

Joist Cause

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Providing the proper information and checking the computer's work will keep the joist portion of any construction project on track.

OPEN WEB STEEL JOISTS—OR BAR JOISTS, AS THEY ARE COMMONLY CALLED—HAVE BEEN USED IN BUILDING CONSTRUCTION SINCE THE EARLY 1920S.

Their original intended purpose was to provide an economical lightweight truss to be utilized as a single-span, uniformly loaded member that supported dead loads, including roofing materials and other permanently affixed materials and equipment, and live loads. Standard details were easy to apply; and the designer could easily enter the economical joist selection guide and pick a standard joist.

Today, however, steel joists have evolved into structural support components with complex geometries and can be designed for numerous loading conditions and load combinations. And thanks to their structural efficiency, steel joists are a sought-after solution for complicated framing conditions. Although many joist manufacturers have the ability to design and build joists for many different conditions, the costs and fabrication lead times for specialty products have increased significantly. In today's fast-track environment, keeping things simple and providing all required information will help manufacturers stay on schedule.

Most structural steel framing members are designed and specified by the project's engineer of record, and solid web beams and columns are typically noted on the structural drawings. The steel fabricator and detailer develop material cut sheets and produce shop drawings directly from these drawings, while the steel joist manufacturer develops its own erection drawings and bills of material for the joists, joist girders, and bridging prior to final design and fabrication. In addition to the physical dimensions required to fabricate the joists and girders, the joist manufacturer must acquire all of the specific loading information in order to complete the designs. Unfortunately, much of the information required for special design requirements for the joists and joist



Open web steel joists can be adapted to a variety of geometric configurations.

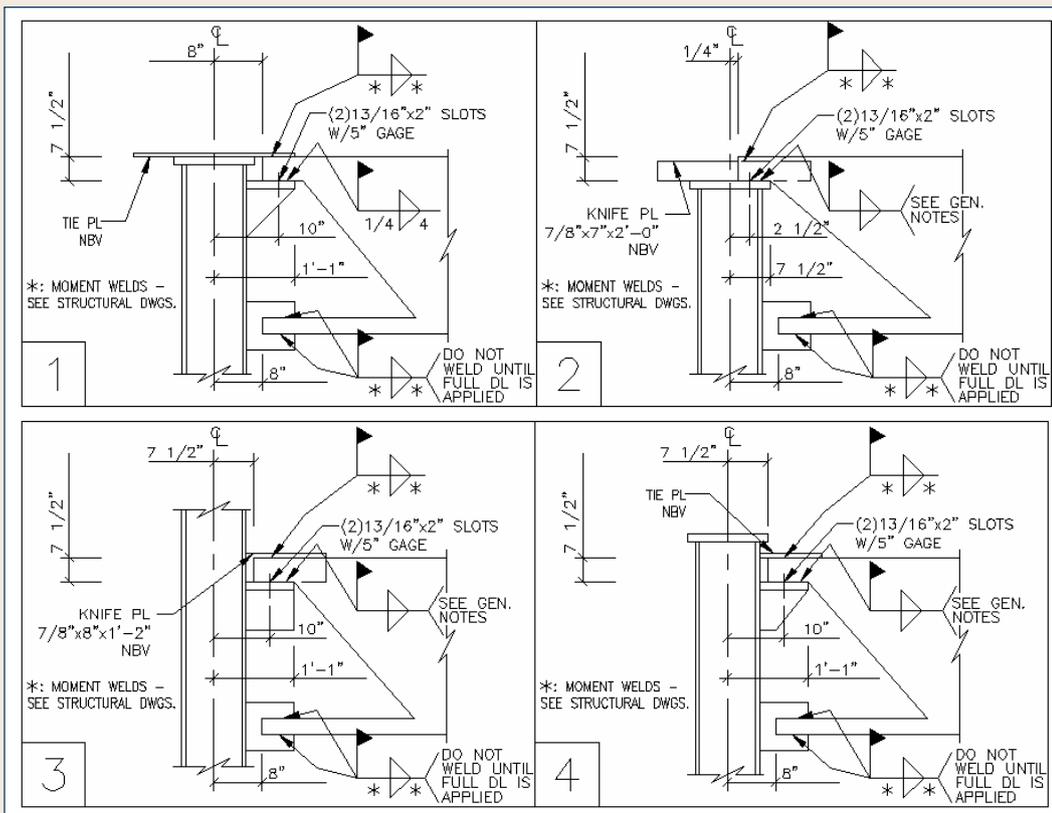
girders is not contained on the structural drawings and must be coordinated between the joist supplier, steel fabricator, general contractor, and engineer.

Below are some tips to make the overall process of selecting, designing, and manufacturing joists more efficient. Following them will allow manufacturers to provide economical and quality products that meet project design requirements and schedules.

Compute, Then Check. Advances in computer technology and proprietary software programs have increased the ability of steel joist manufacturers to design and accommodate a large variety of conditions that meet the structural framing requirements for very complex buildings. Multiple software packages are now available that help manufacturers select standard designation joists. However, software cannot apply engineering judgment; it may select joists that are individually economical, but that might not be economical on a collective basis. For example, it is often more economical to not change joist sizes within a given bay or when the bay is skewed. There is a net loss of economy when joist

designations are changed, even though a specific member has been optimized. The joist selection software may not account for bridging or special erection requirements. It is therefore always prudent to review the results of software-generated joist selections and make adjustments as necessary.

Keep KCS in Mind. KCS series joists (a Steel Joist Institute designation) are usually heavier than standard or load-per-foot designation joists. However, these joists provide excellent versatility and flexibility when loading requirements are unclear or if future changes are anticipated. Over the long term, KCS may be the most economical solution due to additional time and costs that result from design changes; design changes to existing joists often result in expensive joist modifications. Overall costs may be lower because KCS joists are “standard” joists with no special engineering by the joist manufacturer, no special load coordination issues, and no special detailing requirements. It is advisable to use KCS joists wherever possible to minimize the use of “SP” joists and special load diagrams. Remember, KCS joist selections are



Suggested details for transferring lateral forces into columns.

all-inclusive. In other words, all loads must be included in the KCS designation, except for net uplift. Do not specify a KCS joist with additional concentrated loads or other types of additional loads.

Mechanical Matters. Another method to simplify design is through the use of mechanical zones. Often, the final size, location, and weight of mechanical units are unknown when the joist manufacturer begins to detail the job. Therefore, the best solution may be to design whole bays or areas for variable mechanical unit placement. Instead of showing and instructing the joist manufacturer to design each joist for every individual mechanical unit, which may change before the designs are final, instruct them to design for an additional concentrated load at any panel point on all joists within the mechanical zone. This may be a better solution than the use of KCS joists. For example, an envelope solution for a mechanical zone may be to specify each joist to be designed for a 1,000-lb concentrated load at any panel point. This is an economical compromise that still provides needed flexibility and avoids expensive retrofits or joist replacements when changes occur after joist fabrication.

Don't Double. In the past, it was common to use double joists when extra capacity was needed to accommodate additional loads such as mechanical units. As previously described, it is more economical and practical to use mechanical zones or KCS joists, or to specify additional loads to take care of additional capacity requirements. In addition, if bolted cross bridging is required, it is not possible to install the bridging and still meet OSHA erection requirements when joists are doubled.

Space Out. Often, joists are spaced based on the designer's past experience, using rules of thumb or simply dividing the girder length by some arbitrary number. It is almost always more economical to maximize the span of the specified deck when determining joist spacing. (If applicable, remember to check Factory Mutual requirements for maximum deck spans.) Fewer joists result in

lower erection costs. In addition, fewer, heavier joists may require less rows of bridging, which will also reduce erection costs.

Camber Carefully. Oftentimes, disputes arise over mismatched elevations due to standard joist camber. This problem can be avoided by not mixing elements of different stiffness within a bay or interrupting spans of horizontal framing members with columns (e.g., if a bay is framed with 80-ft-long joists, avoid framing the end span with an intermediate column and two 40-ft beams). Do not place joists directly adjacent to walls (masonry or concrete) running parallel to joists. Instead, provide a detail for the deck to be supported on the wall or by an angle attached to the wall, and then provide a full joist space to the first joist adjacent to the wall. Standard camber will not usually be a significant problem because the deck can be easily pushed down and attached at the wall.

Standard joist camber may be excessive at spans around 80 ft to 90 ft. Consideration should be given to the load conditions at which the joists should be level. If camber is a concern, the manufacturer should be given specific instructions to provide special camber and indicate the loads at which the joists are expected to be level. The joist manufacturer will calculate the deflection under those loads and provide camber accordingly. There may be an additional expense for special camber, but special camber is not nearly as expensive as the remedies that are required to correct undesirable camber problems.

Making Ends Meet. It is not uncommon for structural drawings to show $\frac{3}{16}$ -in. or $\frac{1}{4}$ -in. fillet welds for end anchorage. Many joist bearing seats are fabricated using material that is only $\frac{1}{8}$ in. thick. If possible, specify $\frac{1}{8}$ -in. fillet welds with sufficient length to meet the anchorage requirements. If required, bearing seat thickness of $\frac{3}{16}$ in. or $\frac{1}{4}$ in. can be supplied at an additional cost.

The Rule of Four. Standard top chord extensions were developed in order to give designers an idea of the capacity of top chord extensions on standard joists. For example, published capacities for

R4 type extensions are capacities expected for extending the top chord and bearing seat angles of K4 type joists. Therefore, specifying an R10 extension on a K3 joist may present a mismatch problem—an extension and a joist that are incompatible. A good rule of thumb is to limit the numerical difference between the designation size and extension size to *four*. (For example, don't specify an R8 extension on a K3 joist, as the numerical difference is five.) Contact the joist manufacturer for help with other options when this limit is exceeded. Also keep in mind that deeper bearing seats may provide additional capacity for long or heavily loaded extensions

Lightening the Load. Even though there are published capacities for standard joist girder bearing seats subjected to lateral loads, a detail that transfers lateral loads directly from the joist or girder top chord to the supporting structural member is recommended (see above figure). Published values illustrate that there is very little additional capacity available in bearing seats to transfer lateral loads. In addition, the deformation of standard bearing seats under lateral loads may have a negative impact on frame drift.

Bearing it All. K and KCS series joists require 2½-in. minimum bearing on steel, while LH series joists require 4-in. minimum bearing on steel. Sufficient bearing length must be provided to meet required minimums when joists bear on wide-flange beams or other structural support members. A typical problem occurs when joists oppose each other on small wide-flange beams. To resolve this problem, use 6-in. minimum flange widths for supporting members for opposing K series joists and 9-in. minimum flange widths for supporting members for opposing LH series joists. Staggering joists over narrow beams requires additional detailing, complicates the deck layout, and increases the difficulty of joist and deck erection. MSC

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