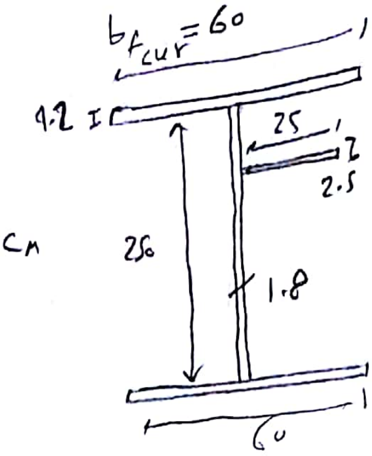
Q10 Roadway :-

→ HZ stiffner :-

$b_{st} = \frac{60 - 1.8}{2} = 29.1$ cm → $b_{st} = 25$ cm



$\frac{B_{st}}{t_{st}} \le \frac{21}{\sqrt{3.6}}$ → $t_s \ge 2.26$ cm → $t_s = 2.5$ cm

$I_{st} = \frac{25^3 \times 2.5}{3} = 13020.83$ cm^4

Check inertia :-

$I_{min} = 4 \times 250 \times 1.8^3 = 5832$ cm^3 $< I_{st}$ o.k

∴ use stiffners (25 × 2.5) cm at $h/5$ from comp. flange

→ VL stiffner :-

$B_{st\,min} = \frac{250}{30} + 5 = 13.3$ cm → $B_{st} = 15$ cm (2 sides)

$\frac{B_{st}}{t_{st}} \le \frac{21}{\sqrt{3.6}}$ → $t_{st} \ge 1.36$ → $t_s = 1.6$ cm

$Q_{act} = 236.8$ t , $q_b = 0.703$ t/cm^2

$C_s = 0.65 \left[\frac{0.35 \times 3.6}{0.703} - 1 \right] \times 236.8 = 121.96$ t

$A = 2 \times 15 \times 1.6 + 25 \times 1.8^2 = 129$ cm^2

$I = \frac{(2 \times 15 + 1.8)^3 \times 1.6}{12} = 4287.66$ cm^4

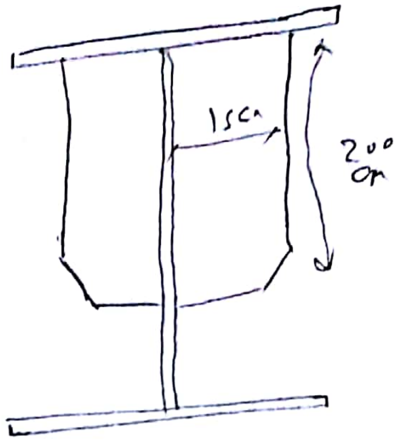
$r = \sqrt{I/A} = 5.77$ cm , $l = 0.8 \times 250 = 200$ cm

$\lambda = \frac{200}{5.77} = 34.66$

$F_{cs} = 2.1 - 0.000135 \times \lambda^2 = 1.938$ t/cm^2

$f_{c_{act}} = \frac{121.96}{129} = 0.95\ t/cm^2 < f_{c_{all}}$ o.k

~> Design of weld :-



$S_w = \frac{121.96}{2 \times 2 \times \frac{250}{3} \times 0.2 \times 5 \times 1} = 0.35$ cm

let $S_{w_{min}} = 6$ mm

~> Bearing stiffner :-

use $b_{st} = 25$ cm $< \frac{60-1.8}{2} = 29.1$ cm

$> \frac{250}{30} + 5 = 13.3$ cm

$> \frac{60}{4} = 15$ cm

$\frac{b_s}{t_s} \leq \frac{21}{\sqrt{F_y}} \rightarrow \frac{25}{21/\sqrt{F_y}} \leq t_s \rightarrow t_s = 2.26$ cm

let $t_s = 2.4$ cm

Area $= 2 \times 25 \times 2.4 + 12 \times 1.8^2 = 158.88\ cm^2$

$I = \frac{(2 \times 25 + 1.8)^3 \times 2.4}{12} = 27798.37\ cm^4$

$i = \sqrt{I/A} = 13.23$ cm

$l = 0.8 \times 250 = 200$ cm

$\lambda = \frac{200}{13.23} = 15.11$

$f_{c_{all}} = 2.1 - 0.000135 \times \lambda^2 = 2.07\ t/cm^2$

$f_{c_{act}} = \frac{236.80}{158.88} = 1.49\ t/cm^2 < f_{all}$ o.k

→ Check bearing

$$f_{bearing} = \frac{236.8}{(25-2) \times 2.4 \times 2} = 2.15 \ t/cm^2 < 2 \times 2.1 \ t/cm^2$$

0.8

→ weld design

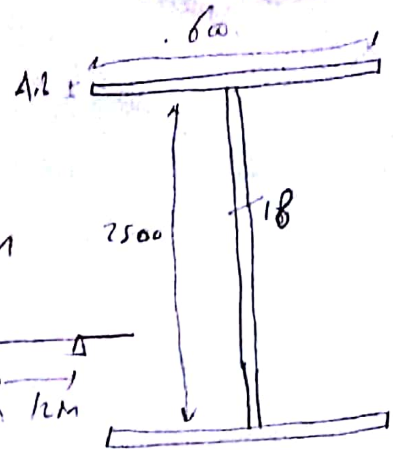
$$S_w = \frac{236.8}{(250-4) \times 1 \times 0.2 \times 5.2} = 0.23 \ cm$$

$S_{w_{min}} = 6 \ mm$

$Z_{x\,cur} = 31163.42\ cm^3$

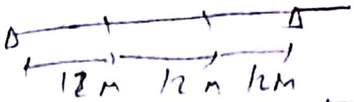
$I_{cur} = 1048 6313.52\ cm^4$

location of splice :- at curtailment location



$\therefore M_{capacity} = 81163.42 \times 2.1$

$= 170443.182\ t.cm$



$Q_{splice} = Q_{cur} = 101.48\ t$

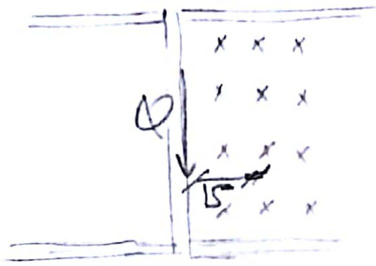
~> {Web splice}:-

assume spacing between bolts = 10 cm

No. bolts / col = $\frac{250-10}{10} = 24$ bolt

$\therefore e = 5\ cm$

- assume using 3 columns of bolts



- S A on splice:-

$Q_y = 101.48\ t$

$M_w = 170443.182 \times \frac{\frac{1.8 \times 250^3}{12}}{10486313.52} = 38095.01\ t.cm$

$M_t = 38095.01 + 101.48 \times 15 = 39617.21\ t.cm$

$Q_{y/b} = \frac{101.48}{3 \times 24} = 1.41\ t$

$\Sigma r^2 = 2 \times 10^2 \times 24 + 2 \times (5^2 + 15^2 + 25^2 + 35^2 + 45^2 + 55^2 + 65^2 + 75^2 + 85^2 + 95^2 + 105^2 + 115^2) \times 3$

$= 349800\ cm^2$

$Q_{y/b\,Mt} = \frac{39617.21}{349800} \times 10 = 1.13\ t$

$Q_{x/b\,Mt} = \frac{39617.21}{349800} \times 115 = 13.02$

$Q_{b\,tot} = \sqrt{(1.41 + 1.13)^2 + 13.02^2} = 13.26\ t$

$13.26 = 2 \times P_s \rightarrow P_s = 6.63$ t

use 24 M 24 (10.9) $\rightarrow P_s = 6.94$ t

→ Design of plate:-

$A_w = 250 \times 1.8 = 450$ cm²

∴ $450 = 2 \times 240 \times t_p \rightarrow t_{p_1} = 0.94$ cm

$t_{p_1} = 1$ cm

$I_w = \frac{1.8 \times 250^3}{12} = I_p = \frac{2 \times t_p \times 240^3}{12}$

$t_{p_2} = 1.08$ cm

$t_{p_2} = 1.2$ cm

∴ use 2 Pl 2400 × 12 mm

→ (flange splice):-

assume using 4 bolts / row

$M_{flange} = 170443.182 - 38095.01 = 132348.172$ t.cm

$T = C = \frac{132348.172}{250 + 4.2} = 520.65$ t

assume using M 24

∴ $n = \frac{520.65}{2 \times 6.94} = 37.5 \approx 40$ bolt

No. of rows $= \frac{40}{4} = 10$ row

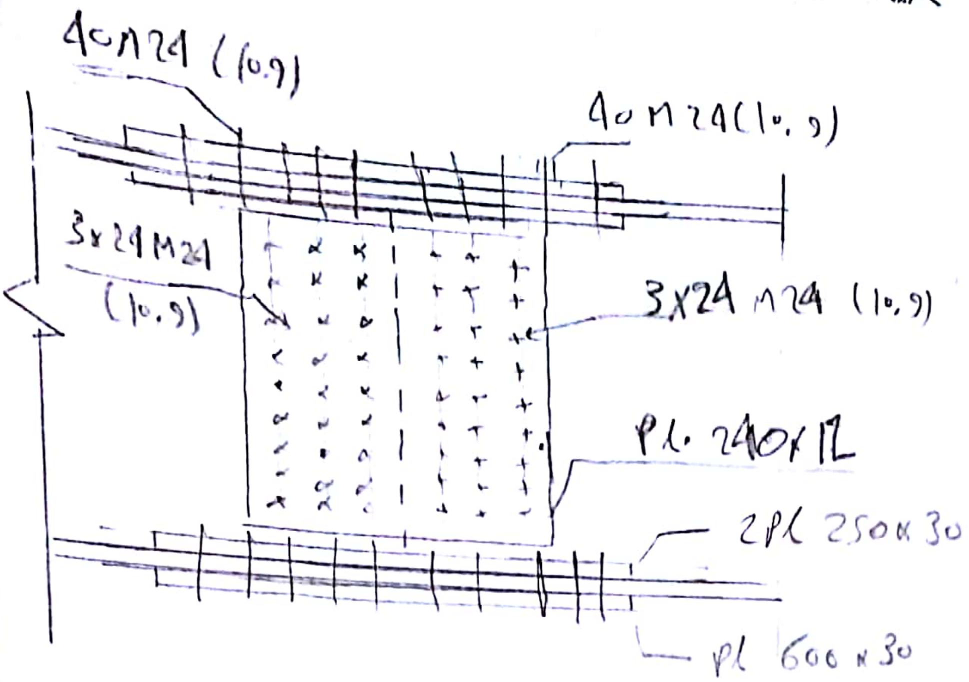
$\frac{B_{cover} - t_w}{2} = \frac{60 - 1.8}{2} = 29.1$ cm $> 6 \times 2.4$ cm

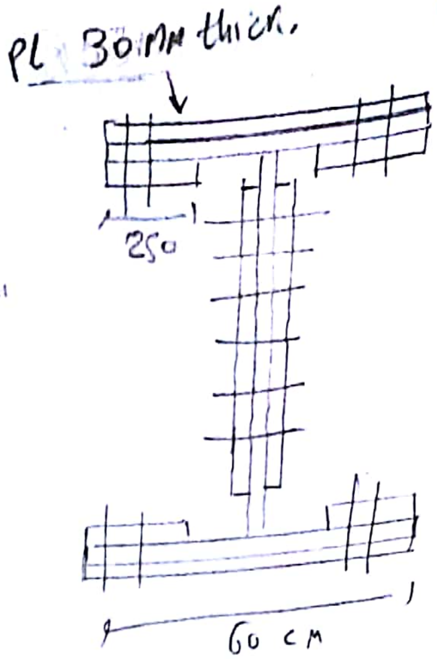
→ Design of plate:-

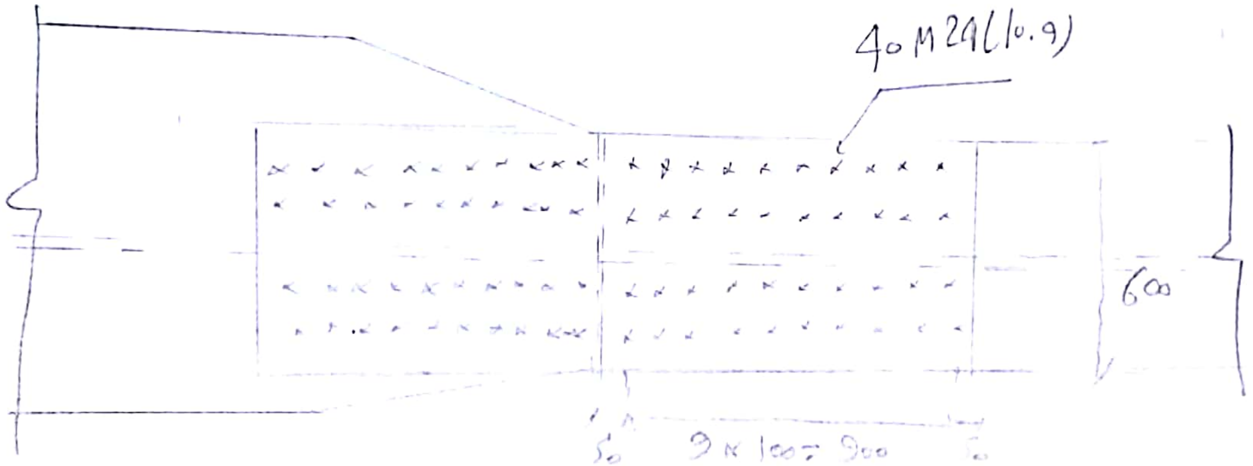
$A_p = \frac{520.65}{2.1} = 247.93$ cm² (assume) $b_1 = 60$ cm, $b_2 = 25$ cm / cc

$247.93 = (60 + 2 \times 25 - 8 \times 2.4) \times t_p$

$t_p = 2.73$ cm $= t_p = 3$ cm


40M24 (10.9)
40M24(10.9)
3x24M24
(10.9)
3x24 M24 (10.9)
PL. 240x12
2PL 250x30
PL 600x30


PL 30mm thick.
250
60 CM


40M24(10.9)
600
50
9x100=900