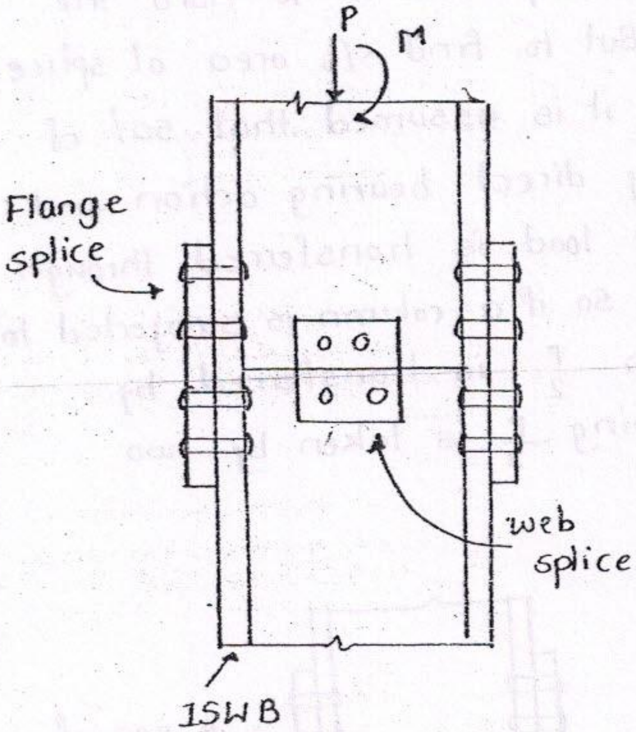
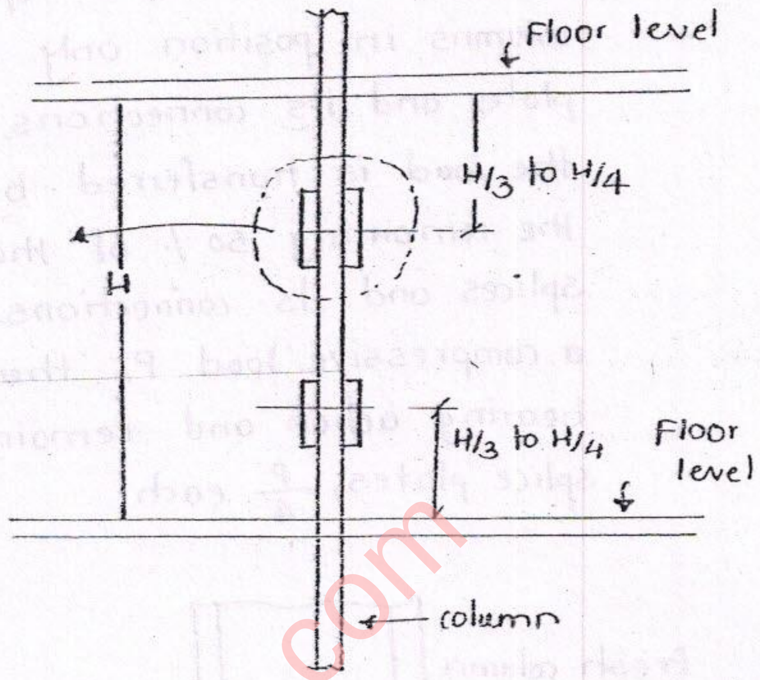
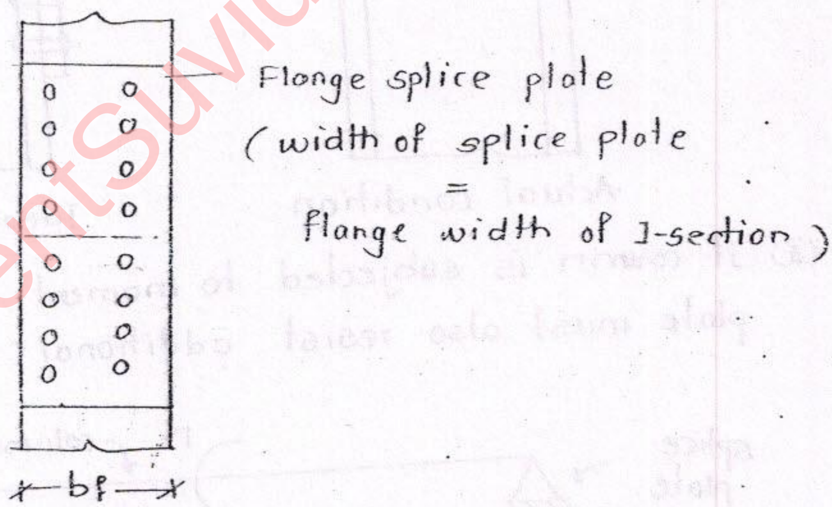
Design of column splices:





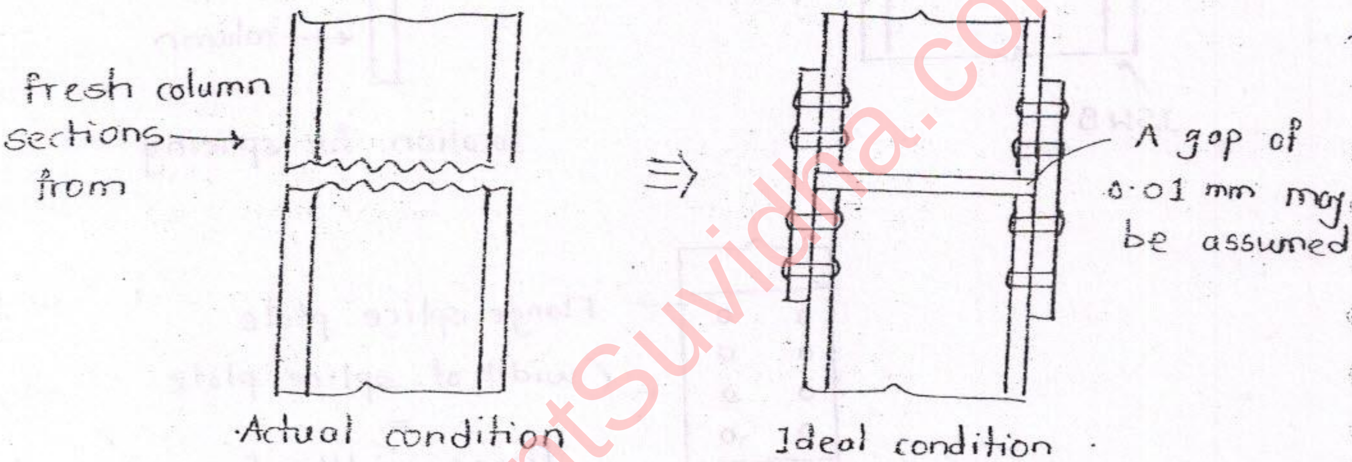
location for splicing



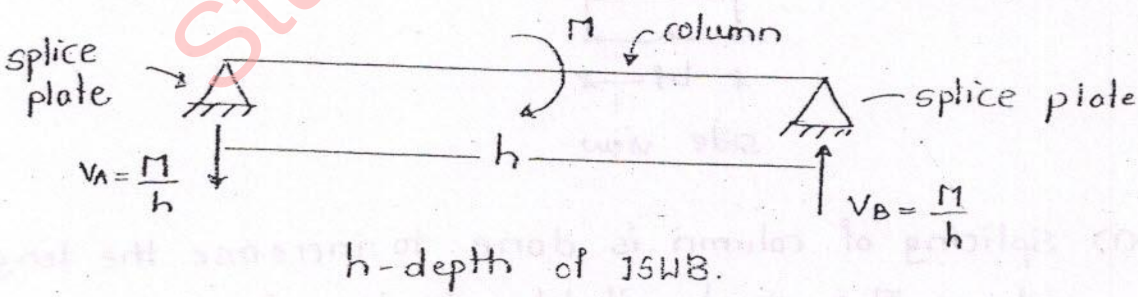
side view

(i) Splicing of column is done to increase the length of column. The most suitable location for column splicing is at distance of $H/3$ to $H/4$ from top or bottom of floor as shown in fig.

(ii) When the column ends are machined (smoothened) for complete bearing and top column flanges are resting on bottom column flanges as shown in fig. then entire load from top column is transferred to the part bottom column by direct bearing action only. In this case the purpose of column splice plates is to hold the columns in position only. But to find c/s area of splice plates and its connections, it is assumed that 50% of the load is transferred by direct bearing action and the remaining 50% of the load is transferred through splices and its connections. So if a column is subjected to a compressive load P, then $\frac{P}{2}$ is transferred by bearing action and remaining $\frac{P}{2}$ is taken by two splice plates, $\frac{P}{4}$ each.



(ii) If column is subjected to moment M also, then splice plate must also resist additional force of $\left(\frac{M}{h}\right)$



h - depth of ISWB.

So, max. force in splice plate $= \frac{P}{4} + \frac{M}{h}$ (each plate)

(When column ends are machined)

(iv) If the column ends are not machined for complete bearing then entire load is assumed to be transferre to the bottom column through splice plates and its connections only. In this case, the splice plate and its connections are designed for a force of $\left(\frac{P}{2}+\frac{M}{h}\right)$

(v) Design of flange splice plate -

(to find thickness of splice plate)

Since width of splice plate is generally equal to flange width of I-section, we find thickness only.

Strength of splice plate in compression

$$= B \cdot t \cdot \sigma_{ac}$$

where.

B – width of splice plate

t – thickness of plate

σ_{ac} – permissible axial compressive stress.

$$\sigma_{ac} = 0.6 f_y \quad \text{(in WSM)}$$

(since there is no buckling possibility in flange splice)

$$= \frac{f_y}{1.1} \quad \text{(in LSM)}$$

ⓐ If the column ends are machined.

$$\frac{P}{4} + \frac{M}{h} \leq B \cdot t \cdot \sigma_{ac}$$

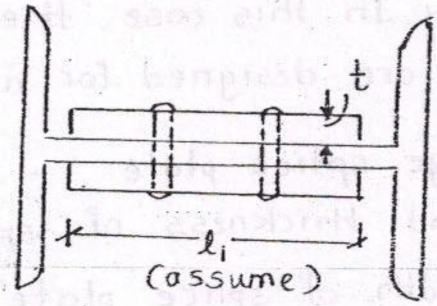
Determine value of 't'

ⓑ If the column ends are not machined.

$$\frac{P}{2} + \frac{M}{h} \leq B \cdot t \cdot \sigma_{ac}$$

find 't'.

(vi) If shear force is also acting at the column splice, a web splice must be provided on both sides of the web as shown in fig.



Web splice.

If 'V' is shear force acting on web splice.

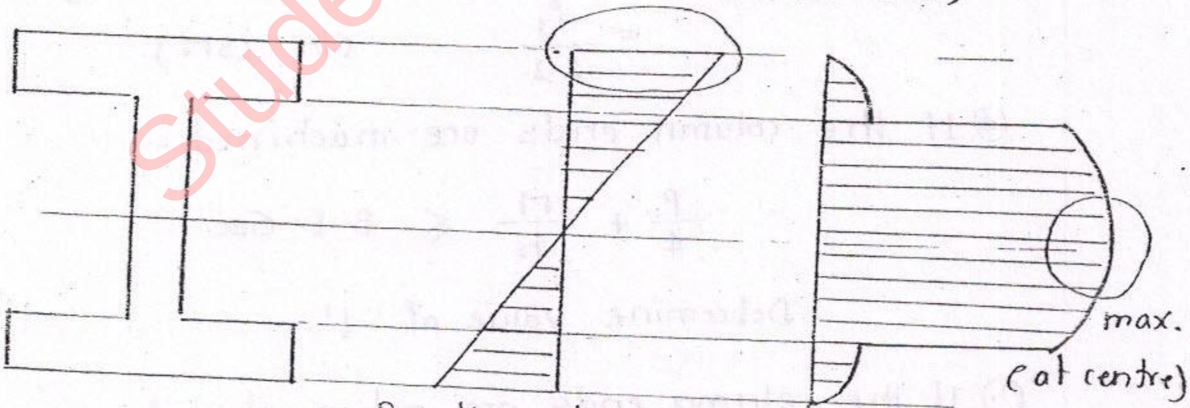
$\tau_{va,cal}$ - calculated shear stress in web splice

$$= \frac{V}{2 \times (l_1 \times t)} \leq \tau_{va} = (0.4 f_y)$$

Assume l_1 and find thickness 't'.

Note:

(i) It is assumed that flange splice takes only B.M. and web splice takes only shear force.



Bending stress shear stress.

(ii) The rivets in web splice are subjected to double shear and bearing. While rivets in flange splice are subjected to single shear and bearing.

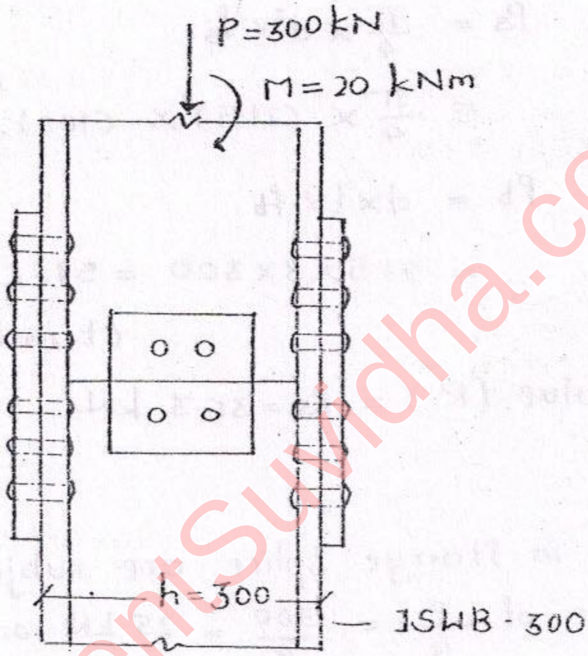
Q. 2-ISWB-300 are spliced at a section. It is subjected to an axial compressive load of 300 kN, S.F. = 75 kN and B.M. = 20 kNm. Assume column ends are machined for the complete bearing. Design column splice.

Given ISWB-300.

$t_w = 7.6\,mm$

$t_f = 10.6\,mm$ ($> t_w$ always)

$b_f = 250\,mm$.



Analysis:

(Finding forces in splice plates).

Since column ends are machined for complete bearing. max. force in splice plate is.

$$= \frac{P}{4} + \frac{M}{h} \qquad h = 0.3\,m$$

$$= \frac{300}{4} + \frac{20}{0.300} = 141.67\text{ kNm}$$

Design:

(finding thickness of flange splice and web splice)

(i) Flange splice:

Assume width of flange splace plate (B) = b_f

$B = 250\,mm$

$\therefore$ $B.t.\sigma_{ac} = \left(\frac{P}{4} + \frac{M}{h}\right)$

$250 \times t \times (0.6 \times 250) = 141.67 \times 10^3$

$t = 3.77$ mm.

Provide thickness of flange splice plate $(t) = 8$ mm or 6 mm

No. of rivets required

Assume $\phi = 20$ mm

$P_s = \frac{\pi}{4} \times d^2 \times f_s$

$= \frac{\pi}{4} \times (21.5)^2 \times (100) = 36.3$ kN

$P_b = d \times t \times f_b$

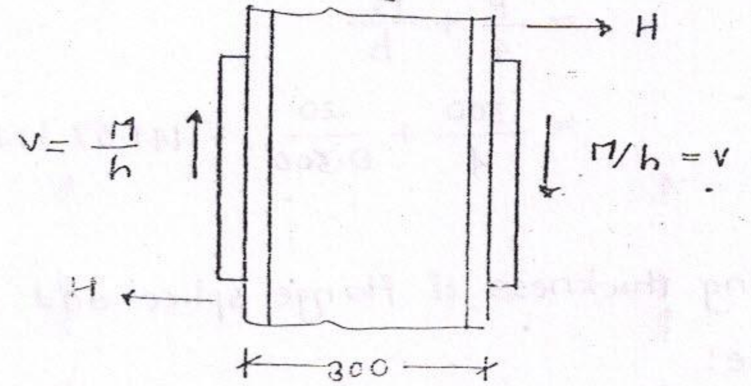
$= 21.5 \times 8 \times 300 = 51.6$

(t is lesser of 8 & 10.6 mm)

$\therefore$ Rivet value. $(R_v) = P_s = 36.3$ kN.

Note:

The rivets in flange splice are subjected to a direct shear force of $\frac{P}{4} = \frac{300}{4} = 75$ kN and moment M of 20 kNm. So calculate the no. of rivets required for $\frac{P}{4}$ and M seperately and add them to get total no. of rivets.



(ii) The moment M can be replaced by a vertical couple or a horizontal couple as shown in fig. If we replace M by horizontal couple, the no. of rivets required will be more

No. of rivets required to resist $\frac{P}{4} = \frac{75}{R_v} = \frac{75}{36.3} = 2.06$

No. of rivets required to resist $M = \sqrt{\frac{6M}{R_v \cdot p \cdot m}}$

p - min pitch $= 2.5 \times 20 = 50$ mm

m - no. of rivet rows $= 2$.

$$n_2 = \sqrt{\frac{6 \times 20 \times 10^6 \text{ Nmm}}{36.3 \times 10^3 \times 50 \times 2}}$$

$= 5.7$ Rivets in each row.

Total no. of rivets $(n) = n_1 + 2n_2$

$= 2.06 + 2(5.7)$

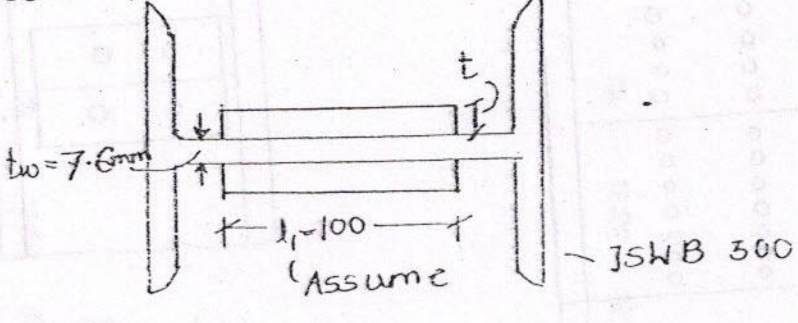
$= 13.47 \simeq 14$ rivets.

So provide 7 rivets in each rivets row.

If M is replaced by vertical couple.

No. of rivets $= \frac{141.67 \text{ kN}}{36.3 \text{ kN}} = 3.9 \simeq 4$ rivets

(ii) Web splice:



Web splice.

$\tau_{va,cal}$ - calculated shear stress in web splice

$$\tau_{va,cal} = \frac{V}{2\times(l_1 \times t)} \leq \tau_{va} = 0.4 f_y$$

$$\frac{75}{2\times(100\times t)} \leq 0.4\times 250$$

$$t = 3.75 \text{ mm.}$$

Provide thickness of web splice plate = 6.00 mm.

No. of rivets required.

$$n = \frac{F}{R_V} = \frac{75}{R_V}.$$

Rivets are in double shear.

$$P_S = 2\times \frac{\pi}{4} \times d^2 \times f_s$$

$$= 2\times\frac{\pi}{4}\times(21.5)^2\times 100 = 72.61 \text{ kN}$$

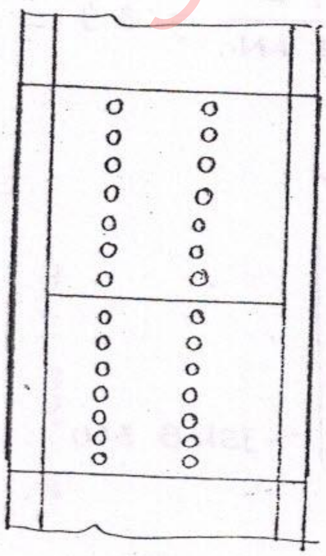
$$P_b = d\times t\times f_b$$

$$= (21.5)\times 7.6\times 300 = 49.02 \text{ kN}$$

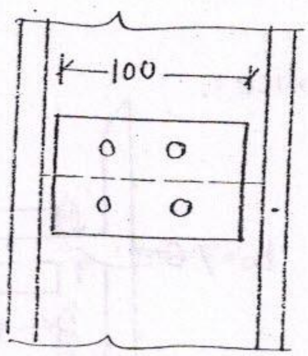
t - is lesser of (6+6) and 7.6 mm

$$R_V = P_b = 49.02 \text{ kN}$$

∴ No. of rivets required $= \frac{75}{49.02} = 1.52 \Rightarrow 2$ rivets



Flange splice



Web splice.