load material shall be such as to prevent any arching action that can seriously alter the intended load pattern. When water is used, care shall be taken to compartmentalize the water in cells to prevent a non-uniform load as the truss and elements deflect. Air bags reacting against restraint frames have also been used.

6.4 *Load and Deflection Measuring Devices*

6.4.1 *Load Measuring Devices*—Loads may be measured using one or more of the following devices. Pressure gages or hydraulic load cells can be incorporated into a hydraulic loading system. These devices must be calibrated with the jacks or cylinders at different positions of piston travel to ensure a true loading history. Spring dynamometers, electronic load cells, or the weighing tables of universal testing machines have also been successfully used. The load measuring device or devices used shall be capable of measuring loads to an accuracy of ± 2 % of design load.

6.4.2 *Deflection Measuring Devices*:

6.4.2.1 Deflection readings may be taken in a variety of ways. One of the simplest methods is by the use of a taut wire or mono-filament line stretched between supports in combination with a mirror-scale located at the desired deflection measuring points. Such a device avoids any magnification of deflection readings due to a settlement of supports during loading. When the taut wire method is used, care must be taken to ensure that the wire will remain under tension during the entire test. This can be accomplished by incorporating a spring into the line or by letting one end run over a pulley with a weight attached to the line. Deflections are read on a scale with a mirror backing. The mirror-scale deflection measuring device is read by visually lining up the top of the wire with its image on the mirror and then reading the scale.

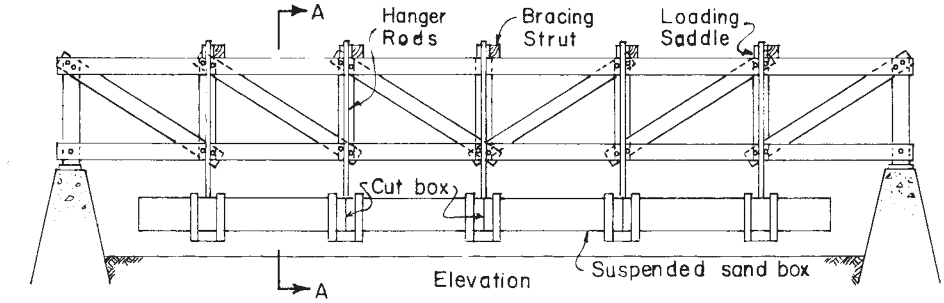
6.4.2.2 Other commonly used devices are such things as direct reading micrometer dial gages, optical levels used to read scales attached to the truss, linearly variable differential transformers (LVDT), or a combination of flexible wire attached at deflection points and monitored remotely through a system of pulleys attached to dial gages. Deflection readings and measuring devices shall have an accuracy of ± 2 % of design load deflection.

6.4.3 *Strain Measurements*—Strain measurements may be taken on truss elements using electrical or mechanical strain gages. Approximate stress distribution and magnitude may be observed by the application of special brittle lacquers to the areas of interest. All of these measurements should be made by personnel experienced in the application and operation of the methods employed on the material being tested.

6.5 *Typical Setups*—Some suggested setups for running truss tests are shown in Figs. 1-3.

7. Hazards

7.1 Full-scale load tests of any large size specimen such as a truss can be hazardous to the individuals performing or observing the tests, and also damage the testing fixtures or the structure housing the test setup due to a sudden release of stored energy at failure. Care should be exercised in the preparation of the test setup to ensure that the failure of a test specimen will not result in a secondary collapse of a structural element not involved in the test.



(*a*) Truss assembly with panel point loading.

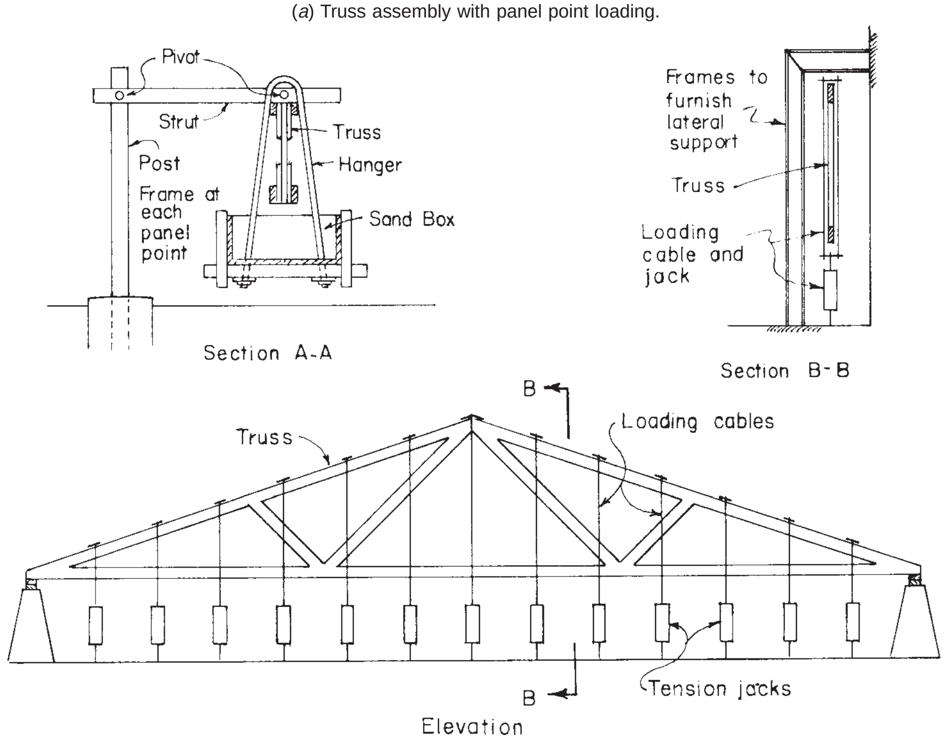


FIG. 1 Trusses Set Vertical, in Normal Position

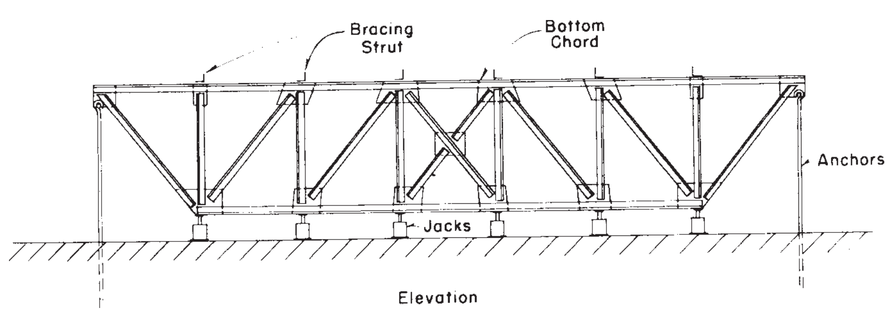


FIG. 2 Truss Set Vertical, in Inverted Position

8. Test Specimens

8.1 *Number of Specimens*—The number of similar trusses that should be tested will vary with the desired precision and reliability of the information to be obtained and with the purpose of the text. Where only approximate values are desired or the assembly is large and contains many elements, a single test may suffice. Where more precise and statistically reliable data are required, a minimum of three or more tests are preferred. The final number will be controlled by the purpose of the tests, and as agreed upon by the sponsor, testing agency or regulatory agency, if any is involved.

8.2 *Materials*:

8.2.1 Truss assembly elements, connectors, and connections shall be typical of those intended for use in the final product or as required to satisfy the intent of the tests.

8.2.2 Truss materials that are moisture, time, temperature or otherwise sensitive to curing or conditioning, which can affect the performance of the test assembly, shall be representative of

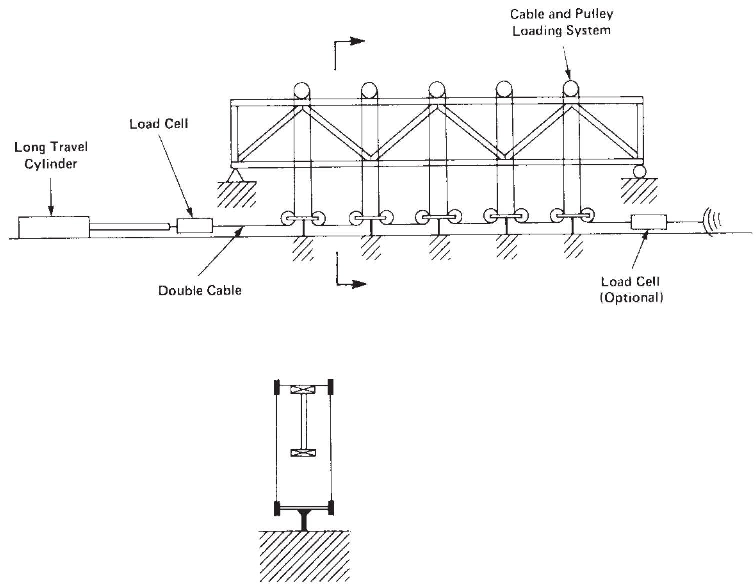


FIG. 3 Truss in Vertical Position

materials intended for use in the final assembly or as required to meet the intent of the tests.

8.3 *Fabrication*:

8.3.1 Fabrication of the test specimens shall be typical of that intended for the finished product or as necessary to satisfy the purpose of the tests. Where "standard" conditions are required at the time of test, such as a particular curing or aging time, moisture content, etc., the truss materials and the fabricated assemblies shall be conditioned, stored and handled in a manner to achieve them.

8.3.2 Connections shall be made in accordance with good practice following the recommendations of the manufacturer of the connectors or connecting material involved.

9. Loading Procedures

9.1 *Load Increments*:

9.1.1 Although the load increments may vary with the intent of the test, satisfactory load-response data can usually be obtained if each of the first four increments of load does not exceed 25 % of the total design live load and any additional load increments do not exceed 50 % of the design live load. Load shall be slowly applied to the truss assembly so as to provide a static loading condition. This is particularly important with materials that are sensitive to time under load.

9.1.2 The above mentioned load increments apply to both uniform and concentrated loads.

9.2 *Deflection Measurements*:

9.2.1 As a minimum, take deflection measurements along the bottom chord at midspan and at quarter points.

9.2.2 When deflection measuring systems that do not compensate for support settlement are used, measurement of support displacement under load is needed to obtain an accurate load-deflection response and recovery after the removal of load.

9.3 *Duration of Load Application*—Except in the instances of impact and racking tests, after each increment of load is applied, the load level shall be maintained as constant as possible for a period of five minutes (see 9.3.1). Deformation readings shall be taken 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. Initial and 5-min readings shall be plotted in the form of load-deformation curves. Complete load-deformation-time records shall be maintained throughout the test. If application of a given load is required for a certain period, such as 24 h, deformation readings shall be taken 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.

9.3.1 Reasons for the 5-min application of constant-level increment loads are as follows:

9.3.1.1 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.)

9.3.1.2 To provide sufficient time for making all observations. (Longer time intervals may be required under certain conditions.)

9.3.1.3 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.

9.3.1.4 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.

9.3.1.5 To assure uniformity in test performance and consistency in test results.

9.4 *Unbalanced Loads*:

9.4.1 When the design of the truss is such that the application of an unbalanced live load in-service can cause member stress reversals or undesirable secondary moments, this type of test shall be run. The magnitude and positioning of the unbalanced live load shall be as specified by the sponsor or the governing code authority.

9.4.2 *Loading Procedure*—Apply the dead load to the truss in not less than two equal increments. Apply the live loads in increments as specified in 9.1. Particular attention shall be paid to the response of the truss to this unbalanced loading condition to determine the effects of secondary stresses.

9.5 *Repetitive Loads*—Where specified, repetitive loads shall be applied to the truss with deflection and other appropriate data being taken during each cycle. When the truss is unloaded to a pre-established level, such as 10 % of the live load, deflection recovery readings shall be taken at the time of unloading and 5 min after unloading to check the recovery. When ten or more loading cycles are to be applied to the truss, the procedures in 9.3, Duration of Load Application Requirement, need not be followed. In this case, full live load shall not be applied to the truss during any cycle in less than 5 min. The intent of this section is not to supercede 9.3, but rather to allow a different period of loading for extended testing that will keep testing time and costs within a reasonable limit. Automatic data recording systems are highly desirable for use during repetitive loads tests.

10. Auxiliary Tests

10.1 To aid in the interpretation of the test results, it is frequently desirable to determine the properties or materials, connectors, or both used in assembling the test trusses. This should be done in accordance with pertinent ASTM standards.

11. Interpretation of Test Results

11.1 No statistical inferences can be made when trusses are tested singly or in pairs if only replication or specimen is tested. Results of these tests will probably be more useful when proof load tests are run or to observe the general response of a design to applied loads rather than trying to determine the safe load carrying capacity for a particular design or family of trusses.

11.2 When a minimum of three trusses are tested and the high and low values are within 10 % of the load for the middle truss, the results may be averaged and appropriate safety or load factors applied to the mean values of the ultimate or proportional limit loads, whichever gives the most conservative value. Where the results of three tests are spread beyond the 10 % limit, average the results of the lower two tests. If the lowest test value is outside the 10 % limit and the reasons are obvious and considered non-representative, the low value may be ignored providing a fourth truss is tested and the above averaging system applied. If the fourth test also is low, average the results of the lowest three tests. A fourth test need not be run if the lowest two test values are averaged even though they differ by more than 10 %. Regardless of whether or not additional tests are conducted due to a low reading, all results shall be reported.

11.3 When a significant number of similar trusses are identically tested, for example six or more, the application of small sample statistics to the results becomes reasonable.

12. Report

12.1 The report shall follow the format and contain information in accordance with Practice E 575.

13. Precision and Bias

13.1 Because of the nature of these tests and the variety of techniques that can be employed in conducting them, no statement can be made about their precision and bias.

14. Keywords

14.1 static load; truss; truss assemblies