

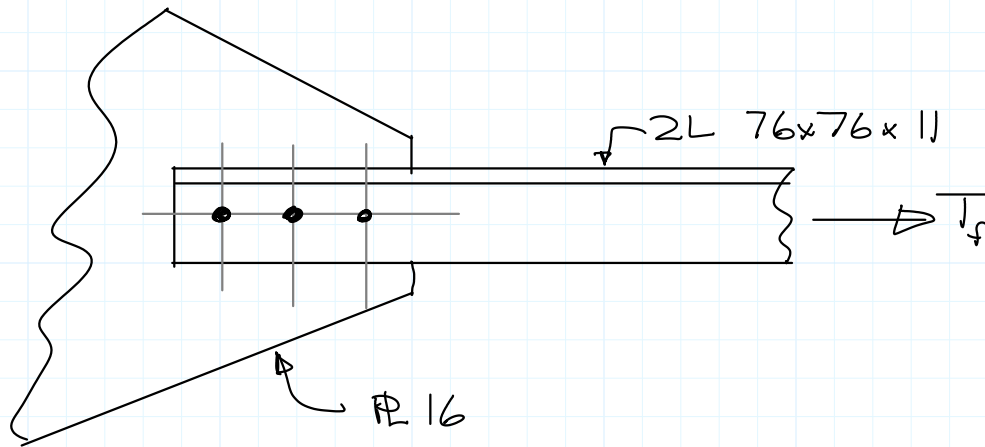
CIVE 3205  
Example C20

Feb 26, 2020

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Revisions:

- Feb 26/20 - new posting



Design bolted connection  
to develop full capacity of angles.

Use 350W Steel  
 $F_y = 350 \text{ MPa}$   
 $F_u = 450 \text{ MPa}$

A325M bolts  
 $F_u = 830 \text{ MPa}$

Try M20 bolts, drilled holes (22mm)

Capacity of 2 angles:

$$A_g = 3140 \text{ mm}^2 \quad (\text{p. 6-125})$$

Gross Yielding:

$$\begin{aligned} T_r &= \phi A_g F_y \\ &= 0.9 \times 3140 \text{ mm}^2 \times 0.35 \frac{\text{kN}}{\text{mm}^2} \\ &= 989 \text{ kN} \end{aligned}$$

Net Fracture:

$$\begin{aligned} A_n &= 3140 - 22\text{mm} \times 11.1\text{mm} \times 2 \\ &= 2652 \text{ mm}^2 \end{aligned}$$

Estimate

$$\begin{aligned} A_{ne} &= 0.8 A_n \quad (\text{at least 4 bolts}) \\ &= 0.8 \times 2652 \\ &= 2122 \text{ mm}^2 \end{aligned}$$

$$\begin{aligned}
 T_r &= \phi_u A_{ne} F_u \\
 &= 0.75 \times 2122 \text{ mm}^2 \times \frac{0.45 \text{ kN}}{\text{mm}^2} \\
 &= 716 \text{ kN}
 \end{aligned}$$

Select bolts for  $T_f = 716 \text{ kN}$

one bolt:

$$\begin{aligned}
 \text{shear: } V_r &= 0.6 \phi_u m n A_b F_u \times 0.7 \quad (\text{threads intercepted}) \\
 &= 0.6 \times 0.8 \times 2 \times 1 \times \frac{20^2}{4} \times 0.83 \times 0.7 \\
 &= \underline{175 \text{ kN}} \quad \leftarrow \text{governs}
 \end{aligned}$$

$$\begin{aligned}
 \text{bearing: } V_r &= 3 \phi_u d t n F_u \\
 &= 3 \times 0.8 \times 20 \times 16 \times 1 \times 0.45 \\
 &= 346 \text{ kN}
 \end{aligned}$$

$$\# \text{ of bolts req'd} = \frac{716 \text{ kN}}{175 \text{ kN}} = 4.09$$

$\therefore$  use 5 bolts.

$$\text{min pitch} = 2.7d = 2.7 \times 20 = 54 \text{ mm.}$$

$$\text{use pitch} = 60 \text{ mm.}$$

check connection length

$$L = 4 \times 60 \text{ mm} = 240 \text{ mm}$$

(c-to-c of end bolts)

$$L < 760 \text{ mm}$$

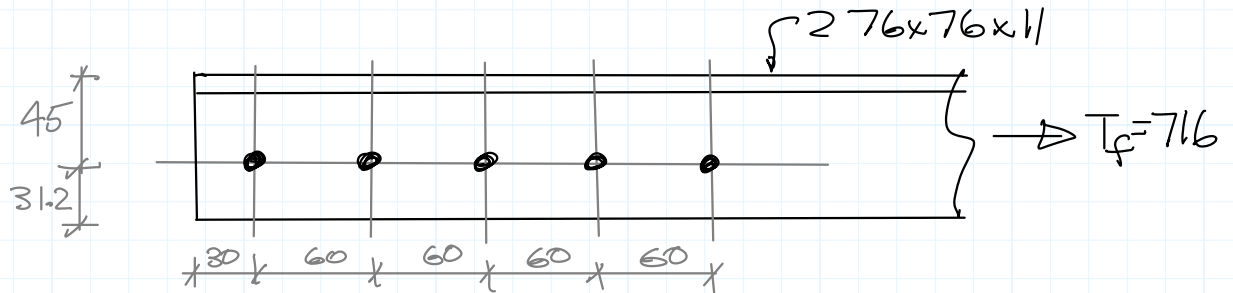
$\therefore$  no strength reduction for long lap connect is required.

min edge distance  
= 26 mm

min end distance  
= 26 mm

use 30 mm

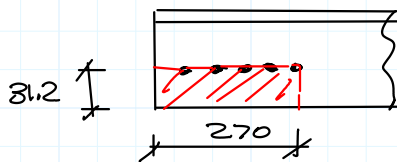
(flange cut ends)



Check Block Shear, 2 angles:

$$F_u = 0.45$$

$$\frac{F_u + F_y}{2} = 0.4$$



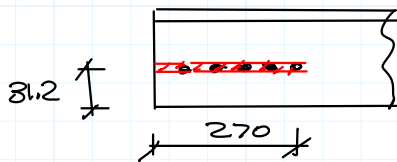
$$A_n = (31.2 - \frac{22}{2}) \times 11.1 \times 2 = 448 \text{ mm}^2$$

$$U_t = 0.6$$

$$A_{gv} = 270 \times 11.1 \times 2 = 5994 \text{ mm}^2$$

$$T_r = 0.75 [0.6 \times 448 \times 0.45 + 0.6 \times 5994 \times 0.4]$$

$$= 1170 \text{ kN} > 716 \text{ OK}$$



$$A_n = 0$$

$$A_{gv} = 5994 \times 2 = 11990 \text{ mm}^2$$

$$T_r = 0.75 \times 0.6 \times 11990 \times 0.4$$

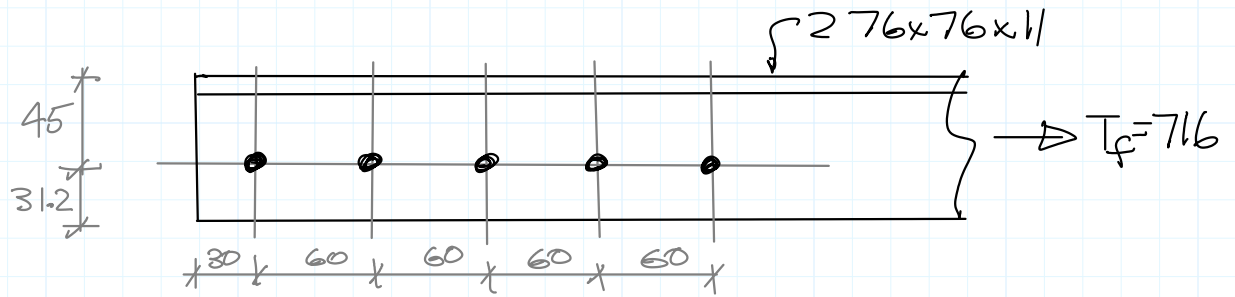
$$= 2160 \text{ kN} > 716 \text{ OK}$$

Similar pattern  
in gusset  $\Phi$   
with  $t = 16 \text{ mm}$

$$T_r = \frac{16}{22.2} \times 2160 = 1560 \text{ kN}$$

$$> 716 \text{ OK}$$

USE:



5 M20 A325 bolts

$$T_r = 716 \text{ kN}$$

