Design tension member + end connections for $T_f = 800$ kN.

Angles & plates -	300W	$F_y = 300$ MPa, $F_u = 440$ MPa
HSS	350W	$F_y = 350$ MPa, $F_u = 450$ MPa
Bolts	A325	$F_u = 825$ MPa
Welds	E49xx	$X_u = 490$ MPa

1. Main Member

Estimate $A_n = 0.9 A_g$

$A_{ne} = 0.85 A_n$

from net area fracture

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

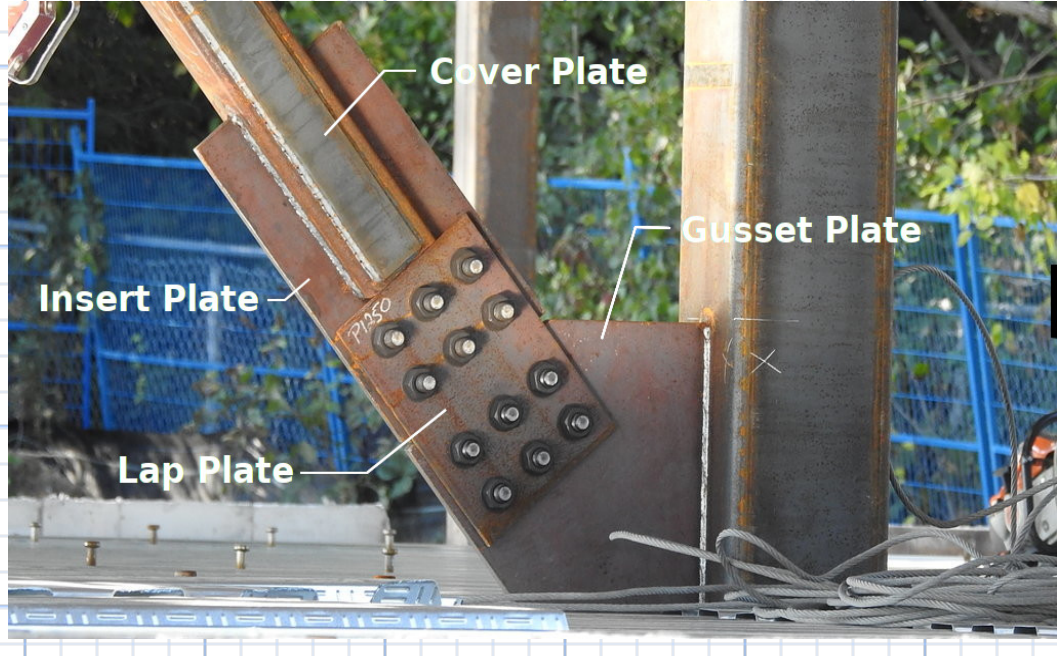
$$= \phi_u \times 0.85 \times 0.9 \times A_g \times 0.45 \frac{kN}{mm^2} \geq 800 \text{ kN}$$

$$A_g \geq 2582 mm^2$$

Try HSS 127 x 127 x 6.4

$A = 2960 mm^2$

In an arrangement similar to this:



Bolting details

min spacing = 2.7 x 19.05 = 51.4 mm. §22.3.1

min edge = 25 mm (rolled edge) Table 6
32 mm (cut edge)

min end distance = 32 mm (cut end) Table 6

max edge distance: 12t ≤ 150 §22.3.3

2. Bolting Requirements

$3/4"$ A325 bolts in 22mm punched holes

bearing-type connection, threads intercepted

$A_b = \pi \times (\frac{3}{4} \times 25.4)^2/4 = 285\ mm^2$ Double Shear

1 bolt: $V_r = 0.6\,\phi_b\, n_m\, A_b\, F_u \times 0.7$

$= 0.6 \times 0.8 \times 1 \times 2 \times 285\ mm^2 \times 0.825 \frac{kN}{mm^2} \times 0.7$

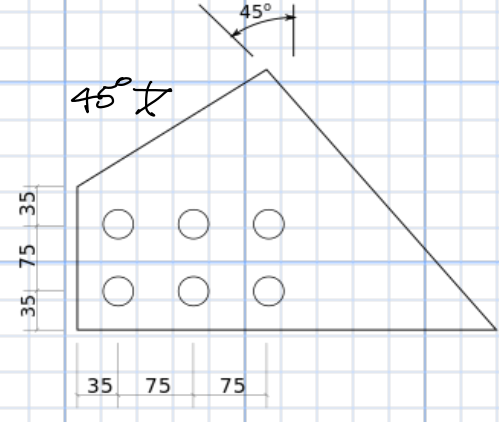
$= 158\ kN$ (or see Table 3-4)

# of bolts reqd $= \frac{800}{158} = 5.06$

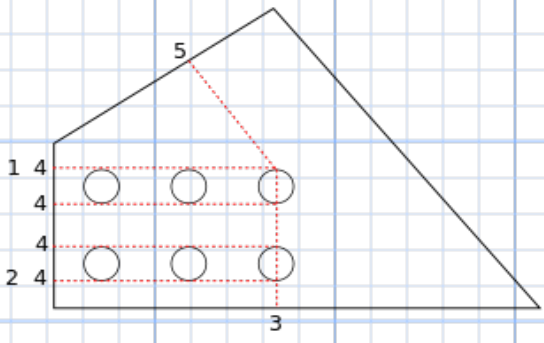
Try 6 bolts in a 2 x 3 pattern.

(to keep connection narrow)

3. Gusset Plate



Compute capacity of 1mm thick, then compute reqd thickness.



3.1 Block Shear - Path 1-2

$A_n = (75 - \frac{24}{2} \times 2) \times 1 = 51 \text{ mm}^2$

$U_t = 1.0$

$A_{gv} = 2 \times (35 + 75 + 75) \times 1 = 370 \text{ mm}^2$

$v_{r_1} = 0.75 \left[1 \times 51 \times .44 + .6 \times 370 \times \frac{.30 + .44}{2} \right]$

$= 78.44 \text{ kN/mm of thickness}$

3.2 Block Shear - Path 1-3

$A_n = (35 + 75 - \frac{24}{2} \times 3) \times 1 = 74 \text{ mm}^2$

$U_t = 0.6$ (conservative)

$A_{gv} = 1 \times (35 + 75 + 75) \times 1 = 185 \text{ mm}^2$

$v_{r_2} = 0.75 (0.6 \times 74 \times .44 + .6 \times 185 \times .37)$

$= 45.45 \text{ kN/mm}$ ⟵ governs

3.3 Tearout - Path 4-4-4-4

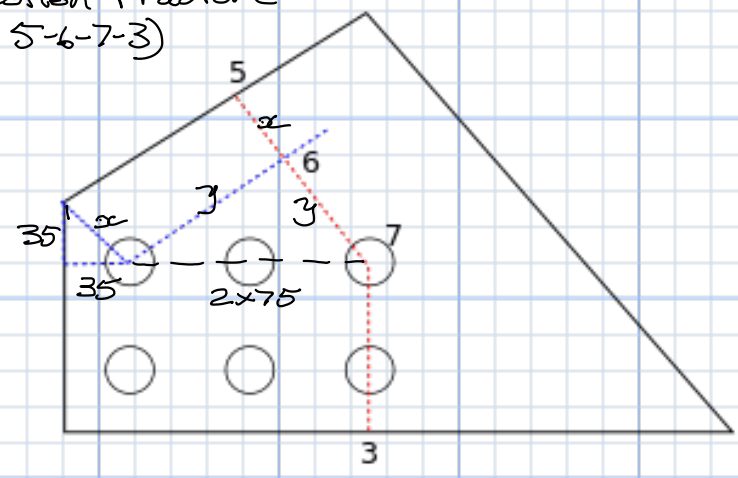
$A_n = 0$

$A_{gv} = 4 \times 185 = 740 \text{ mm}^2$

$v_{r_3} = .75 \times .6 \times 740 \times .37$

$= 123 \text{ kN/mm}$

3.4 Net Section Fracture (Path 5-6-7-3)

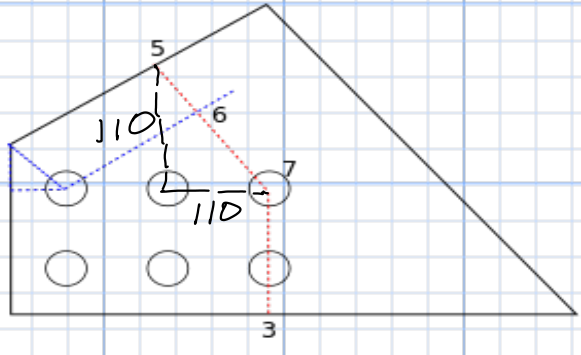


dist 5-6 = $x = \sqrt{35^2 + 35^2}$ = 49.5 mm.

dist 6-7 = $y = 150/\sqrt{2}$ = 106.1 mm

dist 5-7 = $x+y$ = 155.6 mm

dist s = g = $\frac{155.6}{\sqrt{2}}$ = 110 mm



$$A_{ne} = \left(35 + 75 + 155.6 - 2\times 24 + \frac{110^2}{4\times 110}\right)\times 1$$

$$= 245.1 \text{ mm}^2$$

$$tr_t = 0.75 \times 245.1 \times 0.44$$

$$= 80.87 \text{ kN / mm of thickness}$$

3.5 Bearing Resistance

$$B_r = 3\phi_{br} \times n \times d \times t \times F_u$$
$$= 3 \times 0.8 \times 6 \times 19.05 \times 1 \times 0.440$$
$$= 120.7 \text{ kN}$$

Block Shear path 1-3 governs

$$b_r = 45.45 \text{ kN/mm}$$

Req'd thickness

$$\frac{800}{45.45} = 17.6 \text{ mm.}$$

3.7 Try 20 mm Gusset Plate

4: Insert Plate

Plate - slotted into HSS - must be same thickness as gusset

Width required:

- Gross Area Yield:

$$0.9 \times w \times t \times 0.30 \geq 800$$
$$w \geq 148 \text{ mm.}$$

- Net section Fracture

$$0.75(w - 2 \times 24) \times 20 \times 0.44 \geq 800$$
$$w \geq \frac{800}{.75 \times 20 \times .44} + 48$$
$$w \geq 169 \text{ mm.}$$

this leads to edge dist of $\frac{169-75}{2} = 50\,mm.$

Might be better to use 3x2 arrangement

reqd width, net section fracture

$$w = \frac{800}{.75 \times 20 \times .44} + 3 \times 24$$

$$w = 193.2\,mm.$$

using min edge distance

$$w = 32 + 75 + 75 + 32 = 214\,mm.$$

use 220 mm & 35 mm edge distance