A look at concentrated loads on
open-web steel joists.

steelwise
CONCENTRATING ON LOADS

BY JAMES M. FISHER, PE, PhD

WHEN IT COMES TO designing joists, the loading scenario matters.

When open-web steel joists are specified from Steel Joist Institute (SJI) load tables, the joists are designed for the uniform loads from those same tables. The chords are designed for chord axial forces and moments and shears resulting from the uniform loads between panel points. Here are some quick design tips for various loading scenarios.

100-lb Concentrated Loads

The following statement is included in the SJI 44th Edition *Catalog* (SJI 2017): "For nominal concentrated loads between panel points, which have been accounted for in the specified uniform design loads, a 'strut' to transfer the load to a panel point on the opposite chord shall not be required, provided the sum of the concentrated loads within a chord panel does not exceed 100 lb and the attachments are concentric to the chord."

The *Catalog* also indicates that nominal concentrated loads in excess of 100 lb, or that do not meet the criteria outlined above, must be applied at joist panel points. As an alternative, field strut members can be used, as indicated in Figure 1.
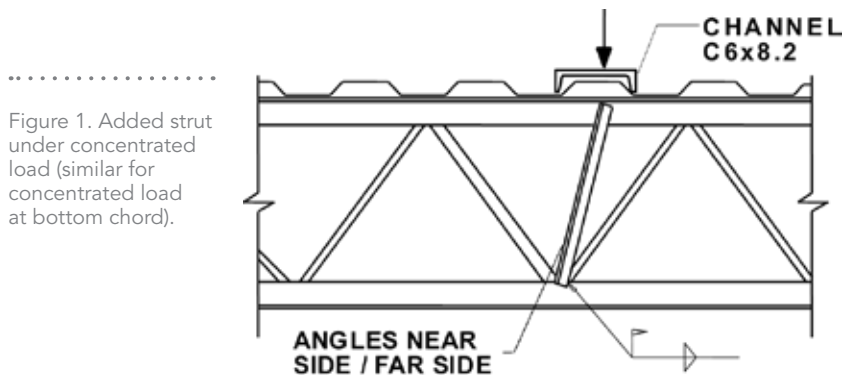
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Figure 1. Added strut under concentrated load (similar for concentrated load at bottom chord).

Concentrated Loads Greater Than 100 lb

When exact dimensional locations for concentrated loads are provided by the specifying professional, the joist manufacturer designs the joist for the loads and load locations provided. This is done without the need for additional field-applied web members at the specified locations unless the concentrated load is of a magnitude that would cause an uneconomical chord size. In this case, the manufacturer may elect to add a strut.

According to the *Catalog*, "For a traveling load with no specific location, the manufacturer can consider the worst case for both the shear and bending moment. When a traveling load is specified, the contract drawings should indicate whether the load is to be applied at the top or bottom chord, and at any panel point, or at any point with the local bending effects considered. For additional information see SJI *Code of Standard Practice*, Section 2.4 – Specifying Design Loads."

SJI suggests several options for designers to specify concentrated loads on open-web steel joists. These are given in the *Catalog* as follows:

Option 1: Select a joist designation from the Standard Load Table (or specify a joist type using a uniform load in the designation) which has been determined to be adequate for all design loads. The shear and moment envelope resulting from the selected uniform load shall meet the actual shear and moment requirements. Thus, this option alone may not be adequate if designing for large concentrated loads.

Option 2: Select a joist designation from the Standard Load Table (or specify a joist type using a uniform load in the designation) *and* also provide the load and location of any additional loads on the structural plan with the following note: "Joist manufacturer shall design joists for additional loads at locations shown." This option works well for a few added loads per joist with known magnitude and location.

Option 3: For additional point loads with exact locations not known along the joist or for incidental loads, either or both of the following can be specified on the structural plan in addition to Option 1 or 2 above:
  a) Design for a __ lb concentrated load located at any one panel point along the joist. This is referred to as an "add-load."
  b) Design for additional bending stresses resulting from a __ lb concentrated load located at any location along ___ chord. This is referred to as a "bend-check" and can be specified on the top chord, bottom chord or both the top and bottom chords. This can be used when the concentrated load is already accounted for in the joist designation, uniform load or specified add-load, yet this specified amount of load shall be permitted to also be located at any location between panel points. The additional bending stresses as a result of this load are then designed for. A bend-check load shall not exceed add-load + 400 lb. A bend-check load can be specified by itself without an add-load.
  c) Both (a) and (b) above can be specified with equal concentrated loads for each—or simply denote: "Design joist for a __ lb concentrated load at any location along the __ chord."

Using the above options allows the estimator to properly price the joists, the joist manufacturer to design the joists in accordance with the latest standard specifications and the owner to obtain the most economical joists.

An eccentric top chord connection.

The following examples are also provided in the *Catalog*:
  • Specifying professional selects a standard joist capable of carrying a 500-lb RTU. However, the location and exact frame size is not yet known, but the frame load shall result in two 250-lb point loads at least 5 ft apart. **Specify a 250-lb bend-check**.
  • Standard joist specified but not selected for a 500-lb RTU load, location not known. **Specify a 500-lb add-load and 250-lb bend-check**.
  • Standard SJI joist selected to carry collateral load of 3 psf. Specifying professional wants bending from 150-lb incidental loads to also be designed for. **Specify a 150-lb bend-check**.

Not noted in the SJI *Catalog* is that specified concentrated loads must be specified as either dead or live loads—and also whether the designated design is ASD or LRFD.
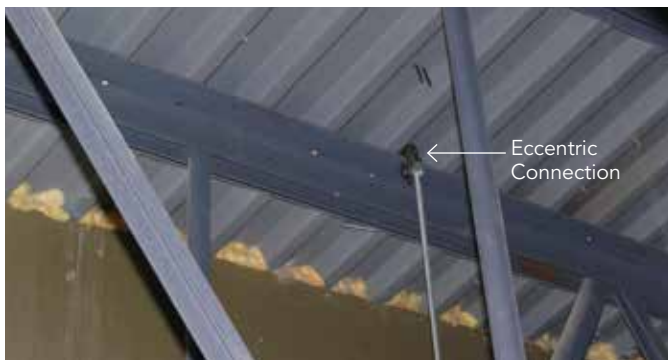
Prevention of Torsion on Joist Chords

Concentrated loads *must* be in a manner not to cause torsion in the joist chords. In other words, the load must be applied to both chords without eccentricity on the two chord angles. The specifying professional should indicate this requirement in the construction documents. In addition, manufacturers of framing clamp systems or suspension clamp systems for use with hanging loads shall design such units to comply with the above requirements.

In summary, keep the following rules and suggestions in mind:
  1. Concentrated loads must be applied concentrically to the joist chord.
  2. Specify whether the load is applied to the top chord or bottom chord.
  3. For a few added loads per joist with known magnitude and locations, use Option 2 (above).
  4. When exact locations of concentrated loads are provided, the SJI manufacturer will *not* count on a field added strut being installed.
  5. When exact locations of concentrated loads are variable or not known, make use of the add-load and bend-check procedures for optimum designs.

Doing so will help you anticipate and design for efficient joist loading. ■