

steel quiz

The answers to this month's Steel Quiz can be found in the *AISC Specification, Manual* and Design Guide 21, as well as on the AISC and *Modern Steel Construction* websites (www.aisc.org and www.modernsteel.com).

- 1 Select the fillet weld size, "w", for the detail shown in Figure 1. Assume that the gusset plate and HSS have already been checked and are adequate. The service load shown is 120 kips for ASD; or use 180 kips for LRFD.

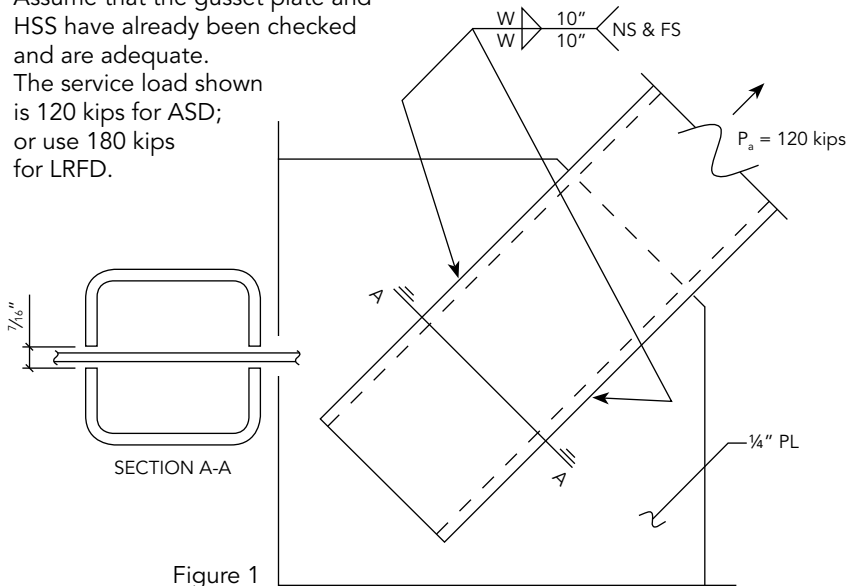


Figure 1

- 2 Why is the size of a fillet weld along the edge of a plate limited to 1/16 in. less than the material thickness for materials 1/4 in. or thicker?

- 3 Does the weld return shown in Figure 2 meet the requirements in the *AISC Specification*?

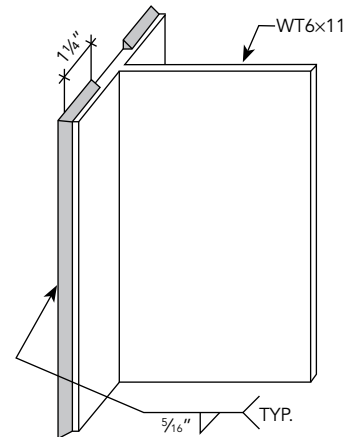


Figure 2

- 4 How much strength does the fillet reinforcement add to the PJP groove-welded detail shown in Figure 3, where $F_{EXX} = 70$ ksi?

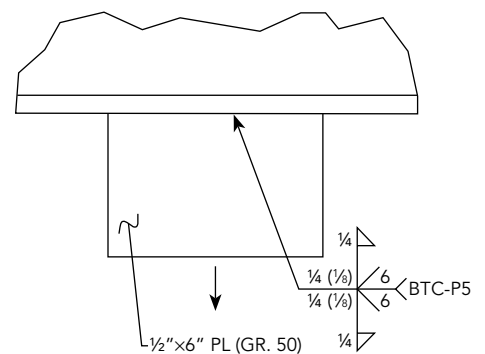


Figure 3

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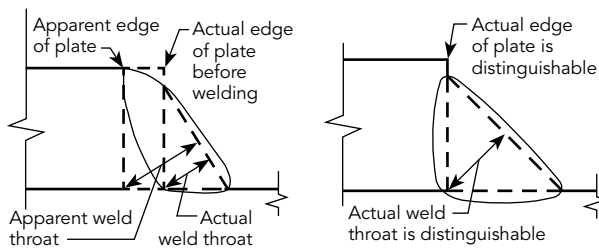
ANSWERS

- 1 A weld size $w = \frac{1}{4}$ in. is required. This can be calculated using either Equation 8-2a for LRFD or Equation 8-2b for ASD from the AISC 14th Edition *Manual*. In LRFD, the design strength is $1.392 \times D \times L$. In ASD, the allowable strength is $0.928 \times D \times L$. In both cases, D = weld size in sixteenths of an inch and L is the total length of the weld in inches.

Thus, for LRFD, $180 \text{ kips} / (1.392 \text{ kips/in.} / \text{sixteenth} \times 4 \text{ welds} \times 10 \text{ in.}) = 3.23 \text{ sixteenths}$. Similarly, for ASD, $120 \text{ kips} / (0.928 \text{ kips/in.} / \text{sixteenth} \times 4 \text{ welds} \times 10 \text{ in.}) = 3.23 \text{ sixteenths}$. A $\frac{1}{4}$ -in. weld size is required.

Note that the fillet weld leg size will need to be increased based on the root opening resulting from the $\frac{1}{2}$ -in. slot in the HSS if this value exceeds $\frac{1}{16}$ ". This adjustment is made by the welder, not the engineer, based upon the actual opening. (See Clause 5.22.1 in AWS D1.1/D1.1M:2010.)

- 2 This prevents the possibility for the welder to melt away the upper corner, resulting in a weld that appears to be full size but actually lacks the required weld throat dimension (see the figure below).



- 3 No. Section J2.2b of the AISC *Specification* states "For connections where flexibility of the outstanding elements is required, when end returns are used the length of the return shall not exceed four times the nominal size of the weld nor half the width of the part." While the weld return in Figure 2 meets the $4w$ requirement, it exceeds half the width of outstanding element, which is equal to the width ($4\text{-in. flange}/2$) divided by $2 = 1$ in. A weld return of $1\frac{1}{4}$ in. exceeds this 1-in. limit.

- 4 The fillet reinforcement adds no strength. It may be tempting to add the strength of a reinforcing fillet weld to the strength of a PJP groove weld when determining the strength of a detail similar to what is shown in Figure 3. This usually is incorrect, however. Instead, the strength must be determined by finding the effective throat of the weld (see the figure below). In this particular example, the effective throat size per inch of weld group (with two PJP groove welds) is equal to:

$$2 \times \sqrt{(\frac{1}{8})^2 + (\frac{1}{8})^2} = 0.354 \text{ in.}^2 / \text{in.}$$

This is then used as shown in AISC *Specification* Table J2.5 to determine the effective weld area and the allowable strength of the weld. In LRFD, the design strength is:

$$0.8 \times (0.6 \times 70 \text{ ksi}) \times 0.354 \text{ in.}^2 / \text{in.} \times 6 \text{ in.} = 71.4 \text{ kips}$$

In ASD, the allowable strength is:

$$(0.6 \times 70 \text{ ksi} / 1.88) \times 0.354 \text{ in.}^2 / \text{in.} \times 6 \text{ in.} = 47.5 \text{ kips}$$

