Examples

1. Design a bolted end plate connection between an ISMB 400 beam and an ISHB 200 @ 40 kg/m column so as to transfer a hogging factored bending moment of 150 KN-m and a vertical factored shear of 150 KN. Use HSFG bolts of diameter 22 mm.

Assume 6 HSFG 8.8 grade bolts of 22mm dia and 180 × 600-mm end plate as shown in figure.

1) Bolt forces

Taking moment about the center of the bottom flange and neglecting the contribution of bottom bolts and denoting the force in the top bolts by F

$4F \times 384 = 150 \times 10^3$

$F = 97.6$ kN

Tension Resistance of the bolt $T_f = T_{nf} / \gamma_{mb}$

$T_{nf} = 0.9 \times f_{ub} \times A_n \leq f_{yb} \times A_{sb} \times \gamma_{m1} \times \gamma_{m0}$

$A_{sb} = \pi / 4 \times 22^2 = 380.13$ mm^2

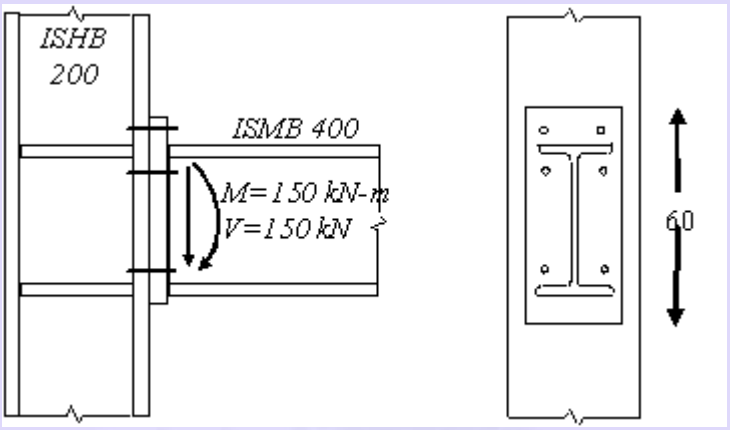
$A_n = 0.8 \times A_{sb} = 304.1$ mm^2

$T_{nf} = 0.9 \times 800 \times 304.11 = 218.96$ KN < 276.458 KN $(f_{yb} \times A_{sb} \times \gamma_{m1} / \gamma_{m0})$

$T_f = 218.96 / 1.25 = 175.168$ KN

Design tension capacity of bolt = 175.168 kN

Allowable prying force Q = 175.168 - 97.6 = 77.568 kN



2) Thickness of end plate assuming 10 mm fillet weld to connect the beam with end plate, distance from center line of bolt to toe of fillet weld b = 60-10 = 50 mm; end plate width be = 180 mm effective width of end plate per bolt w = be/2 = 180/2 = 90 mm

M_p = F x b /2 = 97.6 x 10^3 x 50 / 2 = 2440 N-m

t_{min} = $\sqrt{}$(1.15 x 4 x M_p / p_y x w) = 22.33 mm

provide (T) 30 mm thick end plate

3) Design for prying action distance from the centre line of bolt to prying force n is the minimum of edge distance or 1.1 T $\sqrt{}$ βPo/Py = 1.1 x 30 $\sqrt{}$(2 x 512/250) = 55.66 mm

so, n = 40 mm moment at the toe of the weld = Fb - Qn = 97.6 $\times$ 50 – 77.568 $\times$ 40 = 2412 N-m moment capacity = (py/1.15) x (wT^2/4)

= (250/1.15)(90 x 30^2/4) = 4402 N-m > 2412 N-m Safe !

Prying force $Q = \frac{b}{2n}\left[F - \frac{\beta\gamma P_0 w T^4}{27nb^2}\right]$

β=2 (non-preloaded)

γ =1.5 (for factored load)

$$Q = \frac{50}{2 \text{ x } 40}\left[97.6 - \frac{2 \text{ x } 1.5 \text{ x } 0.560 \text{ x } 90 \text{ x } 30^4}{27 \text{ x } 40 \text{ x } 50^2}\right]$$

= 32.65 KN < allowable prying force

Hence Safe!

4) Check for combined shear and tension

Shear capacity of 22 dia HSFG bolt V_{sdf} = 68.2 KN

Shear per bolt V = 150/6 = 25 KN

Applied tensile load on bolt = 97.6 + 32.65 = 130.25 KN

Design tension capacity = 175.168 KN

$(V/V_{sdf})^2 + (T_e/T_{ndf})^2 = (25.0/68.2)^2 + (130.25/175.168)^2 = 0.687 < 1.0$

Hence Safe!