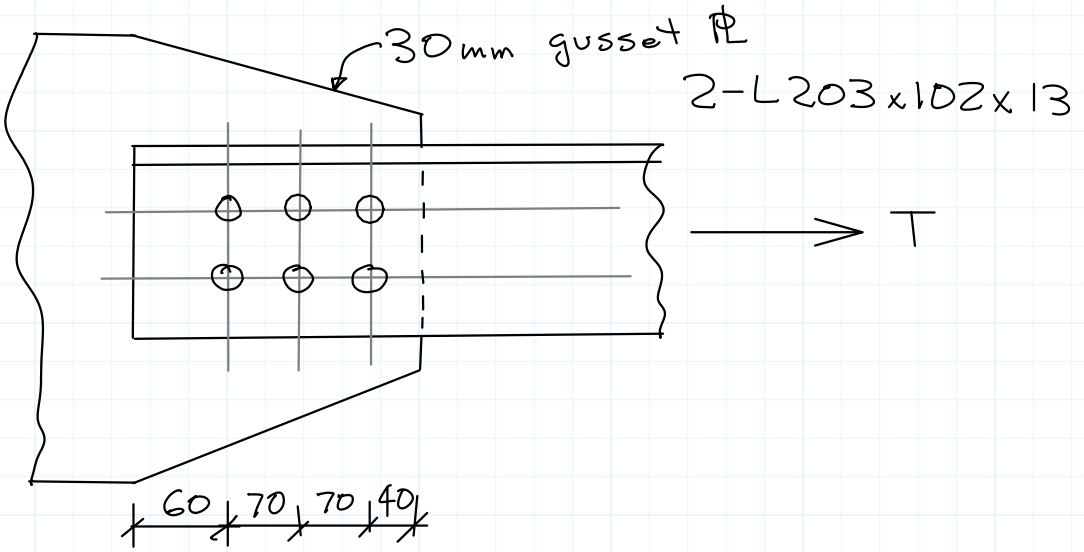
CIVE 3205 Example TPS-2 N. Holtz
January 20, 2020

2) Tension members – compute the factored tensile resistance, T_r, of each of the following assemblies. Unless otherwise noted, assume:

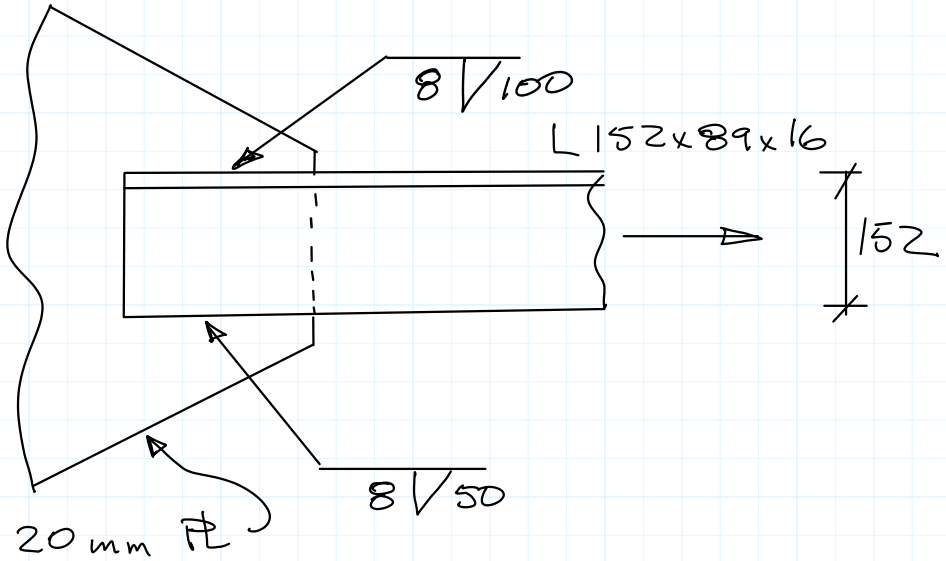
Grade 300W steel
M20 bolts in punched holes

Do not compute strength of fasteners.

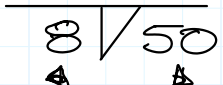
a)



b)



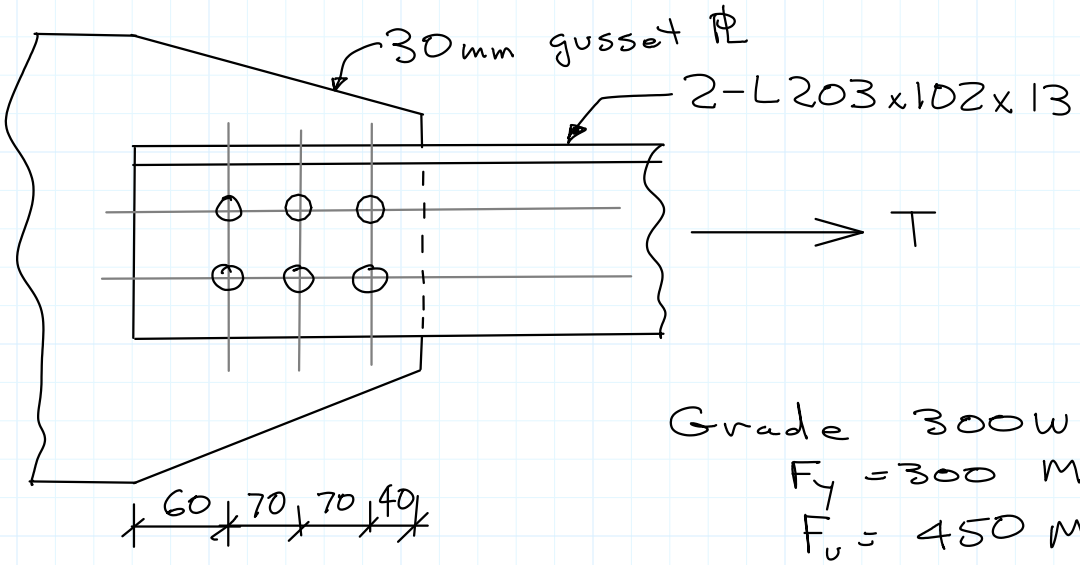
Note: symbol:



leg size of fillet weld (ignore for now)

length of fillet weld

2a)



Grade 300W
$F_y = 300$ MPa
$F_u = 450$ MPa

1-L203x102x13:
$A = 3710\ mm^2$
$t = 12.7$ mm

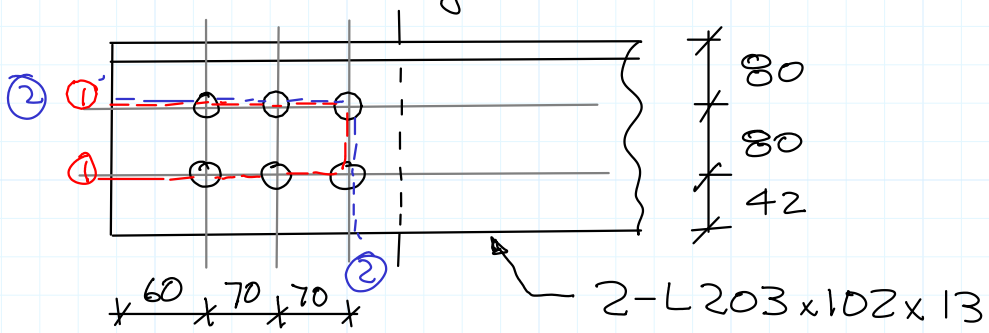
i) angle - gross section yielding

$$T_r = \phi A_g F_y$$
$$= 0.9 \times 3710 \times 300 \times 10^{-3} \times 2$$
$$= \underline{2003\ kN}$$

ii) angle - net section fracture

$$A_n = (3710 - 2\times(20+4)\times 12.7)\times 2$$
$$= 6201\ mm^2$$
$$A_{ne} = 0.6 A_n$$
$$= 0.6 \times 6201$$
$$= 3720\ mm^2$$
$$T_r = 0.75 \times 3720 \times 450 \times 10^{-3}$$
$$= \underline{1256\ kN} \leftarrow \text{governs}$$

iii) Block tearout: angle



Path 1-1:

$A_n = (80 - 24) \times 12.7 \times 2 = 1422\ mm^2$

$A_{gv} = (60 + 70 + 70) \times 12.7 \times 2 \times 2 = 10160\ mm^2$

$U_t = 0.6$ (conservative)

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

$$= 0.75 \left(0.6 \times 1422 \times .450 + 0.6 \times 10160 \times \frac{.30 + .45}{2} \right)$$

$T_r = 2002\ kN$

Path 2-2:

$A_n = (80 + 42 - 1.5 \times 24) \times 12.7 \times 2 = 2184\ mm^2$

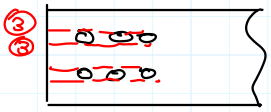
$A_{gv} = (60 + 70 + 70) \times 12.7 \times 2 = 5080\ mm^2$

$U_t = 0.6$

$$T_r = 0.75 \left(0.6 \times 2184 \times .45 + .6 \times 5080 \times \frac{.30 + .45}{2} \right)$$

$T_r = 1299\ kN$

Path 3-3: (Bolt tearout)



$A_{gv} = 2 \times 10160\ mm^2$

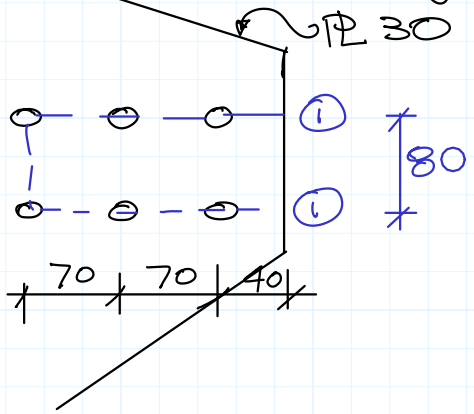
$= 20320\ mm^2$

$A_n = 0$

$$T_r = 0.75 \left(.6 \times 20320 \times \frac{.30 + .45}{2} \right)$$

$= 3429\ kN$

iv) Check block tearout in gusset



By inspection, only 1 path

$A_n = (80-24) \times 30 = 1680\ mm^2$

$U_t = 1.0$

$A_{gv} = (70+70+40) \times 30 \times 2 = 10800\ mm^2$

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

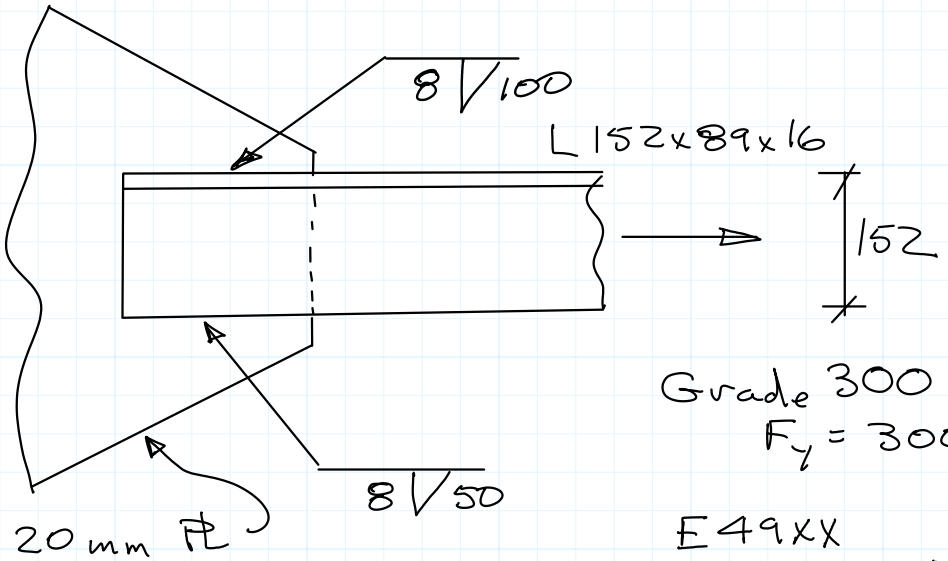
$$= 0.75 \left(1.0 \times 1680 \times .45 + 0.6 \times 10800 \times \frac{.3+.45}{2} \right)$$

$$= \underline{2390\ kN}$$

Net Section fracture ii) governs

$$\underline{\underline{T_r = 1260\ kN}} \longleftarrow$$

2b)



Grade 300 W
$F_y = 300$ $F_u = 450$

E49XX
$X_u = 490$

L152x89x16:
$A_g = 3580\ mm^2$ $t = 15.9\ mm$

Calculate A_{ne} for angle

A_{n2}: $w = 152$ $L_1 = 100$ $L_2 = 50$ $L = 75$

$w > L$ ∴ 12.3.3.3 (b)(iii)

$$A_{n2} = 0.75 L t$$
$$= 0.75 \times 75 \times 15.9$$
$$= 894.4\ mm^2$$

A_{n3}: $L = 100$ $w = 89 - 15.9 = 73.1$
$\bar{x} = w/2 = 36.55$

$w < L$, thus from 12.3.3.3 (c)(i)

$$A_{n3} = \left(1 - \frac{36.55}{100}\right) \times 73.1 \times 15.9$$
$$= 737.5\ mm^2$$

$$A_{ne} = 894.4 + 737.5 = 1632\ mm^2$$

Angle capacity:

yield: $T_r = \phi A_g F_y$
$= 0.9 \times 3580 \times 300 \times 10^{-3}$
$= 966.6\ kN$

fracture: $T_r = 0.75 \times 1632 \times 450 \times 10^{-3}$
$= 551\ kN$ ← governs, angle