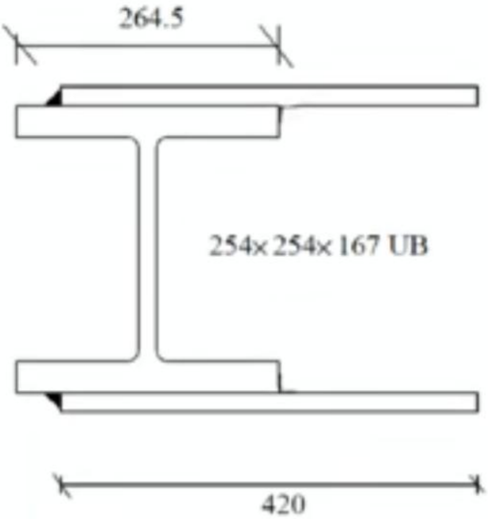
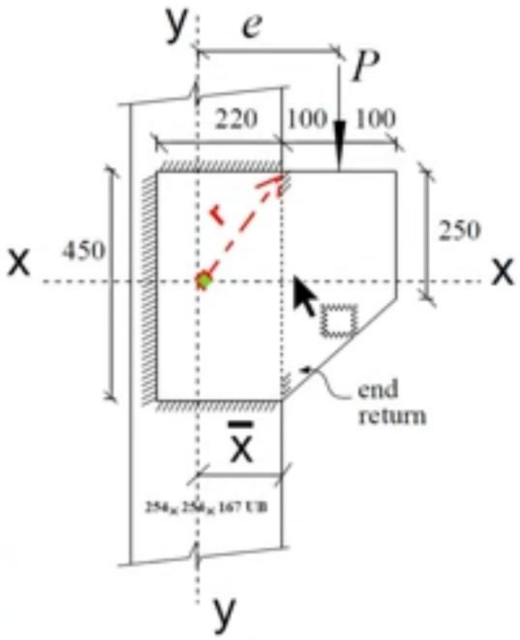
SOLVED EXAMPLE FOR ECCENTRIC CONNECTION IN SHEAR AND TORRSION

The crane beam in the simple portal frame is supported by bracket connection welded to the steel column. Two gusset plates are welded to the flanges of the steel column to form the bracket connection as shown in the figure. The 20mm thick gusset plate is made of grade S275 steel material. The welded connection is used as this rigid moment connection. The electrode of weld is E35 for the welded connection. Design the size of fillet weld in the bracket connection to enable to take factored shear force of 500kN from crane beam.





Solution

The bracket connection is supported to take point load P and the eccentric moment Pe. The three side fillet welds are used to withstand the in-plane shear due to both point load and eccentric moment. The structural adequacy of the most outer side weld should be checked.

DESIGN LOAD

Vertical shear, $P = 500kN$

For unit leg length,

Area of weld, $L_w = 450 + 220 \times 2 = 890mm$

Distance to centroid, $\bar{x} = \dfrac{450 \times 220 + 220 \times 110 \times 2}{890} = 165.6mm$

$$r = \sqrt{165.6^2 + 225^2} = 279.4mm$$

Eccentricity of load, $e = 165.6 + 100 = 265.6mm$

Second moment of inertia about x-x axis,

$$I_x = \frac{450^3}{12} + 220 \times 225^2 \times 2 = 2.987 \times 10^7\, mm^3$$

Second moment of inertia about y-y axis,

$$I_y = \left[\frac{220^3}{12} + 220 \times (165.6 - 110)^2\right] \times 2 + 450 \times (220 - 165.6)^2 = 4.467 \times 10^6\, mm^3$$

Polar moment of inertia about z-z axis,

$$I_z = I_x + I_y = 2.987 \times 10^7 + 4.467 \times 10^6 = 3.434 \times 10^7\, mm^3$$

Direct shear, $F_s = \frac{P}{L_w} = \frac{500 \times 10^3}{890} = 561.8\, N/mm$

Shear due to torsion, $F_T = \frac{500 \times 10^3 \times 265.6 \times 279.4}{3.434 \times 10^7} = 1080.5\, N/mm$

Shear due to torsion

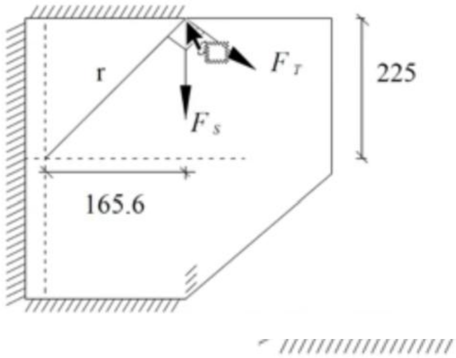
$F_T = Per/I_p$

CAPACITY OF WELD

$$\theta = \tan^{-1}\left(\frac{225}{165.6}\right) = 53.6°$$

Resultant load, $F_R = \sqrt{F_S^2 + F_T^2 + 2F_S F_T \cos\theta}$

$$= \sqrt{561.8^2 + 1080.5^2 + 2 \times 561.8 \times 1080.5 \times \cos 53.6°} = 1484.4\, N/mm$$



Design strength of weld, $p_w = 220\, N/mm^2$

Minimum Leg length required, $s = \frac{1484.4}{0.7 \times 220} = 9.6mm$

$\therefore$ use 10mm weld

Table 10.4 Design strength of fillet welds p_w (kN/mm^2)

Steel grade BS EN10025	*Electrode classification (BS EN499, BS EN440)*		
	35	*42*	*50*
S275	220	(220)	(220)
S355	(220)	250	(250)
S460	(220)	(250)	280

Note: bracket values are under or over matching electrodes

this equation comes as follows
tstep 1 throught =0.7 xLeg =0.7xS
step 2 strenght of weld /mm =through xPw