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Standard Practice for Static Load Testing of Truss Assemblies¹

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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*:²

E196 Practice for Gravity Load Testing of Floors and Low Slope Roofs

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

E631 Terminology of Building Constructions

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

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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.

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 E631.

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 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 E196.

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 success-

fully 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 $\pm 2\%$ 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 $\pm 2\%$ 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