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steel interchange

Design of Lifting Lugs

Are the provisions of AISC 360-10 Section D5 appropriate to use in the design of lifting lugs?

Not really. There are other provisions that are more suitable to this application.

AISC 360 Section D5 is intended for connections of tension members within buildings. Traditionally the provisions were intended to be used with trusses, and the Johnston research upon which they are based was aimed at coming up with design procedures for truss members, such as pin-connected eyebars, during a time when such connections were still very common. Though Section D5 is routinely applied to things such as lifting lugs, this was really not the intended use. Also, since 1989 ASME undertook the task of formalizing Below the Hook Lifting Devices. If you go through the various documents, it is sometimes difficult to come up with clear scopes and definitions for the various components used in lifting operations, but OSHA certainly does make reference to ASME B30.20 and ASME-BTH-1, and this latter reference provides guidance related to the design of lifting devices, including lifting lugs. From this it seems that ASME BTH-1 is more applicable to your condition than AISC 360 Section D5.

Some of the differences are:

- ASME BTH-1 contains safety factors that are more appropriate for lifting operations. It also provides guidance related to impact and fatigue loadings more directly related to items such as lugs. In my experience, accounting for the safety factors for lifting lug design using the AISC *Specification* has been done in a much more ad hoc fashion.
- ASME BTH-1 explicitly addresses the issues involved with the greatly oversized holes common in lifting lugs. Typically, when applying the AISC *Specification*, I would go back to the Pincus and Duerr research to make adjustments for the larger holes. ASME BTH-1 incorporates the Pincus and Duerr results into their design procedures for you.
- ASME BTH-1 uses the $4t$ limit (Equation 3-46) that was shown in the 1989 AISC *Specification* but also includes a stability check when determining the effective width of the plate (Equation 3-47).

I am sure there are other differences between the AISC and ASME documents, but these are the ones that come immediately to mind.

One last point regarding safety factors: The ASME document settles on a factor of safety of 3. Though OSHA references BTH-1, it also in various ways makes reference to a factor of safety of 5. When designing lifting lugs, I have always aimed for a factor of safety close to 5, though embedded in this number are impact effects. I have not seen a clear interpretation from either ASME or OSHA that resolves this discrepancy, so you must review the applicable documents and come to your own conclusion.

In summary, I think you should probably use ASME BTH-1 and not AISC Section D5 to design lifting lugs.

Larry S. Muir, P.E.

Weld Access Hole Dimensions

Are there dimensional requirements for weld access holes in AWS D1.1?

Yes, AWS D1.1 specifies minimum weld access hole sizes. Referring to the 2010 edition, you will find this information in Clause 5.17; dimensions are in Clause 5.17.1. If you are dealing with rolled shapes, then you'll want to review Clause 5.17.1.1 as well, while Clause 5.17.1.2 addresses built-up sections. Not specifically related to dimensions, you will find further requirements in Clause 5.17.2 for Galvanized Shapes and in Clause 5.17.3 for Heavy Shapes. Pictorially, you will find this information in Fig. 5.2.

The AISC *Specification* also has weld access hole geometry and fabrication requirements in Section J1.6 and Section M2.2. Additionally, for high-seismic systems that require it, the AISC *Seismic Provisions* and AWS D1.8 have minimum dimensions for special seismic weld access holes.

Keith Landwehr

NDT Requirements

When is non-destructive testing of welds required?

Historically NDT requirements are found in a variety of places including notes on structural details, general structural notes sheets, project specifications and local (city) building code requirements. Today, it is a little more regular with recent changes to the *IBC* and AISC *Specification*. Here are some general observations:

- If the 2009 *IBC* applies: For high-seismic applications you will want to refer to Section 1707 and 2005 AISC *Seismic Provisions* Appendix Q. For wind and low-seismic applications, the 2005 AISC *Specification* does not contain NDT requirements; as stated previously, this info is usually found in contract documents or local building codes.
- If the 2012 *IBC* applies: For high-seismic applications you will want to refer to Section 1705.11 and AISC *Seismic Provisions* Chapter J. For wind and low-seismic applications, see 2010 AISC *Specification* Chapter N.

When NDT is required, AWS D1.1 and AWS D1.8 provide NDT procedures and acceptance criteria.

Keith Landwehr

Field Verification

Is the field verification of dimensions for connections to an existing structure the responsibility of the steel fabricator?

Typically, field verification of existing conditions is the responsibility of the contractor, not the steel fabricator or erector. The AISC *Code of Standard Practice* Section 1.7.3 states:

"… field dimensioning of an existing structure is not within the scope of work that is provided by either the fabricator or the erector."

However, it is always a possibility that the contract documents could state otherwise. I suggest you check what the contract documents say, as this could be different for each project.

Keith Landwehr

First Order Analysis Method

In the calculation of N_i in AISC 360-10 Equation C2-8 for a portal frame where the columns have different lengths, which length should be chosen to represent the story height (L)? Should it be the shorter one, the longer one, the average of the two or something else entirely?

The equation that you are referencing was developed assuming columns of equal height. However, it can be adapted to your situation. There are two options that I think would be applicable.

- Conservatively use shorter column height.
- Discretize your notional loads to be on a per-column basis; this option uses a notional load on each lateral column based on its height and tributary load.

Heath Mitchell, S.E., P.E.

Reuse of High-Strength Bolts

Can bolts that have been pretensioned be reused?

RCSC Specification Section 2.3.3 prohibits the reuse of "ASTM A490 bolts, ASTM F1852 and F2280 twist-off-type tension-control bolt assemblies, and galvanized or Zn/Al Inorganic coated ASTM A325." It allows the reuse of black A325 bolts, at the discretion of the engineer of record. The Commentary provides further information:

"Pretensioned installation involves the inelastic elongation of the portion of the threaded length between the nut and the thread run-out. ASTM A490 bolts and galvanized ASTM A325 bolts possess sufficient ductility to undergo one pretensioned installation, but are not consistently ductile enough to undergo a second pretensioned installation. Black ASTM A325 bolts, however, possess sufficient ductility to undergo more than one pretensioned installation as suggested in the *Guide* (Kulak et al., 1987)."

Section 4.5 of the *Guide to Design Criteria for Bolted and Riveted Joints* provides more detailed references and research on this topic.

Erin Criste

Slip-Critical Surface Preparation

In a slip-critical connection, are the surfaces under the bolt head and/or washer subject to the same of surface preparation requirements as the inside plies?

No. The area under the nut and head are not subject to the same requirements as the faying surfaces. The Commentary to the RCSC *Specification* (a free download from **www.boltcouncil.org**) does, however, caution against large coating thicknesses (including under the head and the nut). It states:

"Tests have indicated that significant bolt pretension may be lost when the total coating thickness within the joint approaches 15 mils per surface, and that surface coatings beneath the bolt head and nut can contribute to additional reduction in pretension."

Larry S. Muir, P.E.

Coating Thickness Measurements

When painting multiple beams on a paint rack is it acceptable to check the coating thickness on one piece per rack or do I have to check the coating thickness on all of the beams?

The requirements of SSPC-PA2 (May 2012) address your question. Section 8.2 requires that five spot measurements (three readings per spot) be taken for each 100 sq. ft of coating surface. PA2 simply says "random" spots. If each of your beams consists of 100 sq. ft of coating per beam, then you'll be checking each beam.

Assuming less than 100 sq. ft for each beam, then it is typical to find direction in your in-house painting and inspection procedure. The contractor has the option of defining "random" so as to provide direction to the painter and/or coating inspector. I have experienced five spots on one beam and five spots split between multiple members depending on the contractor's experience and consistency of the coating process.

Keith Landwehr

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