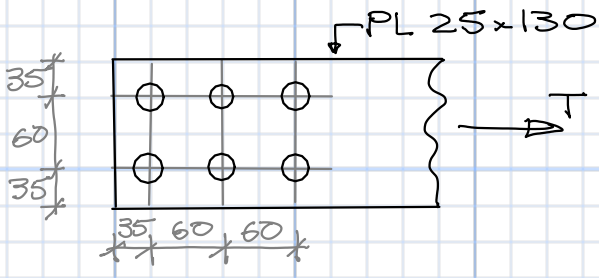
Class Example T-3i

January 23, 2020

Block Shear
in
Bolted Flat Plates

Given: CSA G40.21 350W Steel

21 mm punched holes



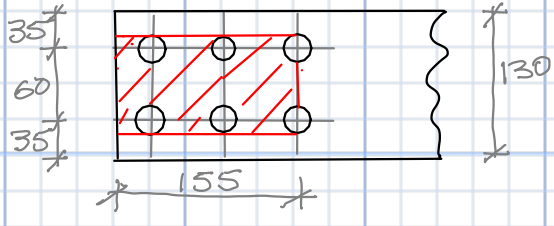
$F_y = 350$ MPa

$F_u = 450$ MPa

$d = 23$ mm (hole allow.)

Determine factored tension resistance of the plate.

Block Shear



Case 1

$A_{gv} = 155\text{mm} \times 25\text{mm} \times 2$
$= 7750\ \text{mm}^2$

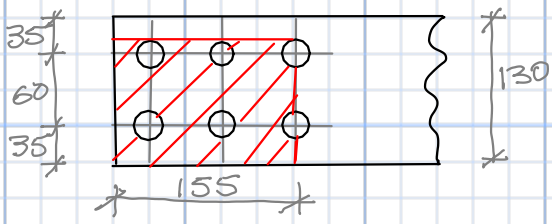
$A_n = 25\text{mm} \times \left(60 - \frac{23}{2} \times 2\right)\text{mm}$
$= 925\ \text{mm}^2$

$U_T = 1.0$ (symmetric p 2-53)

$$T_r = \phi_u \left[U_t A_n F_u + 0.6 A_{gv} \frac{F_y + F_u}{2} \right]$$

$$= 0.75 \left[1.0 \times 925\ \text{mm}^2 \times 0.45 \frac{\text{kN}}{\text{mm}^2} + 0.6 \times 7750\ \text{mm}^2 \times 0.40 \frac{\text{kN}}{\text{mm}^2} \right]$$

$T_r = 1707$ kN



Case 2

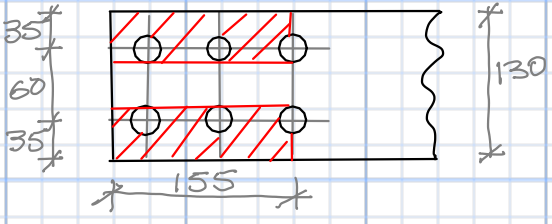
$A_{gv} = 25 \times 155 \times 1$
$= 3875 \text{ mm}^2$

$A_n = 25\left(60+35-\frac{23}{2}\times 3\right)$
$= 1512 \text{ mm}^2$

$U_t = 0.6$ (Figure 2-26 Case 3?)

$T_r = 0.75[0.6 \times 1512 \times 0.45 + 0.6 \times 3875 \times 0.4]$

$T_r = 1004 \text{ kN}$



Case 3

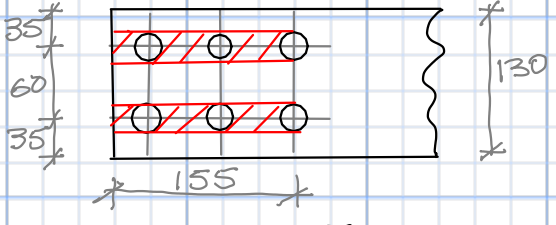
$A_{gv} = 7750 \text{ mm}^2$ (as per case 1)

$A_n = 25 \times \left(35-\frac{23}{2}\right) \times 2$
$= 1175 \text{ mm}^2$

$U_t = 0.9$ (Fig 2-26 Case 8)

$T_r = 0.75[0.9 \times 1175 \times 0.45 + 0.6 \times 7750 \times 0.4]$

$T_r = 1752 \text{ kN}$



Case 4 (Tearout)

$A_{gv} = 2 \times 7750$
$= 15500 \text{ mm}^2$

$A_n = 0$

$T_r = 0.75[U_t \times 0 \times .45 + 0.6 \times 15500 \times 0.4]$

$T_r = 2790 \text{ kN}$

Gross Area Yield

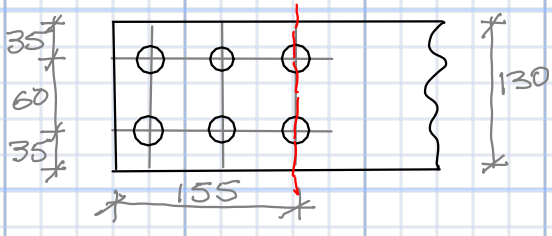
$$A_g = 25\,mm \times 130\,mm = 3250\,mm^2$$

$$T_r = \phi A_g F_y$$

$$= 0.9 \times 3250\,mm^2 \times 0.35\,\frac{kN}{mm^2}$$

$$T_r = 1024\,kN$$

Net Section Fracture



$$A_{ne} = A_n = A_g - \Sigma dt$$

$$= 3250\,mm^2 - 2 \times 23\,mm \times 25\,mm$$

$$= 2100\,mm^2$$

$$T_r = \phi_u A_{ne} F_u$$

$$= 0.75 \times 2100\,mm^2 \times 0.45\,\frac{kN}{mm^2}$$

$$T_r = 709\,kN \longleftarrow \text{governs}$$

Summary

$$T_r = 709\,kN \longleftarrow \text{Ans.}$$

governed by net section fracture