Qu.10

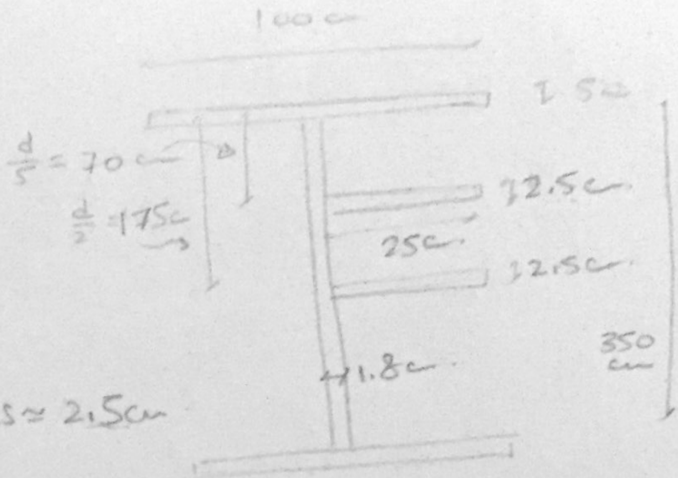
[1] Hz. Stiff:

$b_s \ngtr \frac{b_f - t_w}{2}$

$b_s \ngtr \frac{100 - 1.8}{2} \Rightarrow 49.1c$

use $b_s = 25c$

$\frac{b_s}{t_s} \ngtr \frac{21}{\sqrt{F_y}} \Rightarrow \frac{25}{t_s} \ngtr \frac{21}{\sqrt{3.6}} \rightarrow$ let $t_s \simeq 2.5cm$



⟹ Inertia check:

∵ use @ $\frac{d}{5}$ ∴ use check $I \geq 4 d_w t_w^3$

$I = \frac{b_s^3 t_s}{3} = \frac{25^3 \times 2.5}{3} = 85333.3c^4$

$4 d_w t_w^3 = 4 \times 350 \times 1.8^3 = 13020.8 \; c^4 < I$ ∴ ok ✓

& @ $d/2$ check $I \geq d_w t_w^3 \Rightarrow 13020.8c^4 > 350 \times 1.8^3$ (2041.2)

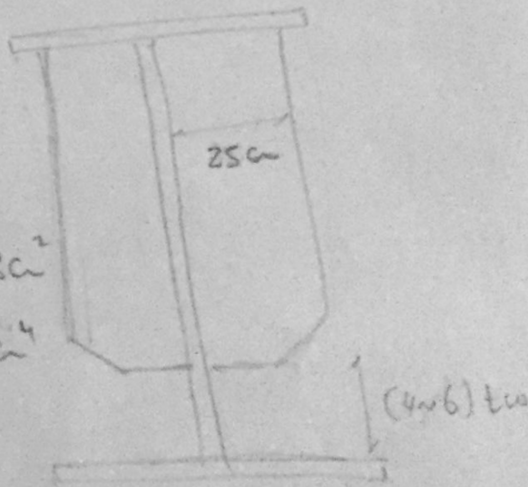
[2] vt. Stiff:

$b_s < \frac{b_f - t_w}{2} = \frac{100 - 1.8}{2} = 49.1c$

$> \frac{d_w}{30} + 5 = \frac{350}{30} + 5 = 16.7c$

$> \frac{b_f}{40} = \frac{100}{4} = 25c$ ∴ use $b_s = 25cm$

$\frac{b_s}{t_s} \ngtr \frac{21}{\sqrt{F_y}} \Rightarrow$ let $t_s = 2.5cm$



$C_s = 0.65 \times \left[\frac{0.35 F_y}{q_b} - 1\right] Q_{act}$

$= 0.65 \times \left[\frac{0.35 \times 3.6}{0.67} - 1\right] \times 416.03 = 238.13t$

$Area = 2 b_s t_s + 25 t_w^2 = (2 \times 25 \times 2.5) + (25 \times 1.8^2) = 270.8c^2$

$I = \frac{(2b_s + t_w)^3}{12} \times t_s = \frac{(2 \times 25 + 1.8)^3}{12} \times 2.5 = 28956.6c^4$

$r = \sqrt{\frac{I}{A}} = 10.34c$

$\lambda = \frac{L}{r} = \frac{0.8 d_w}{r} = \frac{0.8 \times 350}{10.34} = 27.08 < 100$

∴ $F_{all} = 2.1 - 0.000135 \lambda^2 = 2 \, t/c^2$

$F_{act} = \frac{C_s}{A} = \frac{238.13}{270.8} = 0.88 \, t/c^2$ ∴ safe

* Design of weld :

$S'_w = \frac{C_s}{L_w * f_{all}} = \frac{238.13}{(2*2*\frac{350}{3})*(0.2*5.2)} = 0.49c$

$L_w = 2*2*\frac{d_w}{3}$

& $S_{w_{min}} = 8mm$ use $\boxed{S_w = 0.8c}$

[3] Bearing Stiff :

use $b_s = 40c$ & $t_s = 4c$ (∵ same conditions as in Vt Stiff) -

$A = 2b_st_s + 12t_w^2$ (∵ edge single stiff).

$= 2*40*4 + 12*1.8^2 = 358.88c^2$

$I = \frac{(2b_s + t_w)^3 * t_s}{12} = \frac{(2*40+1.8)^3 * 4}{12} = 182447.8c^4$.

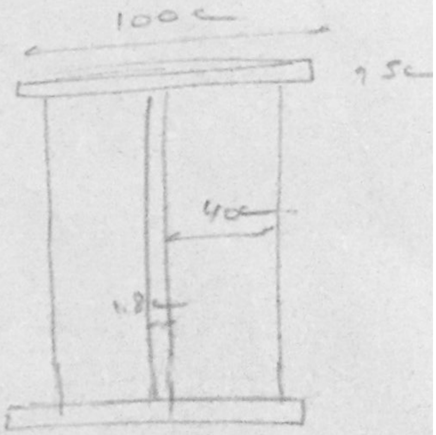
$i = \sqrt{\frac{I}{A}} = 22.55c$.

$\lambda = \frac{L}{i} = \frac{0.8*350}{22.55} = 12.42 < 100$

$f_{all} = 2.1 - 0.00013\lambda^2 = 2.08\ t/c^2$.

$f_{act} = \frac{F}{A} = \frac{416.03}{358.88} = 1.16\ t/c^2 < 2.08$

∴ safe.



* check bearing :

$F = \frac{Q}{(b_s-2)*t_s*2} = \frac{416.03}{(40-2)*4*2} = 1.37\ t/c^2$

∴ safe -

$F_{bearing_{all}} = 2 * f_{all} = 4.16\ t/c^2$

* Design of weld :

$S_w = \frac{Q}{L * f_{all}} = \frac{416.03}{4(350-4)*(0.2*5.2)} = 0.29cm$

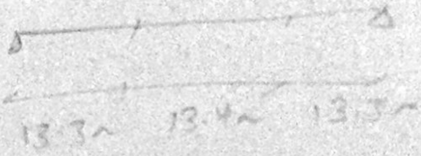
$L = 4(d_w - 4c)$

& $S_{w_{min}} = 8mm$ ∴ use $\boxed{S_w = 0.8c}$

Qu11

⇒ assume splice location is same as flange curtailment location

$M_{cap} = Z_x * F_{all} = 175766.2 * 2.1/100$ $= 3691.1\ t\,m$ (of curtailed section)



$Q = 148.48\ t$

[2] Web Splice:

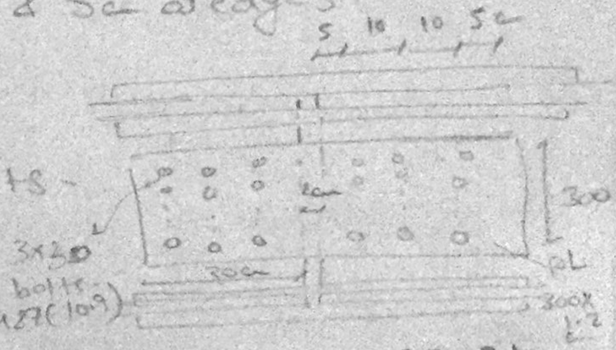
$M_{web_{cap}} = M_{cap} * \frac{I_{web}}{I_T} = 3691.1 * \frac{1.8 \times 350^3/12}{31637916.67} = 750.3\ t\,m$

⇒ arrangement:

assume spacing bet bolts = 10cm & 5cm at edges

let #/column = 30 bolts

assume using 3 columns of bolts



⇒ Str actions:

$Q_y = 148.48\ t$

$M_t = Q_y * e + M_{web_{cap}} = 148.48 \times 15 + 75030 = 77257.2\ t\,cm$

$\Sigma r^2 = \Sigma x^2 + \Sigma y^2 = (30 \times 10^2 * 2) + 6(5^2 + 15^2 + 25^2 + 35^2 + 45^2 + 55^2 + 65^2 + 75^2 + 85^2 + 95^2 + 105^2 + 115^2 + 125^2 + 135^2 + 145^2) = 680250\ cm^2$

$Q_{y_{bolt}} = \frac{Q_y}{n} + \frac{M_t\, x_{max}}{\Sigma r^2} = \frac{148.48}{30 \times 3} + \frac{77257.2}{680250} * 10 = 2.79\ t$

$Q_{x_{bolt}} = \frac{M_t\, y_{max}}{\Sigma r^2} = \frac{77257.2}{680250} * 145 = 16.5\ t$

$Q_b = \sqrt{Q_y^2 + Q_x^2} = 16.73\ t = 2 P_s$

$P_{s_{req}} = 8.37\ t$ ⇒ chose 3×30 M27 (10.9)

$P_s = 9.03\ t$

→ Plate Design:

$2 t_p L_p \geq A_{web}$

$L_p = (30-1)\times10 + 2\times5 = 300$ cm

$2 \times t_p \times 300 \geq 350\times1.8 \rightarrow t_p \simeq 1.1$ cm

or $I_p \geq I_{web}$

$\frac{2 t_p L_p^3}{12} \geq \frac{t_w h_w^3}{12}$

$\frac{2\times t_p \times 300^3}{12} \geq \frac{1.8\times350^3}{12} \rightarrow \boxed{t_p \simeq 1.5 \text{ cm}}$

use pl. 300 × 1.5 cm

[2] Flange Splice:

$M_f = M_{cap} - M_{web} = 3691.1 - 750.3 = 2940.8$ t.m

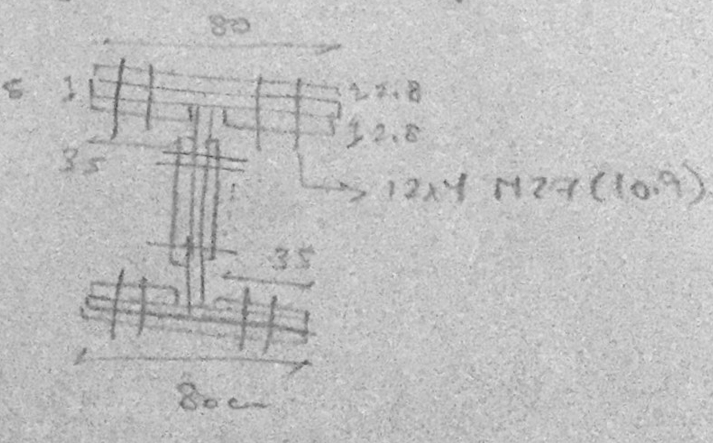
$T = C = \frac{M_f}{h} = \frac{294080}{350+5} = 828.4$ t

assume using 4 bolts/row & M27

$\# = \frac{T}{m\times P_s} = \frac{828.8}{2\times9.03} \simeq 46$ bolts

use 48 bolts → (12×4) M27 (10.9)

check e ⇒ $\frac{80-1.8}{2} = 39.1$ cm $> 6\times2.7$ ✓



* Desing of PLate:

$A_p = (b+2b')\times t_p \geq \frac{T}{F_{sw}}$

let b' = 35 cm

$(80+2\times35)\times t_p \geq \frac{828.4}{2.1}$

→ $\boxed{t_p \simeq 2.8 \text{ cm}}$

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