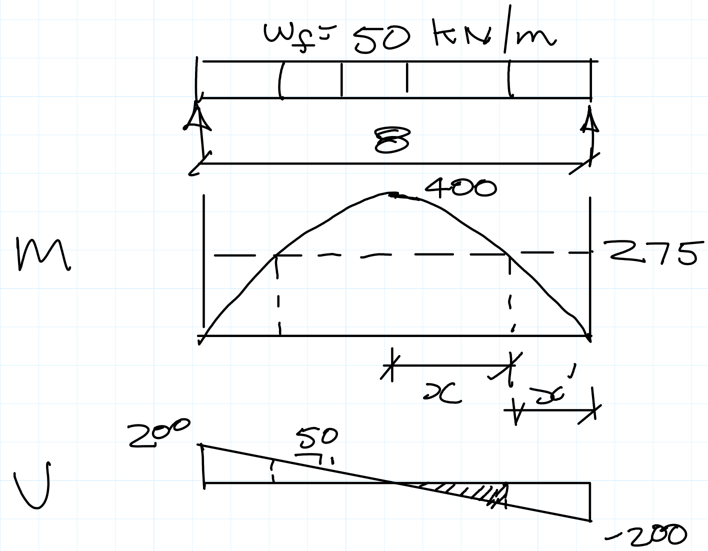
CIVE 3205

Example- Partial Length Cover Plate

A simply supported beam carries a UDL and spans 8m. The existing beam is a W410×46 of grade 350W. Due to a change in use, the factored applied load has increased to 50 kN/m. Design partial length cover plates to enable use of the existing shape.

Assume:
- full lateral support of compr. flange
- deflection not to be checked.

W410×46 $\quad M_r = 275$ kN-m



$$M_f = \frac{50 \times 8^2}{8} = 400 \text{ kN-m}$$

From area under $V = \Delta M$

TCOP: $x \times 50 \times x \times \frac{1}{2} = 400 - 275$

$x^2 = 5$

$x \doteq 2.24$ m

$x' = 4 - 2.24$

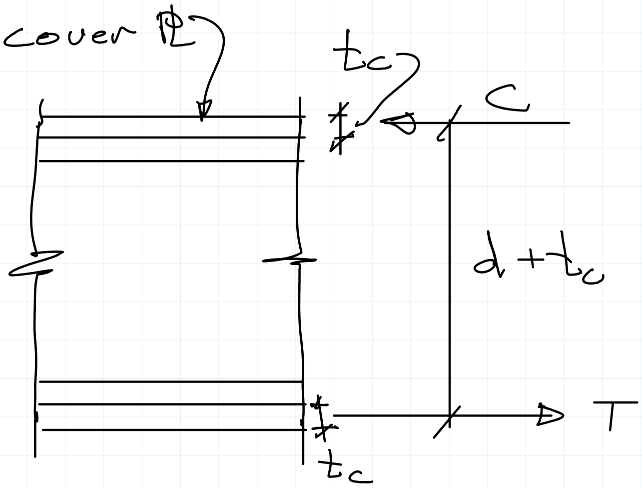
$= 1.76$ m

W410×46 $\quad b = 140$ mm $\quad d = 403$ mm

Try cover PL width $= 140 - 2\times 10 = 120$ mm

Select cover plate to carry $400 - 275 =$ 125 kN-m when fully yielded.

Choose thickness, t_c



$C = T =$ force in cover PL

$= \phi A F_y$

$= 0.9 \times 120 \times t_c \times 350$

$= 37{,}800\, t_c$

$M = C(d + t_c) = 37800 t_c (403 + t_c)$

$= 15.23 \times 10^6 t_c + 37800 t_c^2$

Equating

$15.23 \times 10^6 t_c + 37800 t_c^2 = 125 \times 10^6$ N-mm

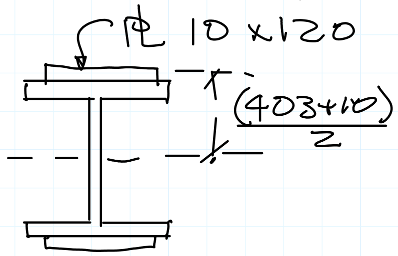
$t_c^2 + 403 t_c - 3307 = 0$

$$t_c = \frac{-403 + \sqrt{403^2 + 4 \times 1 \times 3307}}{2}$$

$= 8.05$ mm

Use $t_c = 10$ mm (could probably use 8)

Properties of plated section:



$I_g = 156 \times 10^6\ mm^4 + 10 \times 120 \times \left(\frac{413}{2}\right)^2$

$= 156 \times 10^6 + 51.2 \times 10^6$

$= 207 \times 10^6\ mm^4$

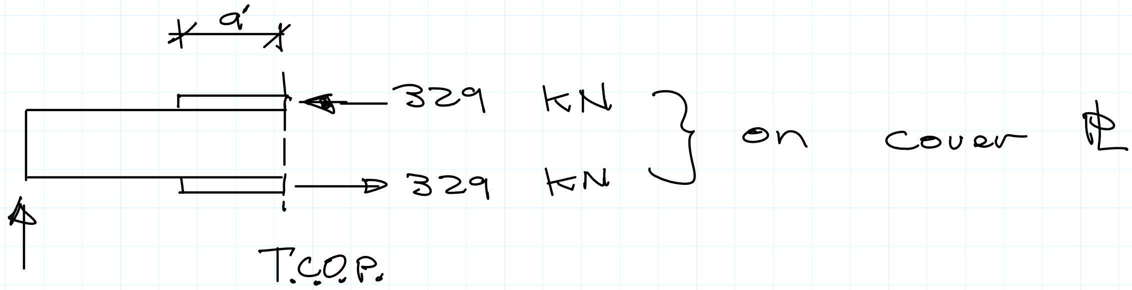
§ 14.2.4 PL past TCOP must be able to develop a tension force of at least

$$P = \frac{A\, M_{fc}\, y}{I_g}$$

$$= \frac{10 \times 120 \times 275 \times 10^6 \times \left(\frac{403+10}{2}\right)}{207 \times 10^6}$$

$$= 329\,000 \text{ N}$$

$$= 329 \text{ kN}$$



Cover plate welds:

min size = 5 mm (p 6-172)

max size = 10-2 = 8mm (p 6-172)

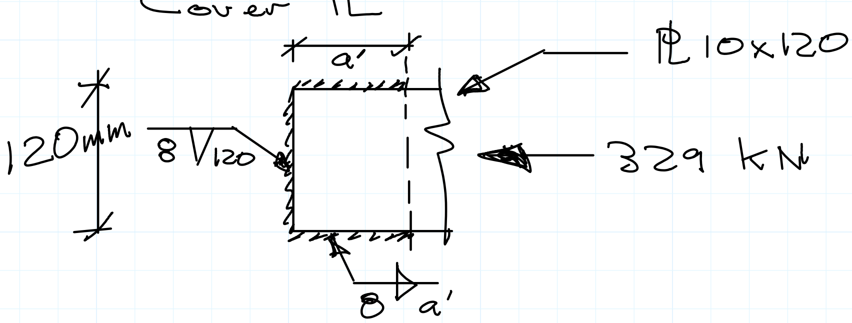
Try 8mm welds

Try weld across end of cover PL & along both sides

then by § 14.2.4 a'_{max} = 120mm

(case (a) $D \geq 3/4\,t$ across end & along sides)

Cover PL



Capacity of transverse weld:

§ 13.13.2.2. weld metal $\theta = 90°$

$$V_r = 0.67\,\phi_w A_w X_u (1 + 0.5 \sin^{1.5}\theta) M_w$$

$$= 0.67 \times 0.67 \times 8 \times .707 \times 120 \times 490 \times 1.5 \times 1 \times 10^{-3}$$

$$= 224 \text{ kN}$$

$\therefore$ Design weld on sides to develop

$$329 - 224 = 105 \text{ kN}$$

Longitudinal welds on sides:

Per 1mm length of 8mm weld:

1^mm of weld metal $\theta = 0°$

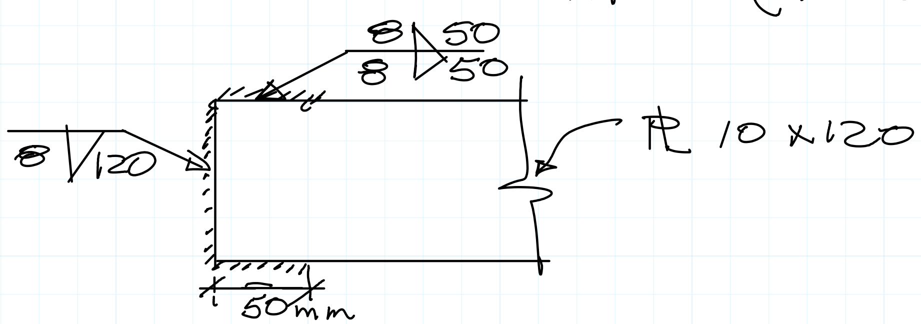
$$V_r = 0.67 \times 0.67 \times 1 \times 8 \times .707 \times 490 \times 1 \times 0.85 \times 10^{-3}$$

$$= 1.057 \text{ kN}$$

$$L_{req.} = \frac{105}{2 \times 1.057} = 49.7\text{mm}$$

$< a'_{max}$ $(= 120)$ o.k.

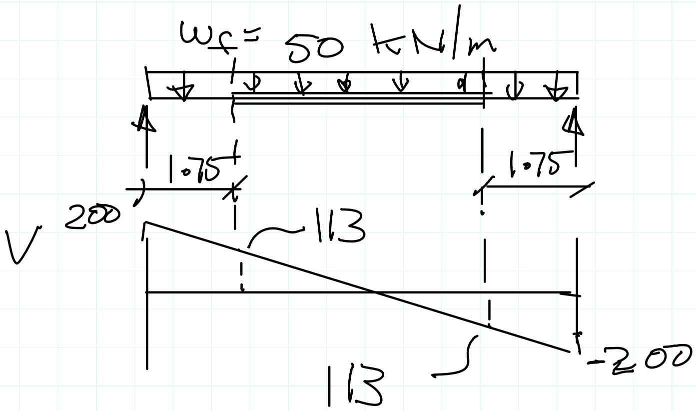
Use 50 mm (> 38 or $4D$ o.k.)



Welds throughout remainder of length to transfer shear flow

$$q = \frac{VQ}{I_g}$$

Use cutoff @ 1.75 m from ends

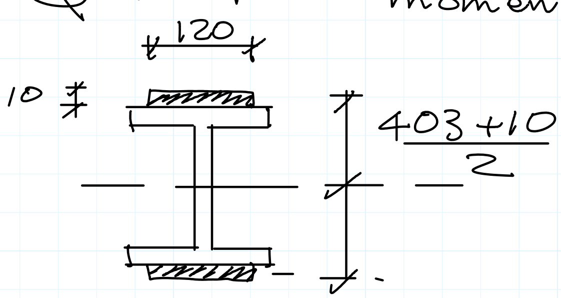


for q

$V = 200 - 1.75 \times 50$

$= 113$ kN

$Q = 1^{st}$ moment of area of cover PL



$Q = 10 \times 120 \times \frac{413}{2} \times 2$

$= 495\,600$ mm^3

$$q = \frac{113 \text{ kN} \times 495\,600 \text{ mm}^3}{207 \times 10^6 \text{ mm}^4}$$

$= .271$ kN/mm of length || to beam

There are 4 welds (2 on each PL)

thus $q_{weld} = 0.0676$ kN/mm of PL

Weld strength = 1.06 kN/mm of weld

Use intermittent welds, not staggered

Min length of weld = 38mm or 4t = 40mm (p 6-172)

use 40mm

§ 19.1.3

max. clear spacing between welds

$$\frac{330\, t}{\sqrt{F_y}} = \frac{330 \times 10}{\sqrt{350}} = 176 \text{ mm}$$

(< 300)

use 40 mm welds @ 200 mm spa
(clear spa = 160 < 176)

In 200 mm of cover PL

total shear force to be xfered to PL's

$$= 200_{mm} \times 0.271 \frac{kN}{mm} = 54.2 \text{ kN}$$

total amt of weld = 40×4 = 160 mm.

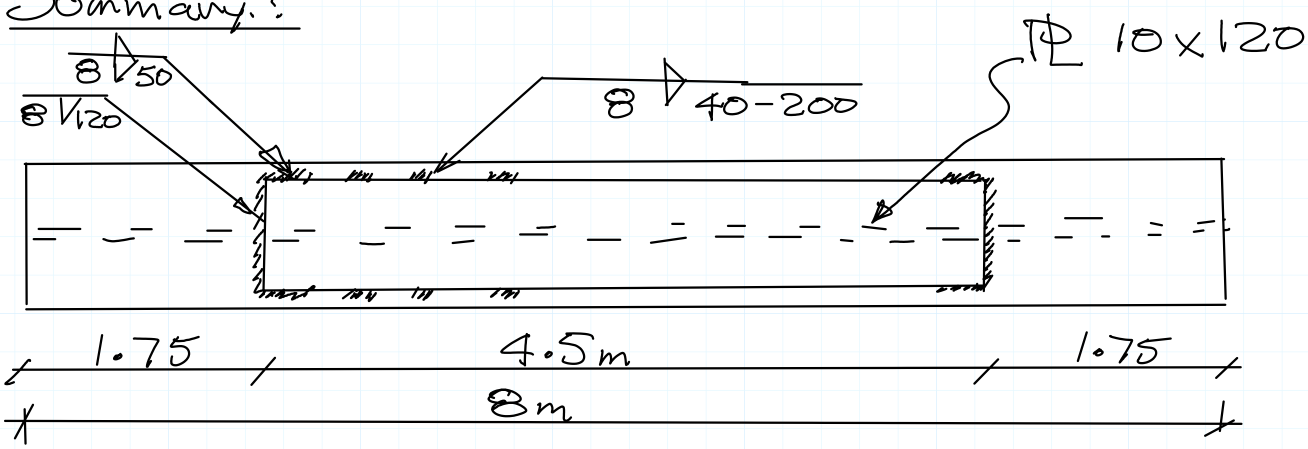
weld capacity = 160 × 1.06

= 170 kN >> 54.2

O.K.

Could possibly use a smaller weld (say 6mm) but its best not to use multiple sizes.

Summary:



N.T.S.