Steel Joists, Joist Girders and Steel Deck

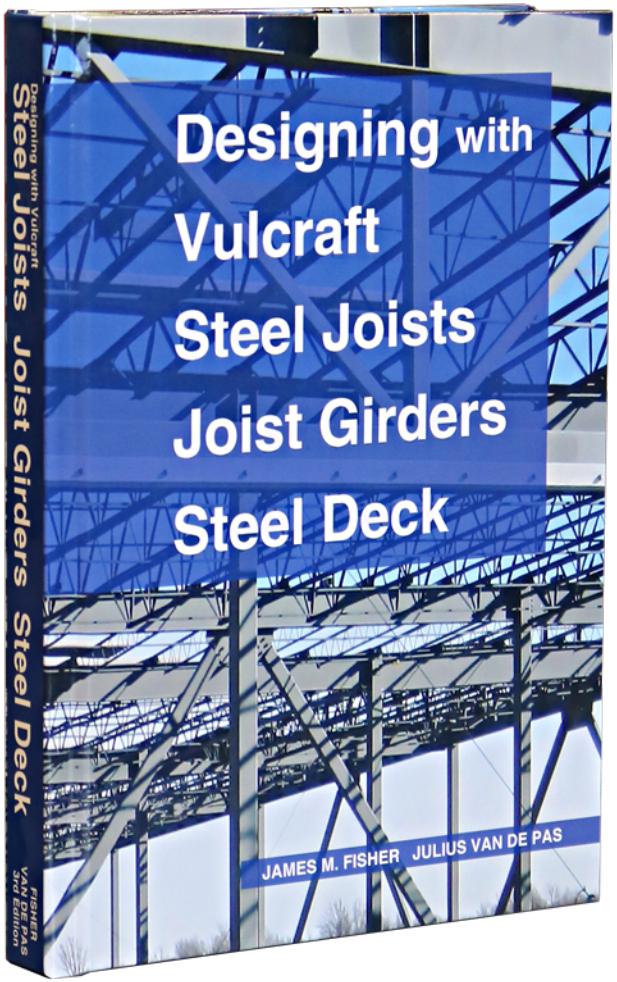
Building Codes

Presented by NUCOR/Vulcraft

Topics

- Topics from the International Building Code
  - Steel Joists
  - Serviceability Requirements
  - Load Combinations
  - Roof Loads (Snow, Rain, Wind, and Seismic)
- Other Standards
  - American Society of Civil Engineers
  - Factory Mutual
  - American Institute of Steel Construction
  - Steel Joist Institute
  - Steel Deck Institute

See Chapter 1, Section 1.6 and Chapter 2, Section 2.4



Building Codes

Individual jurisdictions (states, cities, etc.) adopt and enforce building codes

- The International Building Code (IBC) has been adopted by most jurisdictions in the United States

  (International Building Code)

Jurisdictions adopt a particular edition and often make amendments

Other codes exist are used as well

- NFPA 5000 Building Code, Florida Building Code, California Building Codes, etc.

Other Standards

The IBC references many other standards

- ASCE 7 (Minimum Design Loads for Buildings and Other Structures)
- AISC 360 (Specification for Structural Steel Buildings)
- SJI 100 (Standard Specifications for K-Series, LH-Series, and DLH-Series Open Web Steel Joists, and for Joist Girders)
- SDI RD (Standard for Steel Roof Deck)

Additional Requirements

Example:

If the building is to be insured by Factory Mutual, adherence to FM Data Sheets would be required

FM Global
Property Loss Prevention Data Sheets **1-54**

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ROOF LOADS FOR NEW CONSTRUCTION

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Standards Referenced in this Presentation

- **2018** International Building Code (IBC)
- ASCE 7-**16** Minimum Design Loads for Buildings and Other Structures
- SJI 100-**15** Standard Specifications for K-Series, LH-Series, and DLH-Series Open Web Steel Joists, and for Joist Girders
- SDI RD-**2017** Standard for Steel Roof Deck

IBC Section 2207, Steel Joists

- Section 2207 specifies the responsibilities of the Registered Design Professional (e.g., engineer of record) and the Steel Joist Manufacturer
- "The registered design professional shall indicate on the construction documents …"
- "The steel joist and joist girder manufacturer shall design the steel joists and steel joist girders in accordance with …"

IBC Section 1605.3, Serviceability

- Table 1604.3 provides deflection limits for roof members supporting different types of ceiling and under different loads
  - For example, the live load deflection limit for roof members supporting plaster ceiling is L/360
- Unless specified otherwise, joists are NOT designed for the total load deflection limits of Table 1604.3
- The Engineer of Record can specify other limits in the contract documents

IBC Section 1605, Load Combinations

Two sets of load combinations:

- Load and Resistance Factor Design (LRFD)
- Allowable Stress Design (ASD)

"Structures and portions thereof shall resist the most critical effect resulting from the following combinations of loads"

IBC Section 1605, Load Combinations

1605.2 Load combinations using strength design or **load and resistance factor design**.

1605.2 Basic load combinations

$1.4(D + F)$	(Eqn 16-1)
$1.2(D + F) + 1.6(L + H) + 0.5(L_r \text{ or } S \text{ or } R)$	(Eqn 16-2)
$1.2(D + F) + 1.6(L_r \text{ or } S \text{ or } R) + 1.6H + (f_1 L \text{ or } 0.5W)$	(Eqn 16-3)
$1.2(D + F) + 1.0W + f_1 L + 1.6H + 0.5(L_r \text{ or } S \text{ or } R)$	(Eqn 16-4)
$1.2(D + F) + 1.0E + f_1 L + 1.6H + f_2 S$	(Eqn 16-5)
$0.9D + 1.0W + 1.6H$	(Eqn 16-6)
$0.9(D + F) + 1.0E + 1.6H$	(Eqn 16-7)

f_1 = 1.0 for floors in places of public assembly for live loads in excess of 100 psf and for parking garages, and 0.5 for other live loads.

f_2 = 0.7 for roof configurations (such as saw tooth) that do not shed snow off the structure, and 0.2 for other roof configurations.

Exception: Where other factored load combinations are specifically required by the provisions of this code, such combinations shall take precedence.

IBC Section 1605, Load Combinations

1605.3 Load combinations using **allowable stress design.**

1605.3.1 Basic load combinations

D + F	(Eq. 16-8)
D + H + F + L	(Eq. 16-9)
D + H + F + (Lr or S or R)	(Eq. 16-10)
D + H + F + 0.75L + 0.75(Lr or S or R)	(Eq. 16-11)
D + H + F + (0.6W or 0.7E)	(Eq. 16-12)
D + H + F + 0.75(0.6W) + 0.75L + 0.75(Lr or S or R)	(Eq. 16-13)
D + H + F + 0.75(0.7E) + 0.75L + 0.75S	(Eq. 16-14)
0.6D + 0.6W + H	(Eq. 16-15)
0.6(D + F) + 0.7E + H	(Eq. 16-16)

Roof Loading

Each type of load is defined in IBC 1602.1

Examples of different types of loads:

- D = Dead Load
- L_r = Roof Live Loads
- S = Snow Loads
- R = Rain Loads
- W = Load due to wind pressure (incl. uplift)

Dead Loads (IBC 1606; ASCE 7 Ch. 3)

- Weight of all materials of construction incorporated into the building
- Roofing
  - EPDM membrane plus ballasted surface (10 to 12 psf)
  - Adhered or attached single ply membrane (1 to 2 psf)
- Decking
  - Steel decking (2 to 3 psf, see manufacturer's information)
  - Precast concrete (10 to 20 psf)
- Structural Members
  - Joists, Joist girders, bridging and accessories
- Collateral Dead Loads (typical examples)
  - Mechanical and electrical equipment
  - Piping
  - Fire proofing

Roof Live Loads (IBC 1607; ASCE 7 Ch. 4)

- A load on a roof produced (1) during maintenance by workers, equipment, and materials, and (2) during the life of the structure by movable objects, such as planters or other similar small decorative appurtenances that are not occupancy related
- An occupancy-related live load on a roof such as rooftop assembly areas, rooftop decks, and vegetative or landscaped roofs with occupiable areas, is a live load (L) rather than a roof live load (L_r) for load combinations
- Defined in Table 4.3-1 of ASCE 7
  - Ordinary flat, pitched, and curved roofs - 20 psf
- Roof live load can be reduced in accordance with IBC Section 1607.11 and Section 4.8 of ASCE 7

Snow Loads (IBC 1608; ASCE 7 Ch. 7)

- The Specifying Professional may need to consider unbalanced roof snow load conditions for:
  - Hip and Gable Roofs
  - Curved Roofs
  - Multiple Folded Plate, Sawtooth
  - and Barrel Vault Roofs
  - Dome Roofs

- The Specifying Professional may also need to consider the cases of Partial Loading, Drifts on Lower Roofs, Roof Projections, Sliding Snow, Rain-on-Snow Surcharge Load and Ponding Instability
- If joists are to be designed for any of these loads, they must be noted on the contract drawings

Rain Loads (IBC 1611; ASCE 7 Ch. 8)

- Rain load includes the weight of water that can accumulate on the roof when the primary drainage system is blocked, and the secondary drainage system is discharging water at a specified rate
- Rain load is not uniform since roofs are required to be sloped
- The weight of water causes the roof to deflect and accumulate more water. This nonlinear effect is known as ponding and must be considered by the specifying professional

Wind Loads (IBC 1609; ASCE 7 Ch. 26-31)

- Wind loads include horizontal and vertical components
- Wind loads depend on building exposure, building geometry, and wind velocity
- For buildings with lateral-force-resisting systems at the perimeter, the roof acts as a diaphragm transferring horizontal loads applied along the length of the building to the walls or frames
- Joist and Joist Girder moment frames can also resist the horizontal component of the wind load directly
- The vertical component varies in intensity over the roof surface. It is greater in intensity at roof edges and corners

Wind Loads (IBC 1609; ASCE 7 Ch. 26-31)

- When wind uplift is a design consideration, it should be specified as net uplift on the joists and Joist Girders
- The Specifying Professional knows the design dead load and if there are collateral dead loads that should not be deducted from the gross uplift
- Joists are considered components and cladding.
- The joist tributary width need not be less than one-third the joist span

Seismic Loads (IBC 1613; ASCE 7 Ch. 11-23)

- Seismic loads also include horizontal and vertical components
- The horizontal component depends on the geographic location of the building, site classification (based on soil profile and properties), seismic force resisting system, fundamental period of the structure, and other parameters
- The vertical component is proportional to the dead load and typically has little effect on the design of roofs

References

AISC (2017) 15th Edition, “Steel Construction Manual,” American Institute of Steel Construction, Chicago, IL.

ASCE/SEI (2016), “Minimum Design Loads for Buildings and Other Structures,” ASCE/SEI 7-16, American Society of Civil Engineers, Reston, VA.

IBC (2018), “International Building Code,” International Code Council, Inc. (ICC), Country Club Hills, IL.

SDI (2017) ANSI/SDI RD-2017 “Standard for Steel Roof Deck,” Steel Deck Institute, Glenshaw, PA.

SJI (2015), “Standard Specification for Steel Joists, K-Series, LH-Series, DLH-Series and For Joist Girders,” Steel Joist Institute, Florence, SC.

SJI (2020), “45th Edition K- Series, LH- Series, DLH- Series, Joist Girders,” SJI 100-2020/ANSI, Steel Joist Institute, Florence, SC.

Vulcraft (2017), “Steel Joist & Joist Girder Systems,” Nucor, Vulcraft/Verco Group Nucor Corporation, Charlotte, NC.

Vulcraft (2018), “Steel Roof & Floor Deck,” Nucor, Vulcraft/Verco Group, Nucor Corporation, Charlotte, NC.

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