steel quiz

The answers to this month's Steel Quiz can be found in AISC Design Guide 17 *High Strength Bolts—A Primer for Structural Engineers*, as well as on the AISC and *Modern Steel Construction* websites (www.aisc.org and www.modernsteel.com).

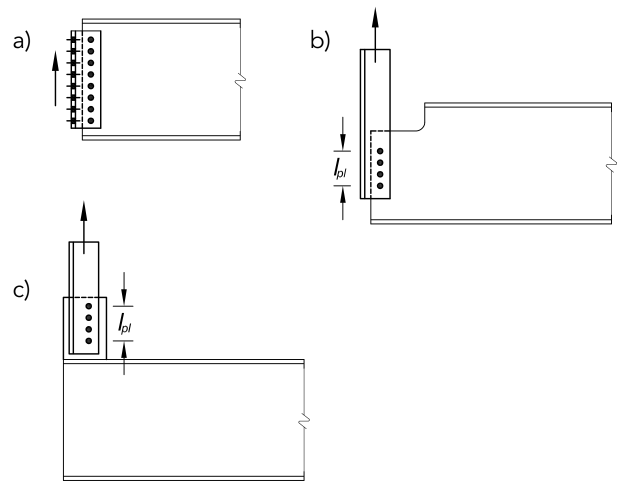
1 How are the following values from Table J3.2 determined?
   a) With threads either included or excluded from the shear planes, $F_{nt} = 0.75\ F_u$.
   b) When threads are excluded from the shear planes, $F_{nv} = 0.563\ F_u$.
   c) When threads are not excluded from the shear planes, $F_{nv} = 0.450\ F_u$.

2 What are end-loading effects in bolted joints?

3 For end-loaded connections with a fastener pattern length greater than 38 in., why do we have to reduce fastener shear values to 83.3% of the tabulated value?

4 For A307 bolts, why are the tabulated shear values reduced by 1% for each 1/16 in. over 5 diameters of length of grip?

5 Which of the following connections are considered end-loaded?

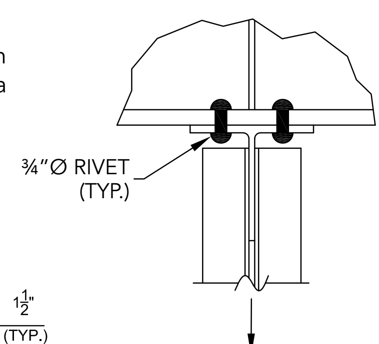


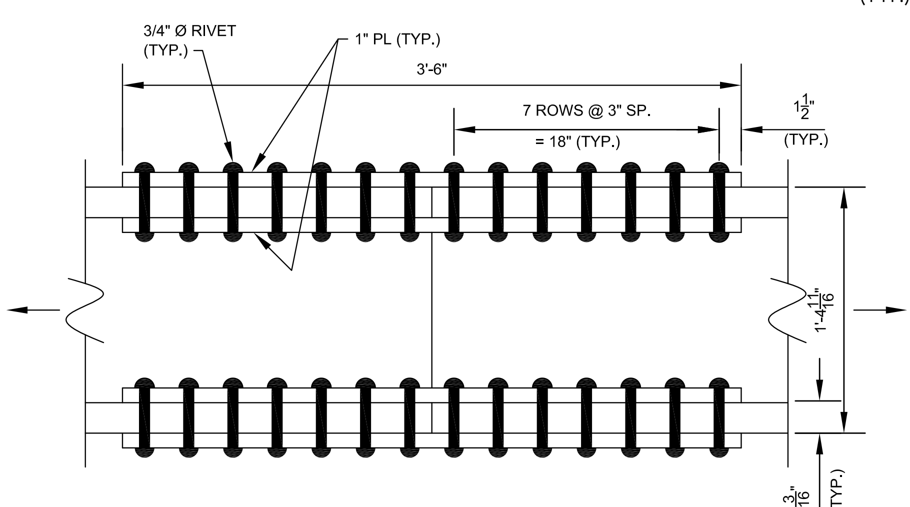
Bonus Questions

You have been tasked with checking the two riveted connections shown below from a building constructed in 1937. The rivet steel is A141-33 with a tensile strength = 52 ksi.

a) For the hanger connection, what would you use for the value of F_{nt}? ➤

b) For the splice connection, what would you use for the value of F_{nv}? ➤





TURN PAGE FOR ANSWERS

1 a) The 0.75 value is determined as the minimum ratio of threaded area to nominal area for the common bolt diameters and threading used for ASTM A325 and A490 bolts. Rather than have the designer calculate the cross-sectional area through the threads, this allows the cross-sectional area of the bolt corresponding to the nominal diameter to be used.

b) The 0.563 value is based on two considerations. The first is the approximation of the bolt shear strength, which is taken as equal to 62.5% of the ultimate tensile strength. This is based on theory and tests. The other is an additional 10% reduction to account for end loading effects.

c) The 0.45 value comes from the 62.5% and 10% reductions discussed in 1b. An additional 0.8 reduction is included to account for the reduction in the nominal bolt area to account for the threads.

2 "End-loading effects" refers to the uneven distribution of bolt shear forces in a multi-bolt connection that does not receive its load uniformly; a bolted flange plate is an example of this. Note the amount of deformation in the bolt at the end of the connection compared to a bolt near the middle of the connection. The longer the connection is, the more deformation the bolts at the ends of the connection will undergo in order for load to distribute to the bolts near the center of the connection (see photo).

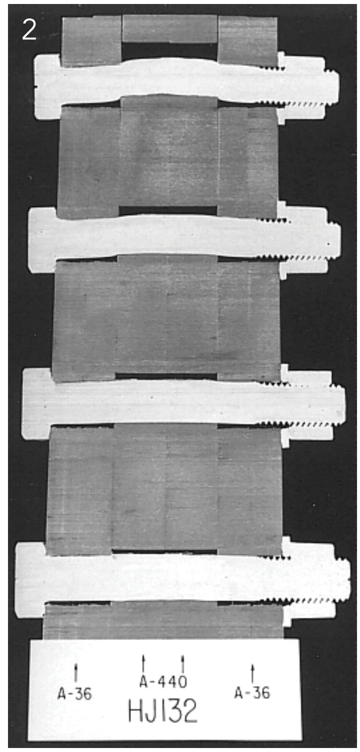


Fig. 5.3. Sawn section of a joint.

3 End-loading effects are already accounted for in connections up to 38 in. long (the 10% reduction discussed in 1b). In longer joints there is even more strain to account for the bolts at the end of the connection. It was determined that a larger reduction, 0.75, is needed to account for end-load effects when lengths are greater than 38 in. Instead of adding a row to Table J3.2, a footnote was added stating that the values be reduced by 83.3% which brings the values down to 0.75. (0.833 × 0.90).

4 This is a carryover from the reduction that was specified for long rivets. Because material strengths are similar, a similar reduction is used.

5 Figures b) and c) are examples of end-loaded connections.

Bonus Question Answers

a) For the hanger connection, F_{nt} = 52 ksi. Note that the 0.75 reduction factor shown in Table J3.2 does not apply here since the rivet has no threads, so no reduction in the rivet area is required.

b) For the splice connection, F_{nv} = 27.2 ksi. There are 3 reductions that apply to this connection. There is a 10% reduction to account for end-loading effects. There is the approximation of shear strength, which is taken as 62.5% of the tensile strength. Finally, there is a 7% reduction due to the length of the grip ($4\frac{3}{16}$" – 5 × ¾" dia. = $\frac{7}{16}$", with a 1% reduction per $\frac{1}{16}$"). Thus, F_{nv} = 52 ksi × 0.9 × 0.625 × 0.93 = 27.2 ksi.