10 Tips for Designing with Steel Joists

by Timothy J. Holtermann, P.E.

You don't have to know how to dance in order to sidestep some of the problems that can surface when designing with steel joists and joist girders. Here are a few ways to avoid common missteps—and make your project (and your joists) more efficient.

1 **Situation:** Setting the joist seat depth too shallow for sloped ends. The typical K-series joist seat depth of 2½ inches is not adequate once the roof slope is ½:12 or greater. At the high end of the joist, it becomes difficult to place the end web member to deliver the end reaction over the support. As shown in Figure 1, the chord angle may not clear the support and would need to be coped.

Solution: Increase the seat depth anywhere that more than a nominal roof slope is used. The joist manufacturer can readily provide a variety of seat depths other than the typical 2½-inch and 5-inch depths.

2 **Situation:** Including a web configuration in load diagrams or joist profiles, when there are not any specific geometric requirements. Drafters will often "fill-in" a joist profile with random web members just to make it look presentable. The joist manufacturer then loses the option of quoting the most efficient geometry.

Solution: Leave the web area blank or add a note stating that the "web may vary." If there is a specific constraint for the placement of the web members, such as a large duct passing through the joist, show this on the joist profile.

3 **Situation:** Limiting the use of joist girders to only those designations found in the Weight Tables. The purpose of the Weight Tables is to provide the approximate self-weight of the joist girder to be included in the structural design. The Weight Table is not a comprehensive listing of all possibilities.

Solution: Use joist girders for any reasonable combination of depth, length, kip loading, and number of panels. In general, most manufacturers can provide joist girders with chord angles of up to 6×6×¾. Several manufacturers have published more extensive Weight Tables. (Steel Joist Institute is planning an expansion of its current Weight Tables to include limits beyond 72 inches deep, 20 kips per panel point, and 60 feet long.)

4 **Situation:** Showing a weld at a joist bottom-chord extension when one is not required, as shown in Figure 2. A typical joist is designed as simply supported with an underslung end. Welding the bottom chord extensions develop a fixed-end moment, which should not be done unless it is considered in the design of both the joist and the overall frame.

Solution: Unless required, don't call for a weld on a bottom-chord extension. The column stabilizer plate in the gap between the chord angles provides the same resistance to the joist overturning without being welded, as if it were welded. If a weld is required, show the appropriate design requirement—either an end moment or an axial bracing force to the bottom-chord extension.

5 **Situation:** Don't call for welds to joists that are bigger than the typical chord-angle sizes. As shown in Figure 2, a ¼ inch fillet weld is specified from the bottom chord to the column stabilizer plate. For a typical K-series joist, this is thicker than the bottom chord angle sizes that would ordinarily be used.

Solution: Use thinner, longer welds. For smaller K-series joists, assume a maximum angle thickness and weld size of ⅛ inch. For larger K-series, and smaller LH-series joists, assume a maximum angle thickness and weld size of 3/16 inch. Call only for a ¼ inch weld at heavy long-span joists, or joist girders.

6 **Situation:** Making the joist manufacturer responsible for tracking down loading information that is not available yet. Structural contract drawings that refer the joist manufacturer to the mechanical contractor or equipment supplier for the joist design loads can often delay joist fabrication.

Solution: When mechanical information is not available, consider designing a roof top unit "zone" with extra capacity. This is far cheaper than reinforcing joists later on in the field.

7 **Situation:** Using joists that are too short. Short joists that are less than 8-feet long are not practical to fabricate. If the drafter is not given other instructions, a minimum joist size may be used even for very short spans, such as the 8K1 joists in the corner of the framing plan of Figure 3.

Solution: Use joist substitutes. The joist manufacturer can build a joist substitute more efficiently than a very short joist. The joist substitute may consist of two angles welded together to make a channel section. It may be made of tube steel or another shape. The Steel Joist Institute recently published a straight-forward Load Table for three standardized joist substitutes with the designations 2.5K1, 2.5K2, and 2.5K3.

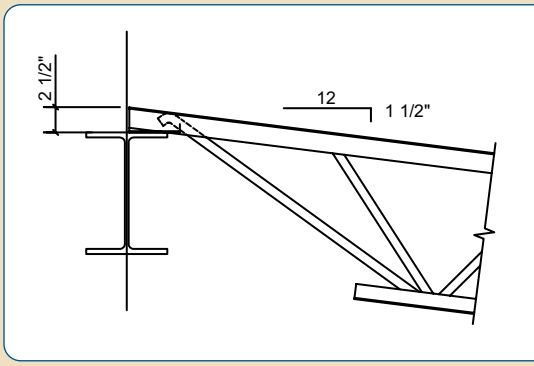

Figure 1.

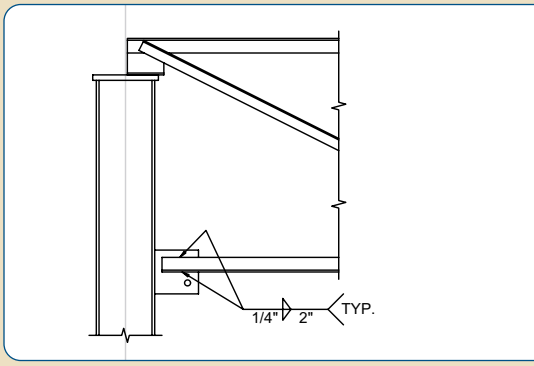

Figure 2.

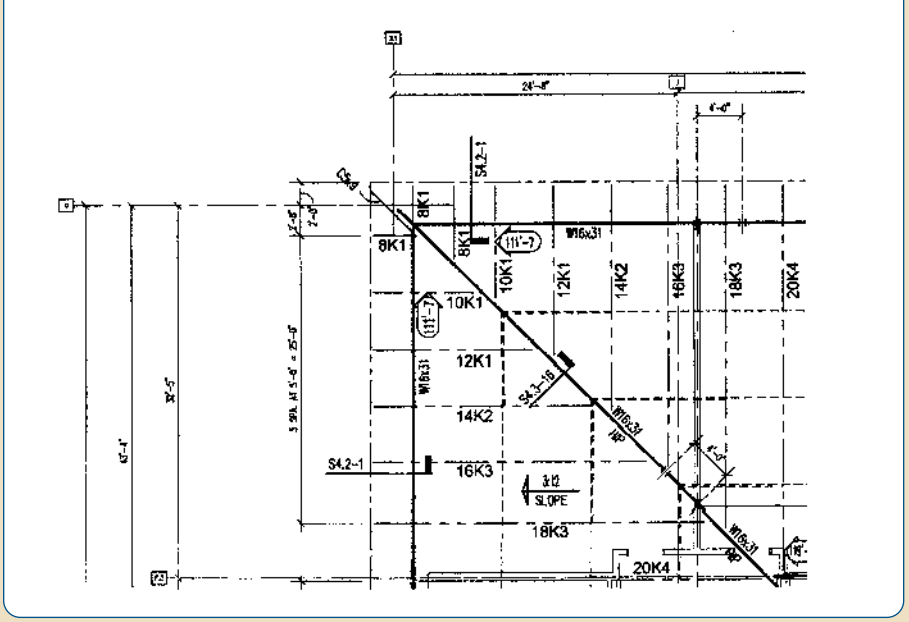

Figure 3.

8 **Situation:** Corner joists or substitutes that are not simply supported at both ends. Notice in Figure 3 that while the typical joist has two supports and a cantilevered top chord extension, the shortest 8K1 joists in the corner are simply cantilevers with no "base" span. This is a problem, whether these joists are designated 8K1 or if they are joist substitutes as discussed above.

Solution: Make sure all the framing members have support at each end. Where necessary, design the edge angle or other edge steel to provide support spanning from the corner to the first non-cantilevered framing member. The size of the edge-framing member, as well as the resultant point loads where that member is supported, should be shown as in Figure 3.

9 **Situation:** "Over-designed" top-chord extensions on small joists. A short 8K1 or 10K1 will have a Load Table capacity of 550 plf total and live load. This capacity may be more than is needed but comes at no great cost for the main span. As with a roof overhang (see Figure 3) or a top chord extension of any length, providing a capacity of 550/550 is difficult for both strength and deflection.

Solution: Use the Steel Joist Institute's Extended End Load Tables and specify a top chord extension type such as "S7" or "R3."

10 **Situation:** Using too many joist depths in a skewed bay. While the economy table might suggest a different joist depth for every span in a skewed bay, the joist manufacturer builds, bundles, and ships by depth.

Solution: Refer to Figure 3. Instead of changing the joist depth several times going into the corner, make only one or two steps down in depth, combining several span lengths in each depth. Then use joist subs for the smallest spans.

For more information about steel joists, to order any of the above mentioned guides or manuals, or to contact an individual manufacturer, please visit the Steel Joist Institute web site at **www.steeljoist.org**. ★

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