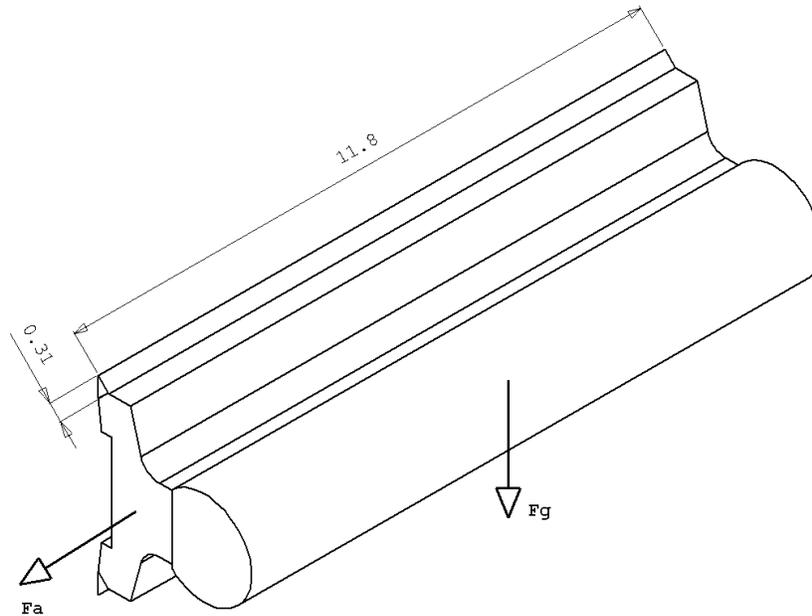
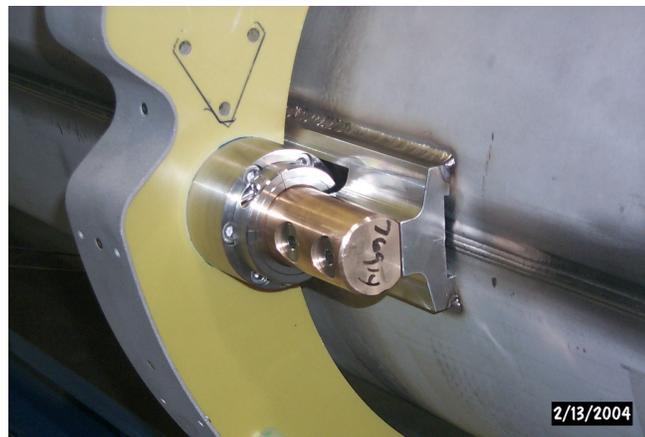


Q1 and Q3 cold mass weld bracket stress analysis

T. Nicol – April 12, 2007



This analysis addresses the weld stress in the LHC IR quadrupole Q1 and Q3 cold mass weld brackets resulting from the weight of the magnets combined with an axial load associated with a proposed cold mass anchor “hook”. In the worst case, the hook can apply a 20,000 load along the length of the block as shown in the above figure. The weld specified on drawing ME-390525 is 8 mm x 8 mm x 300 mm long (0.31 in x 0.31 in x 11.8 in). A typical weld is shown in the figure below.



Three stress cases are considered:

- Case A: Shear stress associated with the 20,000 lb axial load.
- Case B: Shear stress associated with the 5,250 lb gravity weight load (1/4 Q3 weight).
- Case C: Tensile stress associated with the 5,250 lb gravity weight load.

Case A

The shear area in welds is given by:

$$(0.31'' / 1.414) * 11.8'' * 2 \text{ welds} = 5.2 \text{ in}^2$$

And the resulting shear stress is:

$$\tau_A = 20,000 \text{ lb} / 5.2 \text{ in}^2 = 3,805 \text{ psi}$$

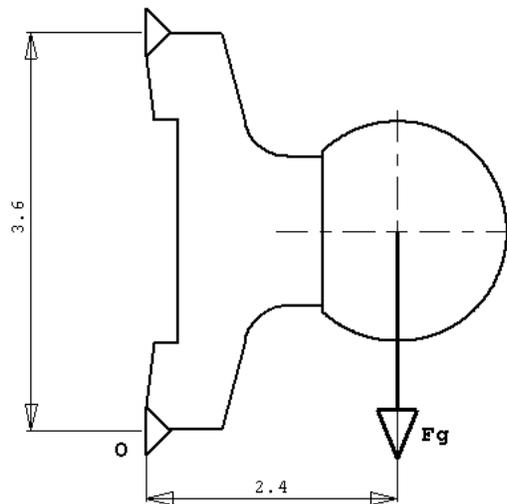
Case B

The shear area is the same as given in Case A so the resulting shear stress is:

$$\tau_B = 5,250 \text{ lb} / 5.2 \text{ in}^2 = 1,010 \text{ psi}$$

Case C

The free body diagram of this weld configuration is shown below



and the resulting tensile stress is given by:

$$\sigma_C = M * c / I = 1,905 \text{ psi}$$

where: $M = F_g * 2.4 \text{ in} = 12,600 \text{ in-lb}$

$$c = 3.6 \text{ in} / 2 = 1.8 \text{ in}$$

$$b = \text{weld length} = 11.8 \text{ in}$$

$$d = \text{weld spacing} = 3.6 \text{ in}$$

$$h = \text{weld height (throat length)} = 0.31 \text{ in} / 1.414 = 0.22 \text{ in}$$

$$I = 0.707 * h * (b * d^2) / 2 = 11.9 \text{ in}^4$$

The equivalent combined stress is:

$$\sigma_e = (1 / 1.414) * (2 * \sigma_C^2 + 6 * (\tau_A^2 + \tau_B^2))^{0.5} = 7,080 \text{ psi}$$

The allowable stress is given by:

$$\sigma_{\text{allowed}} = 16,700 \text{ psi} * 0.55 = 9,195 \text{ psi}$$

where: 16,700 psi is the maximum allowable tensile stress in the cold mass skin (316L)
and 55% is the joint efficiency specified by UW-18 of the ASME Code, Section VIII,
Division 1.

Therefore the weld is adequate.