

Where to look for guidelines and practical advice on using open-web steel joists in floor construction.

conference preview

STEEL JOIST FLOOR SYSTEMS: BEST PRACTICES

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OPEN-WEB STEEL JOISTS have been a popular option for floor framing in steel buildings ever since their introduction to the market nearly a century ago.

And there are multiple resources available to help guide their use in building projects. Listed below are multiple publications that address steel joist design, organized by topic.

Design considerations. Although not specifically codified, design for serviceability is an essential element of successful use of joists in floor construction. Two main aspects of serviceability design are the consideration of deflections and vibrations. Other aspects include the accommodation of mechanical, electrical and plumbing systems and the consideration of future adaptation of the structural framing for changes in use or occupancy, including changes in loads and the addition of floor openings. The *International Building Code (IBC)* provides design loads (uniform and concentrated) for floor construction in Chapter 16 and provisions for the use of open web steel joists in Chapter 22. Provisions for building height and area, with respect to occupancy and class of construction, are found in Chapter 5.

Constant shear joists. Constant shear joists (KCS joists) have published tabulated values for moment resistance and shear. In these joists, the resistance to shear, as the name indicates, is constant from joist end to joist end. KCS joists also have constant moment resistance end-to-end. “Special joists” can be supplied for specifically specified uniform, nonuniform and concentrated loads. Lastly, composite joists are listed in the Steel Joist Institute’s (SJI) *First Edition Standard Specifications for Composite Steel Joists Catalog*.

Vibration. Design for serviceability has been facilitated by the publication of two AISC design guides: Design Guide 3: *Serviceability Design Considerations for Steel Buildings* and Design Guide 11: *Floor Vibrations Due To Human Activity*. Likewise, SJI has published Technical Digest No. 5 *Vibration of Steel Joist—Concrete Slab Floors*.

Fireproofing. Many buildings are not required to be fireproofed based on their height, area and occupancy. But when required, floors framed with joists can be fireproofed. SJI’s Technical Digest No. 10 *Design of Fire-Resistive Assemblies with Steel Joists* provides useful guidance to engineers on this topic.

Adaptability. Joist framing can be adapted when required by changes in use and occupancy. SJI’s Technical Digest No. 12 *Evaluation and Modification of Open Web Steel Joists and Joist Girders* provides tools and techniques for doing this.

New Tools

SJI also provides free online tools to assist structural engineers with joist design (visit steeljoist.org and click the Design Tools link). These tools include Roof Bay Analysis, Virtual Joists, Virtual Joist Girders and Joist Girder Moment Connection Design.

The Floor Bay Analysis tool is expected to be available in May. This tool can optimize the layout and select optimal depths for non-composite K-Series, LH-Series and DLH-Series joists and joist girders as well as the CJ-Series composite joists. Common steel floor decks can be selected from a drop-down box and the tool determines the maximum deck span, available steel deck total uniform load carrying capacity and estimated deck deflection due to the weight of the wet concrete.

A summary for the joist design is provided, including available joist total uniform load carrying capacity and predicted live load deflection. Joist girders are summarized by available panel point concentrated loading and estimated live load deflection. The user has the option to input unit cost data for the concrete, slab reinforcement joists, joist girders, welded shear studs and bridging. They can save a “Run Summary,” change one of the floor design parameters and see what effect this changed parameter has on the floor total cost per square foot.



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In designing a lateral load resisting frame, the engineer must include the joist girders and joists at the column lines in the frame model, and must also provide end-moments and member end-forces to the joist manufacturer for incorporation in the final design. Historically, the coordination process has been hampered because the engineer would not know, at the time of modeling, the design properties for the joist girders or any special joists designed for loads other than uniform gravity loads tabulated in the SJI Standard Load Tables.

For joists and joist girders with nonuniform loading, concentrated loads of varying magnitude and/or externally applied local moments, SJI has recently developed the Virtual Joist and Virtual Joist Girder Tables. These virtual section properties are equivalent-beam section properties based on top and bottom chord material sizes commonly available from joist manufacturers.

The tabulated Virtual Tables do not necessarily represent the final joist or joist girder design. They do, however, yield reasonably close approximations of the final joist and joist girder chord area, effective moment of inertia and weight for use in the structural models.

With the recent incorporation of the Virtual Joist Girder Tables within RAM Structural System, RISA and SCIA Engineer, an engineer can readily determine the resulting joist girder weight and required effective moments of inertia in a lateral load resisting frame. Once approximate joist and joist girder depths are selected using the Virtual Tables, the engineer can specify the joist/joist girder design using conventional nomenclature.

Today's structural engineers have at their fingertips an increasing number of codes, specifications, design guides and design tools to make the design of joists and joist girders more efficient than ever before. The above tools and others will be discussed at our NASCC session. ■

This article is a preview of Session N60 "Steel Joist Floor Systems Best Practices" at NASCC: The Steel Conference, taking place April 13–15 in Orlando. Learn more about the conference at www.aisc.org/nascc.

Steel Joist Institute references are available at www.steeljoist.org. AISC design guides are free downloads for AISC members at www.aisc.org.