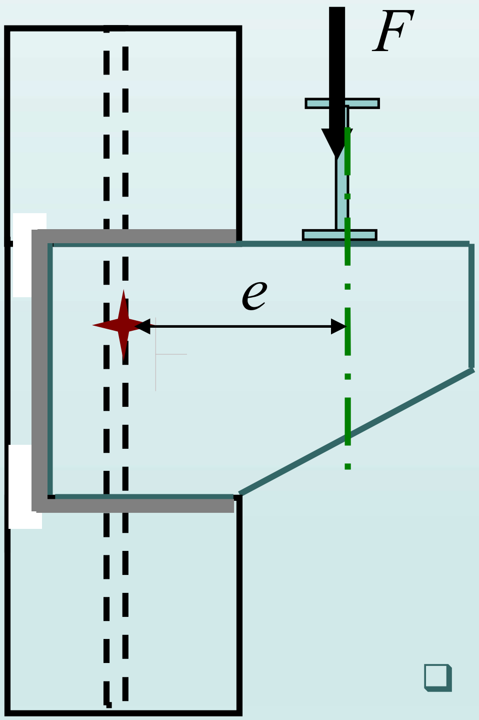
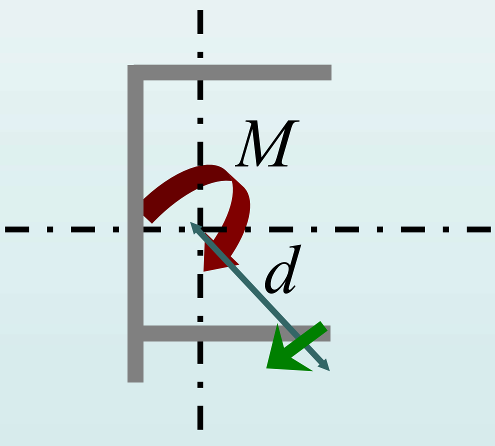
Elastic Analysis of Eccentric Welded Connections

- It is assumed here that the rotation of the weld at failure occur around the elastic centre (EC) of the weld. The only difference from bolts is we are dealing with unit length of weld instead of a bolt





- The shear stress in weld due to torsion moment M is

$$f_2 = \frac{M\ d}{J}$$

- **M** is the moment, **d** is the distance from the centroid of the weld to the weld point where we evaluate the stress, **J** is the polar moment of inertia of the weld

AISC Manual Part 8

Elastic Analysis of Eccentric Welded Connections – Shear & Torsion

- stresses due to torsional moment "M" is

$$M = F\,e$$

$$J = I_x + I_y$$

- Calculation shall be done for t_{eff} $\quad t_{eff} = 0.707\,w$
- Or for $t_{eff} = 1$ mm

$$f_2 = \frac{M\,d}{J}$$

&

$$f_{2x} = \frac{M\,y}{J}$$

$$f_{2y} = \frac{M\,x}{J}$$

Elastic Analysis of Eccentric Welded Connections – Shear & Torsion

- Forces due to direct applied force is

$$f_{1x} = \frac{F_x}{A_{weld}} \qquad f_{1y} = \frac{F_y}{A_{weld}}$$

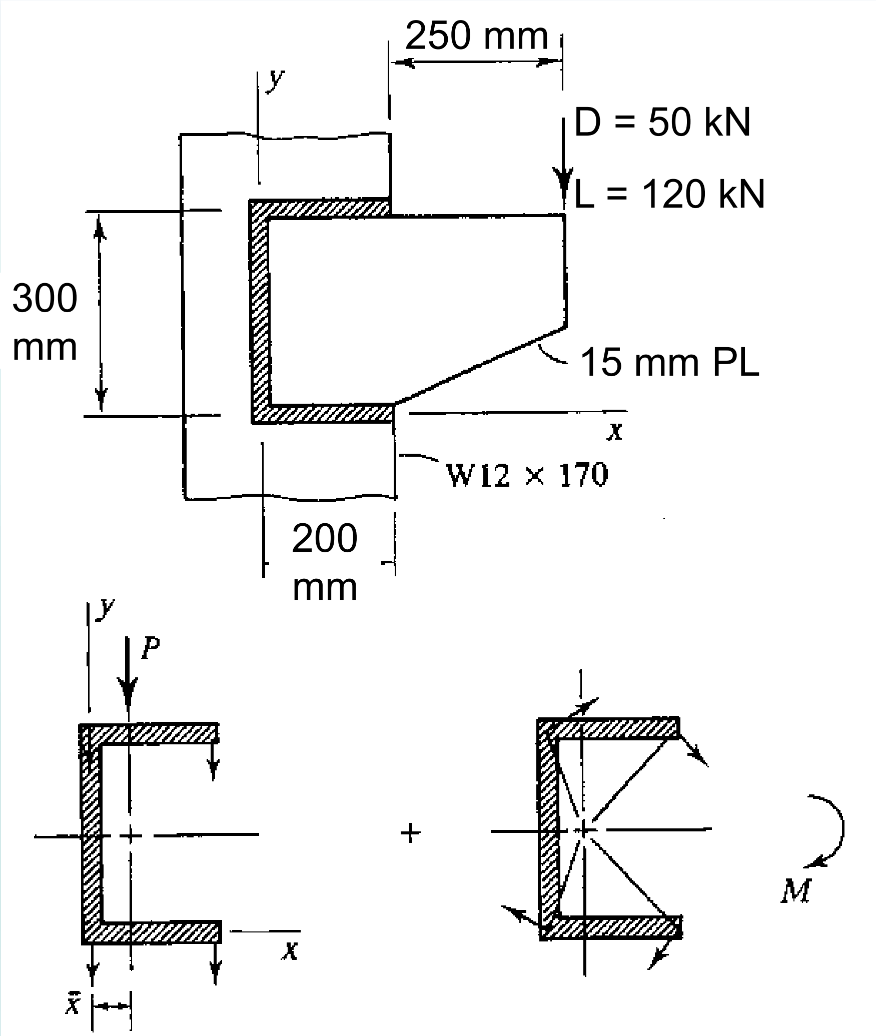
- Total stress in the weld is

$$f_x = f_{1x} + f_{2x} \quad \& \quad f_y = f_{1y} + f_{2y}$$

$$f_v = \sqrt{f_x^{\,2} + f_y^{\,2}} \le \phi R_{n\_weld}$$

Ex. 7.7 – Design Strength of Welded Connection – Shear and Torsion

- Determine the size of weld required for the bracket connection in the figure. The service dead load is 50 kN, and the service live load is 120 kN. A36 steel is used for the bracket, and A992 steel is used for the column.



Calculations are done for t_{eff} = 25 mm

Ex. 7.7 – Design Strength of Welded Connection – Shear and Torsion

- Step I: Calculate the ultimate load:

$$P_u = 1.2D + 1.6L = 1.2(50)+1.6(120) = 252\ kN$$

- Step II: Calculate the direct shear stress:

$$f_{1y} = \frac{252 \times 1000}{200+300+200} = 360\ \text{N/mm}$$

- Step III: Compute the location of the centroid:

$$\bar{x}(700) = 200(100)(2) \quad \text{or} \quad \bar{x} = 57.1\,\text{mm}$$

- Step IV: Compute the torsional moment:

$$e = 250 + 200 - 57.1 = 392.9 \rightarrow M = Pe = 252(392.9) = 99011\ kN\text{-}mm.$$

Ex. 7.7 – Design Strength of Welded Connection – Shear and Torsion

- Step V: Compute the moments of inertia of the total weld **area**:

$$I_x = 1(300)^3\,(1/12)+2(200)(150)^2=11.25\times10^6\ mm^4$$

$$I_y = 2\,\{(200)^3\,(1/12)+(200)(100\text{-}57.1)^2\}+ 300(57.1)^2=3.05\times10^6\ mm^4$$

$$J = I_x + I_y = (11.25 + 3.05)\times10^6 = 14.3\times10^6\ mm^4$$

- Step VI: Compute stresses at critical location:

$$f_{2x} = \frac{M\ y}{J} = \frac{99011(150)\times1000}{14.3\times10^6} = 1039\ \text{N/mm}$$

$$f_{2y} = \frac{M\ x}{J} = \frac{99011(200-57.1)\times1000}{14.3\times10^6} = 989\ \text{N/mm}$$

$$f_v = \sqrt{f_{2x}^2 + \left(f_{1y} + f_{2y}\right)^2} = \sqrt{(1039)^2 + (989+360)^2} = 1703\ \text{N/mm}$$