Designation: D7746 – 21

Standard Practice for Calculating the Superimposed Load on Wood-frame Floor-Ceiling Assemblies for Standard Fire-Resistance Tests[1]

This standard is issued under the fixed designation D7746; 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 covers procedures for calculating the superimposed load required to be applied to load-bearing wood-frame floor-ceiling assemblies throughout standard fire-resistance tests.

1.2 These calculations determine the maximum superimposed load to be applied to the floor-ceiling assembly during the fire resistance test. The maximum superimposed load, calculated in accordance with nationally-recognized structural design criteria, shall be designed to induce the maximum allowable stress in the wood floor-ceiling fire test configuration being tested.

1.3 This practice is only applicable to those wood-frame floor-ceiling assemblies for which the nationally recognized structural design criteria are contained in the *National Design Specification for Wood Construction* (NDS).

1.4 The text of this standard references notes and footnotes which provide explanatory material. These notes and footnotes (excluding those in tables and figures) shall not be considered as requirements of the standard.

1.5 The values stated in inch-pound units are to be regarded as standard. No other units of measurement are included in this standard.

1.6 *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.*

1.7 *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]

D9 Terminology Relating to Wood and Wood-Based Products

D6513 Practice for Calculating the Superimposed Load on Wood-frame Walls for Standard Fire-Resistance Tests

E119 Test Methods for Fire Tests of Building Construction and Materials

E176 Terminology of Fire Standards

E1529 Test Methods for Determining Effects of Large Hydrocarbon Pool Fires on Structural Members and Assemblies

2.2 *Other Standards:*[3]

ANSI/AWC National Design Specification (NDS) for Wood Construction

NDS Supplement Design Values for Wood Construction

3. Terminology

3.1 *Definitions*—Definitions used in this practice are in accordance with Terminology D9 and Terminology E176, unless otherwise indicated.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *gross cross-sectional area, n*—section area calculated from overall actual dimensions of member.

3.2.1.1 *Discussion*—For sawn lumber and glue laminated timber, gross cross-sectional area is based on the standard dressed size of the member as given in the NDS Supplement. For I-joists and structural composite lumber, the gross cross-sectional areas or product dimensions are given in the product literature or code evaluation report.

3.2.2 *net section area, n*—section area calculated by deducting from the gross cross-sectional area the projected area of all materials removed by boring, grooving, dapping, notching, or other means.

[1] This practice is under the jurisdiction of ASTM Committee D07 on Wood and is the direct responsibility of Subcommittee D07.05 on Wood Assemblies.

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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] Available from American Wood Council (AWC), 222 Catoctin Circle SE, Suite 201, Leesburg, VA 20175, http://www.awc.org.

3.2.2.1 *Discussion*—For nailed or screwed connections, the net section area equals the gross cross-sectional area.

3.2.3 *span of member, n*—distance from face to face of supports, plus half of the required bearing length at each end.

3.2.4 *superimposed load, n*—additional external load needed to be applied to the assembly during the test to achieve the required stresses within the assembly after any dead load of the assembly itself is accounted for in the calculations.

4. Significance and Use

4.1 Test Methods E119, E1529, and other standard fire resistance test methods specify that throughout the fire-resistance test, a constant superimposed load shall be applied to a load-bearing test specimen to simulate a maximum allowable load condition. This superimposed load shall be the maximum load allowed by design under nationally recognized structural design criteria for the tested floor configuration (that is, joist selection, spacing, and span).

4.1.1 For this practice, the nationally recognized structural design criteria to be used to determine the maximum load condition are those for the allowable stress design (ASD) method in the NDS (National Design Specification for Wood Construction).

NOTE 1—The NDS should be used to ensure calculation of the superimposed load is in compliance with all applicable provisions of that standard. Appendix X1 describes how to calculate the superimposed load in accordance with the NDS.

4.1.2 Alternatively, the standard fire resistance test methods shall be permitted to be conducted by applying a load less than the maximum allowable load in 4.1.1 for the tested configuration; however, these tests shall be identified in the test report as being conducted under restricted loading conditions.

4.2 This practice describes procedures for calculating the superimposed load to be applied in standard fire resistance tests of wood floor-ceiling assemblies. Practice D6513 provides a similar methodology for calculating the superimposed load on wood-frame walls.

4.3 Statements in either the fire resistance test method standard or the nationally recognized structural design standard supersede any procedures described by this practice.

5. Test Assumptions

5.1 *Floor Assembly Structural Members*—For design considerations, wood-frame floor-ceiling assemblies consist of horizontal structural members (that is, joists), the floor decking or sheathing, and the perimeter rim boards.

5.2 *Loading Conditions*—Horizontal framing members support a vertical load that is placed on the floor assembly to approximate the effects of a uniformly distributed load on the joists. Loading shall be applied to joists without relying on floor sheathing to distribute load. Load effects on joists shall be determined based on the actual load distribution.

5.2.1 The calculation procedure in this standard is not appropriate for a test that uses a load application system that incorporates discrete point load distribution beams or frames with spanning capabilities that serve to artificially re-distribute load from a failing member to the adjacent framing. Such a system would require a higher load to be applied that considers the enhanced load-sharing between members provided by the load frame and the departure from a uniform load condition.

NOTE 2—The intent is to simulate uniform loading conditions as reasonably as possible within typical laboratory constraints. However, loads are commonly applied with discrete loading elements, such as dead weight packs, water barrels, hydraulic cylinders, pneumatic cylinders, etc. An example of a system that conforms to the calculation assumption would be one in which multiple discrete load elements are provided along the floor assembly joists to approximate a uniform surface load. Load for each discrete load element is applied to the floor joists by distribution beams that span across not more than three adjacent floor joists. No more than two distribution beams should be used for each discrete load element and the distribution beams should be centered below the load element to ensure equal load distribution. While the barrels or tanks may be evenly spaced, the distribution beams may not be evenly spaced along the joists, and loads on adjacent joists may need to be offset slightly along the joist length to prevent interference between distribution beams. These constraints result in differences between the load effects from a true uniform load distribution and the load effects due to a series of point loads. Where loading consists of a series of point loads applied to each joist, the difference in structural actions between the assumed uniform loading and the actual load configuration should be considered.

5.3 Lateral or torsional end support, including but not limited to bridging, blocking, or bracing, shall be provided at points of bearing to prevent rotation. When additional lateral or torsional support is used away from the ends to enhance performance of the floor-ceiling assembly, description and locations of the support shall be reported

5.4 Where required to ensure that bearing capacity does not limit the test load, stiffeners or an increased bearing length shall be permitted at the bearing locations to increase capacity.

6. Design Load Calculations

6.1 *Design Values*—-Reference design values: F_b, F_v, $F_{c\perp}$, E and E_{min} for rectangular sections are given in the NDS Supplement, product literature, or code evaluation report. Reference design values: M, V, R_r, E_I, EI_{min}, and K for I-joists are given in the product literature, or code evaluation report.

6.2 *Design Value Adjustments*—Reference design values shall be multiplied by all applicable adjustment factors to determine the adjusted design values. Additional adjustments, required to address special design considerations for the specific member type, shall be applied. Not all factors are applicable to all product types.

6.2.1 *Bending—F_b* for rectangular sections and M for I-joists shall be multiplied by all applicable NDS adjustment factors including: C_D, C_M, C_t, C_L, C_F, C_V, C_{fu}, C_i, C_r, C_c.

6.2.2 Compression parallel to the grain, F_c, shall be multiplied by all applicable NDS adjustment factors including: C_D, C_M, C_t, C_F, C_i, and C_P.

6.2.3 *Shear parallel to grain—F_v* for rectangular sections and V for I-joists shall be multiplied by all applicable NDS adjustment factors including: C_D, C_M, C_t, C_i.

6.2.4 Tension parallel to grain, F_t, shall be multiplied by all applicable NDS adjustment factors including: C_D, C_M, C_t, C_F, C_i.

6.2.5 *Bearing:*

6.2.5.1 *Compression perpendicular-to-grain—$F_{c\perp}$* for rectangular sections shall be multiplied by all applicable NDS adjustment factors including: C_M, C_t, C_i, C_b.