



# Research Report

## Bottom Chord Live Load Concurrency and Truss Design

SRR No. 1607-02

Structural Building Components Association (SBCA)

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This research report is based on practical scientific research (literature review, testing, analysis, etc.). This research report complies with the following sections of the building code:

- [IBC Section 104.11.1](#) and [Section 1703.4.2](#) – "**Research reports.** Supporting data, where necessary to assist in the approval of materials or assemblies not specifically provided for in this code, shall consist of valid research reports from *approved sources*."
- [IBC Section 202](#) – "**APPROVED SOURCE.** An independent person, firm or corporation, *approved* by the *building official*, who is competent and experienced in the application of engineering principles to materials, methods or systems analyses."

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### **Introduction:**

This SBCA Research Report (SRR) examines the application of live loads to the bottom chord of trusses for uninhabitable attics in accordance with the International Residential Code (*IRC*) Table R301.5 and the International Building Code (*IBC*) Table 1607.1 and ASCE 7-10 Table 4-1. The truss industry is currently employing ASCE as its source for the correct loading of trusses. Correct loading is key to proper truss design and results in safer trusses, better truss performance and ultimately lower costs. However, there currently is a discrepancy regarding concurrency of bottom chord live loads between ASCE 7, the *IBC* and the *IRC*.

### **Key Definitions:**

**ATTIC** ([IRC Section R202](#)) – The unfinished space between the ceiling assembly and the roof assembly.

**AUTHORITY HAVING JURISDICTION** (Interpreted from [IBC Section 104.1](#)) – The building official authorized and directed to enforce the provisions of a building code who also has the authority to render interpretations of the code and to adopt policies and procedures in order to clarify the application of its provisions.

**BUILDING DESIGNER** ([ANSI/TPI 1 Section 2.2](#)) – Owner of the building or the person that contracts with the owner for the design of the Building Structural System and/or who is responsible for the preparation of the Construction Documents. When mandated by the legal requirements, the Building Designer shall be a Registered Design Professional.

**DEAD LOADS (D)** ([IBC Section 2](#)) – The weight of the material of construction incorporated into the building, including but not limited to walls, floors, roofs, ceilings, stairways, built-in partitions, finishes, cladding, and other similarly incorporated architectural and structural items, and fixed service equipment, such as cranes, plumbing stacks and risers, electrical feeders, heating, ventilating and air-conditioning systems and automatic sprinkler systems.

**HABITABLE SPACE** ([IBC Section 2](#)) – A space in a building for living, sleeping, eating or cooking. Bathrooms, toilet rooms, closets, halls, storage or utility spaced and similar areas are not considered habitable spaces.

**LIVE LOAD (L)** ([IBC Section 2](#)) – A load produced by the use and occupancy of the building or other structure that does not include construction or environmental loads such as wind load, snow load, rain load, earthquake load, flood load or dead load.

**LOADS** ([IBC Section 2](#)) – Forces or other actions that result from the weight of building materials, occupants and their possessions, environmental effects, differential movement and restrained dimensional changes. Permanent loads are those loads in which variations over time are rare or of small magnitude, such as dead loads. All other loads are variable loads (see “Nominal loads”).

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### Background:

The truss industry uses *ASCE 7*, a referenced standard in both the *IBC* and the *IRC*, as the basis for the design of trusses with respect to the application of loads applied to uninhabitable attics with and without storage. *ASCE 7-10* (both 1<sup>st</sup> Printing and 3<sup>rd</sup> Printing) contains a live load table with content similar to the tables found in the *IRC* and the *IBC*.

ASCE 7-10 Table 4-1 states the following:

Occupancy or Use	Uniform psf (kN/m <sup>2</sup> )
Residential	
One- and two- family dwellings	
Uninhabitable attics without storage	10 (0.48) <sup>l</sup>
Uninhabitable attics with storage	20 (0.96) <sup>m</sup>

Footnote “*l*” from ASCE 7-10 Table 4-1 states (emphasis added):

<sup>l</sup>Uninhabitable attic areas without storage are those where the maximum clear height between the joist and rafter is less than 42 in. (1,067 mm), or where there are not two or more adjacent trusses with web configurations capable of accommodating an assumed rectangle 42 in. (1,067 mm) in height by 24 in (610 mm) in width, or greater, within the plane of the trusses. **This live load need not be assumed to act concurrently with any other live load requirement.**

Footnote “*m*” from ASCE 7-10 Table 4-1 states (emphasis added):

<sup>m</sup>Uninhabitable attic areas with storage are those where the maximum clear height between the joist and rafter is 42 in. (1,067 mm), or greater, or where there are two or more adjacent trusses with web configurations capable of accommodating an assumed rectangle 42 in. (1,067 mm) in height by 24 in (610 mm) in width, or greater, within the plane of the trusses. For attics constructed of trusses, the live load need only be applied to those portions of the bottom chords where both of the following conditions are met:

- i. The attic area is accessible from an opening not less than 20 in. (508 mm) in width by 30 in. (762 mm) in length that is located where the clear height in the attic is a minimum of 30 in. (762 mm); and
- ii. The slope of the truss bottom chord is no greater than 2 units vertical to 12 units horizontal (9.5% slope).

The remaining portions of the bottom chokes shall be designed for a **uniformly distributed nonconcurrent live load of not less than 10 lb/ft<sup>2</sup> (0.48 kN/m<sup>2</sup>).**

In the *ASCE 7-10* (both 1<sup>st</sup> Printing and 3<sup>rd</sup> Printing) footnotes, the application of this non-storage live load is non-concurrent in both cases. *ASCE 7-10* Errata, dated January 11, 2011, contains the same live load table with content similar to the tables found in the *IRC* and the *IBC*, but with two changes to the language of footnote “*m*” (emphasis added):

<sup>m</sup>Uninhabitable attic areas with storage are those where the maximum clear height between the joist and rafter is 42 in. (1,067 mm), or greater, or where there are two or more adjacent trusses with web configurations capable of accommodating an assumed rectangle 42 in. (1,067 mm) in height by 24 in (610 mm) in width, or greater, within the plane of the trusses. ~~For attics constructed of trusses~~At the trusses, the live load need only be applied to those portions of the bottom chords where both of the following conditions are met:

- i. The attic area is accessible from an opening not less than 20 in. (508 mm) in width by 30 in. (762 mm) in length that is located where the clear height in the attic is a minimum of 30 in. (762 mm); and
- ii. The slope of the truss bottom chord is no greater than 2 units vertical to 12 units horizontal (9.5% slope).

The remaining portions of the bottom chokes shall be designed for a **uniformly distributed concurrent live load of not less than 10 lb/ft<sup>2</sup> (0.48 kN/m<sup>2</sup>).**

Note the change in language to “concurrent”, this is an inadvertent anomaly which did not make it into the 3<sup>rd</sup> printing of *ASCE 7-10* in 2013.

This error created a discrepancy in the 2012 & 2015 *IRC* table R301.5 which contains this information:

USE	LIVE LOAD
Uninhabitable attics without storage <sup>b</sup>	10
Uninhabitable attics with limited storage <sup>b, g</sup>	20

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Footnote “b” from 2012 *IRC* Table R301.5 (*IRC* 2015 reads similarly) (emphasis added):

b. Uninhabitable attics without storage are those where the maximum clear height between joists and rafters is less than 42 inches, or where there are not two or more adjacent trusses with the same web configurations capable of accommodating an assumed rectangle 42 inches high by 24 inches in width, or greater, within the plane of the trusses. **This live load need not be assumed to act concurrently with any other live load requirements.**

Footnote “g” from 2012 *IRC* Table R301.5 (2015 *IRC* reads similarly) (emphasis added):

g. Uninhabitable attics with limited storage are those where the maximum clear height between joists and rafters is 42 inches or greater, or where there are two or more adjacent trusses with web configurations capable of accommodating an assumed rectangle 42 inches in height by 24 inches in width, or greater, within the plane of the trusses.

The live load need only be applied to those portions of the joists or truss bottom chords where all of the following conditions are met:

1. The attic area is accessible from an opening not less than 20 inches in width by 30 inches in length that is located where the clear height in the attic is a minimum of 30 inches.
2. The slopes of the joists or truss has a bottom chords are no greater than 2 inches vertical to 12 units horizontal.
3. Required insulation depth is less than the joist or truss bottom chord member depth.

**The remaining portions of the joists or truss bottom chords shall be designed for a uniformly distributed concurrent live load of not less than 10 lb/ft<sup>2</sup>**

Note that, in footnote “b”, the uninhabitable attics without storage have a 10 psf live load that is non-concurrent with other live loads. This same load in footnote “g” (i.e. the area of the attic where storage loads are not applied) is listed as a 10 psf live load concurrent with other live loads.

The discrepancy is also found in the 2012/2015 *IBC*. Table 1607.1 of the 2012/2015 *IBC* contains the following information:

OCCUPANCY OR USE	UNIFORM (psf)
25. Residential	
One- and two- family dwellings	
Uninhabitable attics without storage <sup>i</sup>	10
Uninhabitable attics with storage <sup>ij,k</sup>	20

Footnote “i” from the 2012 *IBC* Table 1607.1 (2015 *IBC* reads the same) (emphasis added):

i. Uninhabitable attics without storage are those where the maximum clear height between the joists and rafters is less than 42 inches, or where there are not two or more adjacent trusses with web configurations capable of accommodating an assumed rectangle 42 inches in height by 24 inches in width, or greater, within the plane of the trusses. **This live load need not be assumed to act concurrently with any other live load requirements.**

Footnote “j” from the 2012 *IBC* Table 1607.1 (2015 *IBC* reads the same) (emphasis added):

j. Uninhabitable attics with storage are those where the maximum clear height between the joists and rafters is 42 inches or greater, or where there are two or more adjacent trusses with web configurations capable of accommodating an assumed rectangle 42 inches in height by 24 inches in width, or greater, within the plane of the trusses.

The live load need only be applied to those portions of the joists or truss bottom chords where both of the following conditions are met:

- i. The attic area is accessible from an opening not less than 20 inches in width by 30 inches in length that is located where the clear height in the attic is a minimum of 30 inches; and
- ii. The slopes of the joists or truss bottom chords are no greater than two units vertical in 12 units horizontal.

**The remaining portions of the joists or truss bottoms chords shall be designed for a uniformly distributed concurrent live load of not less than 10 lb/ft<sup>2</sup>.**

Just as in the *IRC*, the *IBC* is inconsistent in the application of the concurrency of the non-storage load. In footnote “i”, uninhabitable attics without storage have a 10 psf live load that is non-concurrent with other live loads. This same load in footnote “j” (i.e. the area of the attic where storage loads are not applied) is listed as 10 psf live load concurrent with other live loads. The development of the *IBC* and *IRC* language provides a background in determining which statements are correct.

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During the code development process for the 2012 *IBC* and *IRC* code change proposal S57-09/10, parts I and II were accepted by the code development committee and subsequently approved at the final action hearings. Proposal S57-09/10 changes the language in the footnotes for *IBC* Table 1607.1 and *IRC* Table R301.5 that deal with uninhabitable attics without storage. The reason for the change was stated as follows:

**Reason:** The purpose for this proposal is to correlate the *IBC* and *IRC* with the 2010 edition of ASCE7. The need for correlation is due to ASCE 7 Proposal LLSC-LL-9, which has been approved by the Live Load Subcommittee and is being balloted by the Main Committee (Item #5 of the Second Main Committee Ballot on Live/Dead Load Provisions). It is expected that the Main Committee will approve the proposal. The changes are seen as largely editorial. In footnotes (i) and (j), the threshold that is based on a 24-inch by 42-inch rectangular is changed to an assumed condition (rather than an actual one), which is considered more appropriate for building code requirement...

As noted in the reason statement above, the proposed language was based on a proposal to change ASCE 7-10, which had not yet completed the balloting process. Subsequently, the language in the ASCE 7-10 proposal was corrected to reflect the intended non-concurrency of the live load in non-storage areas, and that approved language now shows this load as non-concurrent. This approved language was not picked up in the *IBC* and *IRC* process. The 10 psf live load on those portions of the bottom chords not serving as storage areas was intended to reflect the requirement to provide a 10 psf load per *IBC* Table 1607.1 and *IRC* Table R301.5, for uninhabitable attics without storage. Footnotes “b” (*IRC*) and “j” (*IBC*) clearly indicate that this is a non-concurrent load. It was also intended to coordinate with ASCE 7-10 Table 4-1. Current truss design methodology also treats this 10 psf non-storage load as a non-concurrent maintenance load.

Furthermore, the Commentary in *IBC* Section 1607.1 Live Loads, General states (emphasis added):

Historically, a minimum load of 10 psf (0.48 Kn/m<sup>2</sup>) has been viewed as appropriate where occasional access to the attic is anticipated for maintenance purposes, but significant storage is restricted by physical constraints, such as low clearance or the configuration of truss webs. It provides a minimum degree of structural integrity, allowing for occasional access to an attic space for maintenance purposes. **Allowing the application of this load to be independent of other live loads is deemed appropriate, since it would be rare for this load and other maximum live loads to occur at once.**

The above clearly states that the maintenance live load need not be applied at the same time as other live loads. In other words, it is non-concurrent with other live loads.

### **Application:**

It is the position of the Structural Building Components Association (SBCA), that truss design should continue the use of ASCE 7's provisions for bottom chord storage live load **non-concurrent** with other live loads. The language of the *IBC* and *IRC* was inadvertently created from an erroneous version of the ASCE 7, which it was intended to match. Subsequently, ASCE 7 was corrected to revert back to the non-concurrent status of these loads.

### **Building Designer Responsibility:**

Responsibilities:

- The information contained herein is a product, engineering or building code compliance research report prepared in accordance with the referenced building codes, testing and/or analysis using accepted engineering procedures, experience, and good technical judgment.
- SBCA Research Reports provide an assessment of only those attributes specifically addressed within a given report.
- Applicability to a specific project is the sole responsibility of the Building Designer.

This research report is subject to periodic review and revision. For the most recent version of this report, visit [sbcindustry.com](http://sbcindustry.com). For information on the current status of this report, contact SBCA.

## SBCA Research Report (SRR)

### **References:**

*ANSI/AWC National Design Specification (NDS) for Wood Construction*; American Wood Council; 2015.

*ANSI/TPI 1 – National Design Standard for Metal Plate Connected Wood Truss Construction*; Truss Plate Institute; 2007.

*ASCE/SEI 7 – Minimum Design Loads for Buildings and Other Structures*; American Society of Civil Engineers and the Structural Engineering Institute; 2010.

*International Building Code*; International Code Council; 2012.

*International Residential Code*; International Code Council; 2012.

*International Building Code*; International Code Council; 2015.

*International Residential Code*; International Code Council; 2015.