

Live Load Considerations for Truss Bottom Chords

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Issue:

There is a lack of uniformity in when and where it is appropriate to apply the non-storage live load and the storage live load between various building codes and code jurisdictions. There is an advantage to all construction professionals to have a solution that provides the greatest uniformity across code jurisdictions as implementation will be better understood and more likely to be consistently applied.

Unique Definitions for Structures that require a RDP:

BUILDING DESIGNER:

The Owner of the Building contracts with a Registered Design Professional for the design of the Building Structural System and who is responsible for the Construction Documents.¹

TRUSS DESIGN ENGINEER:

The individual or organization responsible for the design of Trusses. Each individual truss design drawing shall bear the seal and signature of the Truss Design Engineer.²

Unique Definitions for Structures that do not require a RDP:

BUILDING DESIGNER:

The Owner of the Building or the individual or organization that contracts with the Owner for the design of the Building Structural System and/or who produces the Construction Documents.³

TRUSS DESIGNER:

The individual or organization responsible for the design of trusses.⁴

Analysis:

The load differences can be illustrated by the variations in the requirements in the International Residential Code (IRC) 2000 (*Appendix A*), IRC 2003 (*Appendix B*), IRC 2006 (*Appendix C*), and the Michigan Residential Code (MRC) 2003 (*Appendix D*).

¹ Adapted from IBC section 106.1.

² Adapted from IBC section 2303.4.

³ Adapted from IBC 106.1

⁴ Adapted from IBC 2303.4



Prepared with assistance from Structural Building Components Association of Michigan, a local chapter of SBCA.

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Issue	IRC 2000	IRC 2003	MRC 2003	IRC 2006
Non-storage load value	10 psf	10 psf	10 psf	10 psf
Non-storage concurrency	References R802.10.1	Not addressed	Non-concurrent	Non-concurrent
Non-storage application		Not addressed	Assumed length of Bottom Chord (BC)	Entire length of BC
Storage load value	20 psf	20 psf	20 psf	20 psf
Storage load application	Over 3/12 pitch & References R802.10.1	Over 3/12 pitch	Per location on voluntary Roof Load Data sheet	BOCA/S14 —Attics without storage are those where there are not two or more adjacent trusses with the same web configuration capable of containing a rectangle 42 inches high by 2 feet wide, or greater, located within the plane of the truss, and The truss shall have a bottom chord pitch less than 2:12

There is no question that the code requirements regarding ceiling loading in the 2000 and 2003 IRC editions is vague and subject to conflicting interpretations as to the application of both the non-storage load and the storage load. The IRC 2006 language was written to capture what has been intended by the building code all along and to be much clearer than the IRC 2000, 2003 or MRC 2003.

Non-Storage Load Comparison

Both the MRC 2003 and the IRC 2006 address the issue of the non-concurrency of the non-storage load. The application of the non-storage load appears to be similar, but only based upon an interpretation of the MRC, not upon explicit and clear language.

- ◆ It is not clear in the MRC 2003 how or when the non-storage load is to be applied, nor is it clear from the voluntary Roof Load Data Sheet which attic live load is being described for the indicated application. The MRC apparently intends that the 10 psf non-storage load is applied over the full extent of the bottom chord, whenever no other live load (storage or living) is specified.
- ◆ The IRC 2006 requirements are the same regarding bottom chord live loads and are concise in their application of the non-storage load. They also require that the non-storage load be applied in cases where storage or living load is not considered:

Attics without storage are those where the maximum clear height between joist and rafter is less than 42 inches, or where there are not two or more adjacent trusses with the same web configuration capable of containing a rectangle 42 inches high by 2 feet wide, or greater, located within the plane of the truss. The truss shall have a bottom chord pitch less than 2:12.

- ◆ In both cases the applied non-storage load is non-concurrent with other live loads and therefore will not control the design of the bottom chord.

Storage Load Comparison from MRC 2003 Commentary

The MRC 2003 only appears to address the application of the storage load (20 psf) by way of the voluntary Roof Load Data Sheet. This allows someone to specify the load that is to be applied and its location in the structure (to the entire attic area or only designated areas). There is no information regarding how the load is to be considered if no Roof Load Data Sheet is provided. When applying the storage loading in truss design software, if the load is applied only in specific areas on a bottom chord, the loading would have to be addressed manually on a truss by truss basis. This loading could easily be applied incorrectly depending on how the non-concurrent rules are interpreted.

This approach also requires that this load be applied to scissors trusses since there is not requirement defined for bottom chord slope.

This approach may also require the Building Designer to develop special load cases instead of using the pre-defined BOCA loading option already programmed into existing software.

IRC 2006 Commentary

The IRC 2006 implementation uses a time-accepted method which is also available in all the truss design software based upon the accepted BOCA model. In addition to providing specific load location guidance, it provides guidance regarding accessibility and bottom chord slope.

g. For attics with limited storage and constructed with trusses, this live load need only be applied to those portions of the bottom chord where there are two or more adjacent trusses with the same web configuration capable of containing a rectangle 42 inches (1067 mm) high or greater by 2 feet (610 mm) wide or greater, located within the plane of the truss. The rectangle shall fit between the top of the bottom chord and the bottom of any other truss member, provided that each of the following criteria is met:

- i. The attic area is accessible by a pull-down stairway or framed opening in accordance with Section 807.1; and
- ii. The truss shall have a bottom chord pitch less than 2:12.

Conclusion:

The IRC 2006 method clarifies the application of the bottom chord live load in clear and concise language that is easy to apply given that this specific design concept is available in all the truss design software based upon the traditionally accepted BOCA model. The 2006 version also contains an improvement in that all bottom chords greater than 2:12 are exempted from storage loading.

There is an advantage to our industry to have a solution that is available in all truss design software, can be more easily understood and applied without interpretation error, and provides the greatest uniformity across all US code jurisdictions.

Appendix A

2000 International Residential Code
 CHAPTER 3 - BUILDING PLANNING
 SECTION R301: DESIGN CRITERIA
 Table R301.4

R301.4 Live load.

The minimum uniformly distributed live load shall be as provided in [Table R301.4](#).

TABLE R301.4 MINIMUM UNIFORMLY DISTRIBUTED LIVE LOADS (in pounds per square foot)
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USE	LIVE LOAD
Exterior balconies	60
Decks ^f	40
Fire escapes	40
Passenger vehicle garages ^a	50 ^a
Attics without storage ^{b,e}	10
Attics with storage ^{b,e}	20
Rooms other than sleeping rooms	40
Sleeping rooms	30
Stairs	40 ^c
Guardrails and handrails ^d	200

For SI: 1 pound per square foot = 0.0479 kN/m²; 1 square inch = 645 mm²; 1 pound = 4.45 N.

- a. Elevated garage floors shall be capable of supporting a 2,000-pound load applied over a 20-square-inch area.
- b. No storage with roof slope not over 3 units in 12 units.
- c. Individual stair treads shall be designed for the uniformly distributed live load or a 300-pound concentrated load acting over an area of 4 square inches, whichever produces the greater stresses.
- d. A single concentrated load applied in any direction at any point along the top.
- e. Attics constructed with wood trusses shall be designed in accordance with [Section R802.10.1](#).
- f. See [Section R502.2.1](#) for decks attached to exterior walls.

Appendix B

2003 International Residential Code
 CHAPTER 3 - BUILDING PLANNING
 SECTION R301: DESIGN CRITERIA

Table R301.5

(footnote e was removed by code change)

TABLE R301.5 MINIMUM UNIFORMLY DISTRIBUTED LIVE LOADS (in pounds per square foot)	
USE	LIVE LOAD
Attics with storage ^b	20
Attics without storage ^b	10
Decks ^e	40
Exterior balconies	60
Fire escapes	40
Guardrails and handrails ^d	200
Guardrails in-fill components ^f	200
Passenger vehicle garages ^a	50 ^a
Rooms other than sleeping rooms	40
Sleeping rooms	30
Stairs	40 ^e

For SI: 1 pound per square foot = 0.0479 kN/m², 1 square inch = 645 mm², 1 pound = 4.45 N.

- a. Elevated garage floors shall be capable of supporting a 2,000-pound load applied over a 20-square-inch area.
- b. No storage with roof slope not over 3 units in 12 units.
- c. Individual stair treads shall be designed for the uniformly distributed live load or a 300-pound concentrated load acting over an area of 4 square inches, whichever produces the greater stresses.
- d. A single concentrated load applied in any direction at any point along the top.
- e. See Section R502.2.1 for decks attached to exterior walls.
- f. Guard in-fill components (all those except the handrail), balusters and panel fillers shall be designed to withstand a horizontally applied normal load of 50 pounds on an area equal to 1 square foot. This load need not be assumed to act concurrently with any other live load requirement.

Appendix C

2006 International Residential Code
 CHAPTER 3 - BUILDING PLANNING
 SECTION R301: DESIGN CRITERIA
 Table R301.5

Table R301.5 Change Footnote b and add new table footnotes as shown: (RB42-03/04, S13-03/04 and S14-03/04)

**TABLE R301.5
 MINIMUM UNIFORMLY DISTRIBUTED
 LIVE LOADS
 (in pounds per square foot)**

USE	LIVE LOAD
Attics with limited storage ^{b, g, h}	20
Attics without storage ^b	10
Guardrails and handrails ^d	200 ⁱ
Guardrails in-fill components ⁱ	50 ⁱ

(Portions of table not shown do not change)

- a. (No change to current text)
- b. Attics without storage are those where the maximum clear height between joist and rafter is less than 42 inches, or where there are not two or more adjacent trusses with the same web configuration capable of containing a rectangle 42 inches high by 2 feet wide, or greater, located within the plane of the truss. For attics without storage, this live load need not be assumed to act concurrently with any other live load requirements.
- c through f (No change to current text)
- g. For attics with limited storage and constructed with trusses, this live load need be applied only to those portions of the bottom chord of not less than two adjacent trusses with the same web configuration containing a rectangle 42 inches high or greater by 2 feet wide or greater, located within the plane of the truss. The rectangle shall fit between the top of the bottom chord and the bottom of any other truss member, provided that each of the following criteria is met:
 - 1. The attic area is accessible by a pull-down stairway or framed opening in accordance with Section R807.1; and
 - 2. The truss shall have a bottom chord pitch less than 2:12.
- h. Attic spaces served by a fixed stair shall be designed to support the minimum live load specified for sleeping rooms.
- i. Glazing used in handrail assemblies and guards shall be designed with a safety factor of 4. The safety factor shall be applied to each the concentrated load-applied to the top of the rail, and to the load on the in-fill components. These loads shall be determined independent of one another, and loads are assumed not to occur with any other live load.

Appendix D

Michigan Department of Labor and Economic Growth
 Bureau of Construction Codes & Fire Safety
 2003 Michigan Residential Code (MRC)
 Table R301.5 & Roof Loading Data Sheet

R 408.30546 Minimum uniformly distributed live loads.

TABLE R301.5
MINIMUM UNIFORMLY DISTRIBUTED LIVE LOADS
 (in pounds per square foot)

USE	LIVE LOAD
Attics with storage ^b	20
Attics without storage ^{b,g}	10
Decks ^e	40
Exterior balconies	60
Fire escapes	40
Guardrails and handrails ^d	200
Guardrails in-fill components ^f	200
Passenger vehicle garages ^a	50 ^a
Rooms other than sleeping rooms	40
Sleeping rooms	30
Stairs	40 ^c

For SI: 1 pound per square foot = 0.0479 kN/m², 1 square inch = 645 mm², 1 pound = 4.45 N.

- a. Elevated garage floors shall be capable of supporting a 2,000-pound load applied over a 20-square-inch area.
- b. No storage with roof slope not over 3 units in 12 units.
- c. Individual stair treads shall be designed for the uniformly distributed live load or a 300-pound concentrated load acting over an area of 4 square inches, whichever produces the greater stresses.
- d. A single concentrated load applied in any direction at any point along the top.
- e. See section R502.2.1 for decks attached to exterior walls.
- f. Guard in-fill components (all those except the handrail), balusters, and panel fillers shall be designed to withstand a horizontally applied normal load of 50 pounds on an area equal to 1 square foot. This load need not be assumed to act concurrently with any other live load requirement.
- g. Load shall be applied non-concurrent with other variable loads.

Voluntary Roof Loading Data Sheet

Attic Live Load	
Entire Attic	Y/N
Specific Areas (if yes, list areas below)	Y/N
List Rooms:	



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