Planning a pick then executing that plan are both important parts of steel erection.

Planning and Picking

BY WILLIAM W. MERRELL, P.E.

AN INTERESTING, AND NOT SURPRISING, irony in the structural steel industry results from two generally standard industry practices:

a) Members (beams, columns, braces and trusses) are designed without concern for how they will be picked for erection placement

b) Members are picked and placed without concern for how they have been designed

Ironic or not, we all like it that way! The structural engineer of record does not want to be involved with the selection and usage of hitches and lift beams any more than the erector wants to be involved with the calculation of required element strengths using "Second Order Analysis by Amplified First-Order Elastic Analysis."

The engineer's lack of responsibility related to the use hitches and lift beams does not imply, however, that the erector's riggers can perform all of their pick-related duties without some engineering assistance. Jerry Klinke, in the 3rd Edition of his *Rigging Handbook*, states, "Suggested procedures (relating to the use of slings) should not, therefore, be used without first securing competent engineering advice for any given application."

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Let's explore some pick and placement options. Figure 1 shows a preliminary plan for the lift beam pick of a 110-ft-span truss. The lift beam is classified as a below-the-hook lifting device that must be designed by a qualified engineer. The engineer, in addition to checking the adequacy of the lift beam, is charged with establishing the adequacy of the truss members and connections when picked at the specified points. Because the final pick plan would indicate the loads in the hook-to-beam and beam-to-truss lift lines, the lift line sizes can be selected by qualified field rigging personnel from published capacity standards in such documents as OSHA, ASME B30.9 and various rigging handbooks.

The hitch types shown consist of a two-leg bridle hitch for the hook-to-lift-beam lift lines and a basket hitch for the lift-beam-to-truss lift lines. These hitch types, as well as the choker type hitch, are further discussed below.

Bridle, Basket and Choker Hitches

The 25-ft lift lines in Figure 1 extend from the hook to the lift beam to form a two-leg bridle hitch. As shown in Figure 2, bridle hitches also can have three or four legs. In bridle hitches,

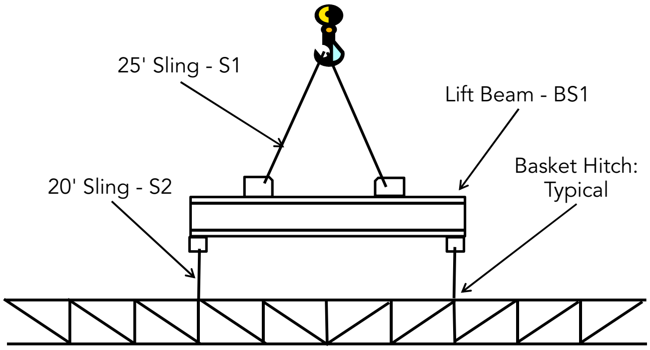

Fig. 1: A two-leg bridle hitch.

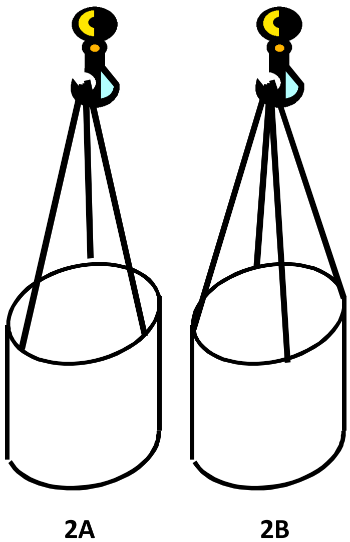

Fig. 2: Three-leg and four-leg bridle hitches.

the upper end of the sling is attached to the lifting device and the lower sling end is attached to the load to be picked by means of an engineered connection. A typical connection design consists of a lug plate and shackle.

In three-leg bridle hitches the picked load is shared by all legs. Care must be taken by the rigging crew with four-leg bridle hitches to ensure that the load can be shared equally by all legs. While ASME B30.9 tables show all four legs as sharing the load, it is common practice by many to design the hitch such that the load is carried by two legs with the other two legs acting to provide pick stability.

ASME B30.9 defines a basket hitch as "a method of rigging a sling in which the sling is passed around the load and both loop eyes are attached to the lifting device." Implicit in this definition is the fact that the load is circular in cross section.

As shown in Figure 3, the "lifting device" can consist of either one or two points of sling attachment. When there are two points of sling attachment, and the lift lines are at an angle of 90° from horizontal, the hitch is sometimes referred to as a "true basket hitch." When there is one point of attachment, as shown in Figure 3B, an adjustment factor must be applied to account for the lift angle. Published basket hitch capacity data are presented in ASME B30.9 for lift angles of 90°, 45° and 30°.

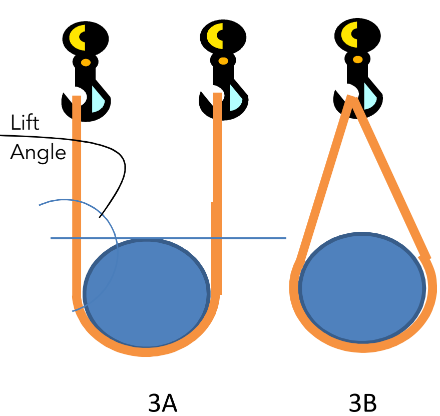

Fig. 3: Basket hitch variations.

The ratio of the diameter of the picked item (D) to the diameter of the sling (d) is of significant importance. Capacity tables in ASME B30.9 limit this ratio from 15/1 to 25/1 depending on the method that was used to fabricate the loop eyes at the sling ends. For applications where the D/d ratio is less than required, an efficiency factor must be applied. Representative efficiency factors of 50%, 65%, 75%, 86% and 92% are presented in Klinke's *Rigging Handbook* for D/d ratios of 1, 2, 5, 10 and 20, respectively.

Basket hitches are frequently used to pick loads with rectangular cross sections. In such cases a D/d type efficiency factor of 50% should be applied. Because the hitch will introduce compressive forces to the picked load, the structural adequacy of the picked load must be determined by a qualified engineer. Additionally, OSHA requires that the sharp corners of the picked load be padded or covered to protect the sling.

As shown in Figure 4, a choker hitch is one in which the sling is passed around the load, then through one loop eye, with the other loop eye attached to the lifting device. ASME B30.9's published capacities are applicable for choke angles that are equal to or greater than 120°. Applicable capacity reductions for choke angles less than 120° are 87% at 90° to 120°, 74% at 60° to 89°, 62% at 30° to 59° and 49% at 0° to 29°. D/d reductions must also be made as discussed above.

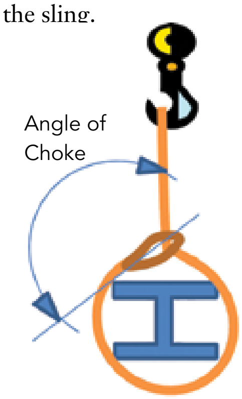

Fig. 4: A choker hitch.

Care must be taken to ensure that the choker hitch does not distress the picked load. In some cases a qualified engineer will be required to confirm the adequacy of the picked item.

Lift Beams

Structural devices located between the crane hook and the load to be picked are referred to as lift beams. These devices also may be referred to as balance or spreader beams.

The governing codes and specifications for lift beams include ANSI/ASME B30.20-2010, *Below-the-Hook Lifting Devices*, which provides guidance for administrative and inspection activities. B30.20 references the use of ASME BTH-1, *Design of Below-the-Hook Lifting Devices*, for the design of the lift beam itself. The design provisions of ANSI/AISC 360-10, *Specification for Structural Steel Buildings*, can be conservatively implemented if adjustments are made to ensure that the lift beam safety factors are in the neighborhood of 3.

Central to the task of lift beam design is the determination of the total load to be picked. That total includes the dead load component of the picked load, slings, connection hardware and lift beam plus an allowance for the more subjective loading resulting from possible impact, load acceleration and load deceleration. In an article in the 4th Quarter 1991 *Engineering Journal*, "Design and Construction of Lifting Beams" (available online at **www.aisc.org/ej**) author Dave Ricker proposed using a factor of 1.8 on the calculated picked dead loads to cover these subjective items.

The ultimate load for slings with manufactured eyes is five times the working load limit, and the ultimate load for shackles is 6 to 1. In consideration of these large safety factors, the appropriate safety factor for the design of the lugs that connect the sling hardware to the lift beam comes into question. One practical approach is to set the lug plate safety factor, for all applicable lug limit states, to values that are comparable to the safety factors used in the design of the lift beam.

Ben Hur Construction

Using two cranes, each with a two-sling bridle hitch, instead of a lift beam.

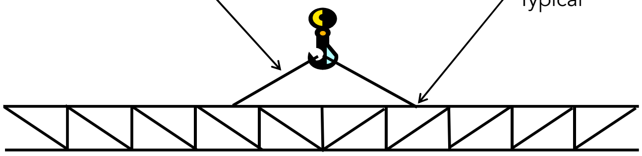

Fig. 5: A modified set of rigging that led to multiple problems lifting a long truss.

Keep in mind that lift beams may not always be the optimum choice for long-span trusses. As shown in the photo, a four-point, two-crane pick was planned by the steel erector's engineer to pick the 140-ton, roughly 400-ft-long truss. The use of two, two-sling bridle hitches with 60-ft-long slings precluded the need for lift beams.

Plan and Execute

The pick shown in Figure 1 was actually developed in 1967 for a steel mill project. The six trusses for that project were shipped to the site fully assembled in a vertical orientation on three railcar units. The erector's rigger, faced with offloading the trusses, modified the pick plan by eliminating the lift beam and connecting the 25-ft lift lines as close to the prescribed truss pick points as possible (see Figure 5). In the process the rigger also changed the planned vertical basket hitch to a two-leg bridle hitch with choker hitch connections to the truss chord.

Upon picking, the truss bottom chord buckled in the out-of-plane direction and was totally destroyed. The remaining five trusses, still on the railcars, were totally destroyed in a domino effect started by the lateral movement of the ill-picked first truss.

The moral of the story is that picks must be planned and plans must be executed. MSC