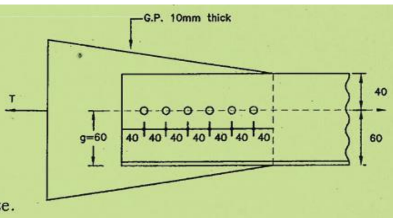
Example

- A single unequal angle 100x75x6mm is connected to a 10 mm thick gusset plate at the end with 6 nos. 16mm dia. Bolts to transfer tension. Determine the design tensile strength of the angle assuming that the yield and the ultimate stress of steel used are 250 MPa and 410 MPa. Assume that the longer leg is connected to the gusset plate.



Solution:

d = 16 mm, 6 nos. of bolts

d_h = 16 + 2.0 = 18 mm

f_y = 250 MPa (N/mm^2)

f_u = 410 MPa (N/mm^2)

g = gauge distance

= 60 mm (from H.B. of steel, SP-6)

It may be taken about 60% of the connected leg size.

Area of the gross section for ISA 100 × 75 × 6 mm

A_g = 1014 mm^2 (from steel table)

Minimum edge distance = 1.7 d_h | IS : 800, P.74 cl. 10.2.4.2

= 1.7 × 18

= 30.6

Provide e = 40 mm

Minimum pitch = 2.5 d | IS : 800, P.73 cl. 10.2.2

= 2.5 × 16

p = 40 mm

(a) Strength governed by yielding of gross section. | IS : 800, cl. 6.2 P.32

$T_{dg} = A_g \cdot f_y/\gamma_{mo}$

$= 1014 \times 250/1.10$

$= 230454$ N

= 230.45 kN ...... (1)

(b) Strength governed by rupture of critical section | IS : 800 cl. 6.3.3 P.33

$T_{dn} = 0.9\, A_{nc} \cdot f_u/\gamma_{m1} + \beta A_{go} \cdot f_y/\gamma_{mo}$

Where,

$\beta = 1.4 - 0.076 \left(\frac{w}{t}\right)\left(\frac{f_y}{f_u}\right)\left(\frac{b_s}{Lc}\right) \geq 0.7$

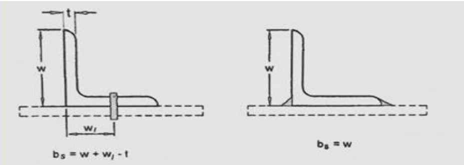


FIG. 6 ANGLES WITH SINGLE LEG CONNECTIONS

∴ w = outstand leg width = 75 mm

b_s = shear lag width

= 75 + 60 - 6

= 129 mm

L_C = Length of connection

= c/c distance between the outermost bolts in the direction of load.

= 5 × 40

= 200 mm

$\therefore\ \beta = 1.4 - 0.076 \left(\frac{w}{t}\right)\left(\frac{f_y}{f_u}\right)\left(\frac{b_s}{Lc}\right)$

$= 1.4 - 0.076 \left(\frac{75}{6}\right)\left(\frac{250}{410}\right)\left(\frac{129}{200}\right)$

$= 1.026 > 0.7$

and,

$f_u \cdot \gamma_{mo}/(f_y \cdot \gamma_{m1}) = 410 \times 1.10/(250 \times 1.25)$

$= 1.44$

$1.026 < 1.44$ ∴ OK

$\therefore\ \beta = 1.026$

A_{nc} = net area of connected leg

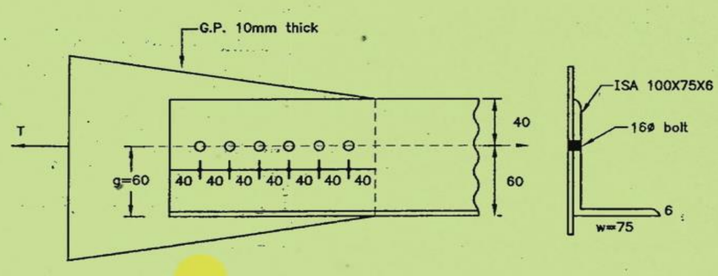
$= (100 - \frac{6}{2} - 18) \times 6$

$= 474\ mm^2$

A_{go} = gross area of outstanding leg

$= (75 - \frac{6}{2}) \times 6$

$= 432\ mm^2$



$\therefore\ T_{dn} = 0.9\ A_{nc} \cdot f_u/\gamma_{m1} + \beta \cdot A_{go} \cdot f_y/\gamma_{mo}$

$= 0.9 \times 474 \times 410/1.25 + 1.026 \times 432 \times 250/1.10$

$= 139{,}924.8 + 100{,}734.54$

$= 240{,}659.3\ N$

$= \mathbf{240.66\ kN}$ .... **(2)**

(c) Strength governed by block shear :

$A_{vg} = (5 \times 40 + 40) \times 6 = 1440\ mm^2$

$A_{vn} = ((5 \times 40 + 40) - 5.5 \times 18) \times 6 = 846\ mm^2$

$A_{tg} = 40 \times 6 = 240\ mm^2$

$A_{tn} = (40 - 0.5 \times 18) \times 6 = 186\ mm^2$

IS : 800
cl.6.4
P.33

$\therefore\ T_{db1} = A_{vg} \cdot f_y/(\sqrt{3} \cdot \gamma_{mo}) + 0.9\ A_{tn} \cdot f_u/\gamma_{m1}$

$= 1440 \times 250/(\sqrt{3} \times 1.10) + 0.9 \times 186 \times 410/1.25$

$= 188951 + 54907$

$= 243858\ N$

$= 243.86\ kN$

$T_{db2} = 0.9\ A_{vn}\ f_u/(\sqrt{3} \cdot \gamma_{m1}) + A_{tg} \cdot f_y/\gamma_{mo}$

$= 0.9 \times 846 \times 410/(\sqrt{3} \times 1.25) + 240 \times 250/1.10$

$= 144187 + 54{,}545$

$= 198732\ N$

$= 198.73\ kN$

Smaller of T_{db1} and T_{db2} is T_{db}

$\therefore\ \mathbf{T_{db} = 198.73\ kN}$ **... (3)**

Thus, the design tensile strength of the angle is the smaller of T_{dg}, T_{dn} and T_{db}.

$\therefore\ \boxed{T_d = 198.73\ kN}$

Efficiency of the member :

Tension capacity of the member,

$T_{dg} = A_g \cdot f_y/\gamma_{mo}$

$= 230.45\ kN$

tensile strength of the member,

$\boxed{T_d = 198.73\ kN}$

$\therefore$ efficiency of the member,

$$\eta = \frac{T_d}{T_{dg}}$$

$$= \frac{198.73}{230.45} \times 100\%$$

$= 86.23\ \%$