Steel Interchange

Steel Interchange is an open forum for *Modern Steel Construction* readers to exchange useful and practical professional ideas and information on all phases of steel building and bridge construction. Opinions and suggestions are welcome on any subject covered in this magazine. If you have a question or problem that your fellow readers might help to solve, please forward it to *Modern Steel Construction*. At the same time feel free to respond to any of the questions that you have read here. Please send them to:

Steel Interchange
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Suite 3100
Chicago, IL 60601

Answers and/or questions should be typewritten and double spaced. Submittals that have been prepared by word-processing are appreciated on computer diskette (either as a wordperfect file or in ASCII format).

The opinions expressed in *Steel Interchange* do not necessarily represent an official position of the American Institute of Steel Construction, Inc. It is recognized that the design of structures is within the scope and expertise of a competent licensed structural engineer, architect or other licensed professional for the application of principles to a particular structure.

Information on ordering AISC publications mentioned in this article can be obtained by calling AISC at 312/670-2400 ext. 433.

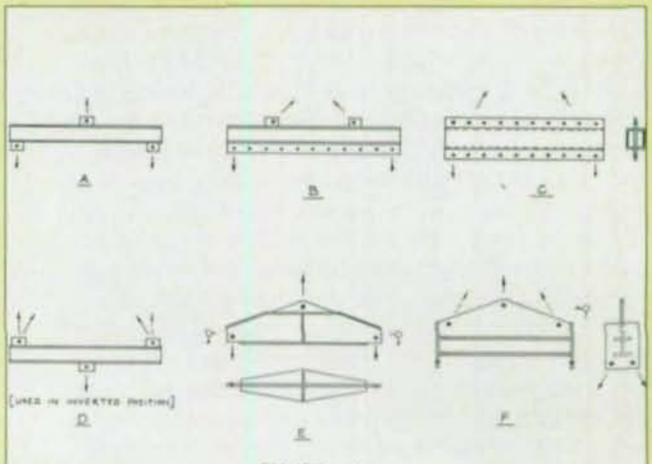

FIGURE 1

The following responses to questions from previous Steel Interchange columns have been received:

How do you decide when to use doubler plates and when to increase the size of a column?

Unfortunately, many engineers release structural drawings without analysis and include a statement to provide a doubler plate "if needed". It is too late, at this stage, to pick a column with a thicker web. Most fabricators would be more than happy to help the designer with this decision during the design stage. Designers should ask for this advise.

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The design of steel structures is clearly discussed in the AISC Manuals and publications; however, how does one design and analyze the steel beams and members used to aid in erection?

The design of steel members used in the hoisting process during construction is discussed in the *Engineering Journal* article by Dave Ricker titled, *Design and Construction of Lifting Beams*. This article appeared in the fourth quarter 1991 issue starting on page 149 and will be summarized here.

Lifting beams which are used during erection can also be called spreader beams. Some examples of lifting beams are shown in the figures printed above.

Figure A is the basic lifting beam and provides two places of attachment to the object being lifted, this avoids the possibility of overstressing if a single attachment were used. This also allows for a straight pull on the object rather than an oblique pull as would result if chokers alone were used. It is sometimes important to minimize unwanted erection stresses or to prevent reversal of stress in certain portions of the lifted object. For instance an oblique pull may cause excess compression in the top chord of the truss at a time when that chord is laterally unbraced. A lifting beam can be used as a "strong back" to provide multiple lifting points on a relatively flexible object.

Other elements commonly associated with lifting beams are hooks, shackles, chokers, and slings. Shackles are used to connect the lines to the lifting beams. Shackles come in various patterns and capacities. Chokers are often used to wrap around the object to be lifted and are usually fastened to the underside of the lifting beam by means of shackles. Slings are used to suspend the lifting beam from the main hook. Hooks are often used with shackles or oblong rings. Hooks with safety latches which prevent the shackles or lines from escaping the throat of the hook are recommended.

A lug plate with its pin hole is an important component of the lifting beam assembly. Tests have indicated that the ratio of pin diameter to hole diameter has little influence on the ultimate strength of the lug material. The diameter of the hole in the lifting lug should be at least 1/16 in greater than the largest pin (or bolt) diameter which is anticipated. However, it is not necessary to have the pin fit snugly in the hole. In fact, the pins are apt to be rough cast and not perfectly round. More often than not, the pin

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may be considerably smaller than the hole. Pins as small as one half the hole diameter are not rare.

If the lug plate proves to be deficient in bearing strength, washer plates can be welded around the hole to increase the thickness. If the pin is less than a snug fit the lug plate must be designed to prevent tearing failure at the plate edge. Tear-out results when the pin attempts to plow through the plate edge, often resulting in a bulge whose outer edge is in severe local tension. The dimension must be adequate to prevent tear-out but small enough so it will accommodate the shackle length.

In order to prevent the line or shackle from fouling the square corner of the lug plate, the corner may be cut on a diagonal or it may be rounded.

Since lifting beams are often used and stored outdoors, it is recommended that welds be made water tight to prevent hidden corrosion. The weld should be sized to account for any eccentricies which may result from various angles of pull. The thickness of the lug should be such that it will accommodate the "jaw" opening of the shackle. It is not necessary that the lug plate fit snugly in the jaw opening. However, a gross mismatch may cause the lifting beam to hang slightly out-of-vertical which may result in undesirable torsion stresses. A suggested rule of thumb is lug thickness should be no less than one-half the jaw opening. Bottom lugs are treated much the same as top lugs except that they are apt to be continuous plates in order to be more versatile.

Since dead weight is sometimes a factor it may be desirable to use high-strength steel. Lifting beam deflection is hardly ever a governing factor. Column sections, that is wide-flange shapes that are approximately as wide as they are deep, are popular for lifting beams because they generally have longer L and Lu lengths. The unsupported length of a lifting beam is the length between the outermost lifting holes.

In establishing the lifting capacity of a lifting beam, several factors must be considered in addition to the static weight of lifting beam, shackles, and lines must be included. In addition, the effects of impact, acceleration, deceleration, wear, deterioration, and abuse must considered. An effective way to account for these unknowns is to apply an additional factor of safety to the static load. If the normal allowable stresses are reduced by a factor of 1.8, the resulting maximum working bending stress in the lifting beam will be about a fifth of the minimum ultimate bending strength of the steel. This is in line with other components of the lifting assembly such as the shackles, lines, and hooks, which are usually load rated for ¼, ⅕, or ⅙ of their ultimate capacity. ANSI/ASME Standard B30.20 requires that lifting beams be designed using a minimum design factor of 3 based on yield strength.

Lifting beams and associated lines and equipment should be inspected before and after use.

After the beam has been assembled and welded, it is usually cleaned and given a coat (or coats) of rust-inhibitive paint. The color should be light in hue and one which contrasts sharply with the primer colors normally used by the fabricator. The lifting capacity of the beam in tons should be clearly stenciled on both sides of the beam in block numbers and letters at least 5 in. in height. If the lifting beam must be used in the upright position only, the top of the beam must be stenciled: USE THIS SIDE UP ONLY. Very often the fabricator or erector will want to stencil the company name on the lifting beam for advertising and identification purposes. Although stenciling in paint is the most common means of marking, a more positive method consists of bead welding the messages onto the beam. Welded figures will endure even if the beam is repainted at a future time.

Equally important as the strength of the lifting beam is the strength of the other components used in conjunction with the beam. Theses are lines, chokers, hooks, and shackles. Only a knowledgeable experienced rigger should be entrusted with the selection of these other items.

New Questions

Listed below are some questions that we would like the readers to answer or discuss. If you have an answer or suggestion please send it to the Steel Interchange Editor. Questions and responses will be printed in future editions of Steel Interchange Also if you have a question or problem that readers might help solve, send these to the Steel Interchange Editor.

1. Consider eccentricity and what has to be done to accommodate it in various connections.

2. AISC says end-plates and shear tabs shouldn't be more than 6 or 7 bolts deep and clips shouldn't be thicker than ⅝". Can these rules be relaxed if the connection is only on one side of a header beam?

3. Are there concerns about bending of the tube wall in shear tab type connections? When should the shear plate be carried through the tube section?

4. When would you justify the additional cost of high bond epoxy paint and coating for an exterior steel frame exposed to weather and water? What if there is standing water at the base of the column?