steel quiz

This month's Steel Quiz focuses on the weld ductility factor, which is addressed in Part 13 of the AISC *Manual*.

1 When a gusset plate is directly welded to the beam or column, it is recommended that the connection be designed for the larger of the peak stress and _______ times the average stress.
a. 1.25 **b.** 1.4 **c.** 1.5 **d.** 2

2 The weld ductility factor referred to above is also sometimes referred to as ______________.
a. The PWBTW Act **b.** The Maxwell Dilemma
c. The Richard Factor **d.** #WeldItBigger

3 True or False: A weld that is sized to develop the strength of the gusset plate does not need to be increased by the weld ductility factor.

4 True or False: The weld ductility factor does not apply to welds that are subjected to shear only.

5 Which point in Figure 1 would you expect to be the location of peak stress due to uneven stress distribution?

6 Using the information provided in Figure 2, calculate the average and peak stresses on the gusset plate, which will be used to size the fillet weld, *w*. The gusset plate thickness is 1¾ in. The resulting forces on the gusset to beam connection interface are:
H_b = 643 kips (shear)
V_b = 237 kips (axial)
M_b = 5,090 kip-in. (moment)

7 Use the controlling stress calculated in Question 6 to size the fillet weld, *w*, shown in Figure 2. Use LRFD.

FIGURE 1

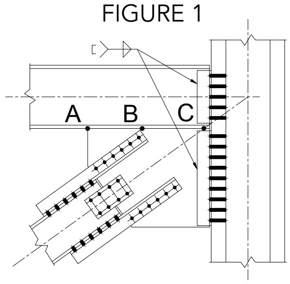
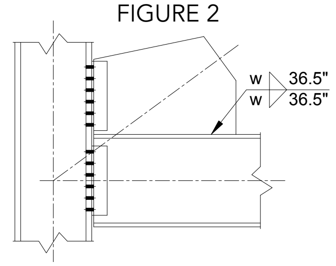


FIGURE 2



TURN PAGE FOR ANSWERS

1 **a.** 1.25. This is recommended in Part 13 of the 14th Edition *Steel Construction Manual*. The 25% increase is recommended to provide ductility to allow adequate force redistribution in the weld group.

2 **c.** Richard Factor. It comes from stress distributions Ralph Richard characterized in his research on bracing connections.

3 True. A weld that develops the strength of the plate can rely on the ductility of the plate for load redistribution capability.

4 True. AISC Design Guide 29 states, on page 155: "The weld ductility factor is not used for welds that resist shear forces only." Shear forces can redistribute along the length of a gusset; it's the tension forces that can produce concentrations that require special consideration.

5 Point B. Because of the proximity of the brace claw angle to the gusset to beam connection, a peak stress can be expected at point B.

6 $$f_v = \frac{643 \text{ kips}}{1.75 \text{ in.} \times 36.5 \text{ in.}} = 10.1 \text{ ksi}$$

$$f_a = \frac{237 \text{ kips}}{1.75 \text{ in.} \times 36.5 \text{ in.}} = 3.71 \text{ ksi}$$

$$f_b = \frac{5{,}090 \text{ kip-in.} \times 4}{1.75 \text{ in.} \times (36.5 \text{ in.})^2} = 8.73 \text{ ksi}$$

$$f_{peak} = \sqrt{(3.71 \text{ ksi} + 8.73 \text{ ksi})^2 + (10.1\text{ksi})^2} = 16.0 \text{ ksi}$$

$$f_{avg} = \frac{1}{2}\left[\sqrt{(3.71\text{ksi} - 8.73\text{ksi})^2 + (10.1\text{ksi})^2} + \sqrt{(3.71 \text{ ksi} + 8.73 \text{ ksi})^2 + (10.1 \text{ ksi})^2}\right] = 13.7 \text{ ksi}$$

$$f_{weld} = max\,(f_{peak}, 1.25f_{avg}) = max\,(16.0 \text{ ksi}, 1.25 \times 13.7 \text{ ksi}) = 17.1 \text{ ksi}$$

7 Determine the directional strength increase value:

$$\theta = tan^{-1}\left(\frac{3.71 \text{ ksi} + 8.73 \text{ ksi}}{10.1 \text{ ksi}}\right) = 50.9°$$

$$F_{nw} = 0.6 \times 70 \text{ ksi} \times (1.0 + 0.5\, sin^{1.5}\, 50.9°) = 56.4 \text{ ksi}$$

For two fillet welds, the required fillet weld size, w, is calculated using the following relationship:

$$2 \times 0.75 \times 56.4 \text{ ksi} \times 0.707 \times w = 17.1 \text{ ksi} \times 1.75 \text{ in.}$$

$$w = 0.500 \text{ in.}$$

Use a ½-in. fillet weld.