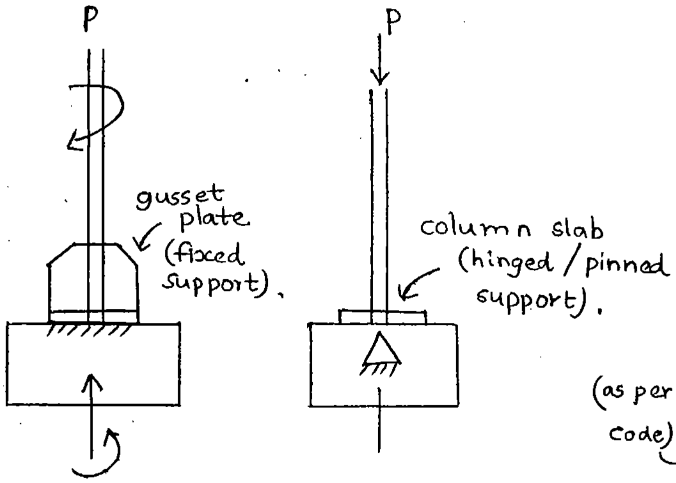
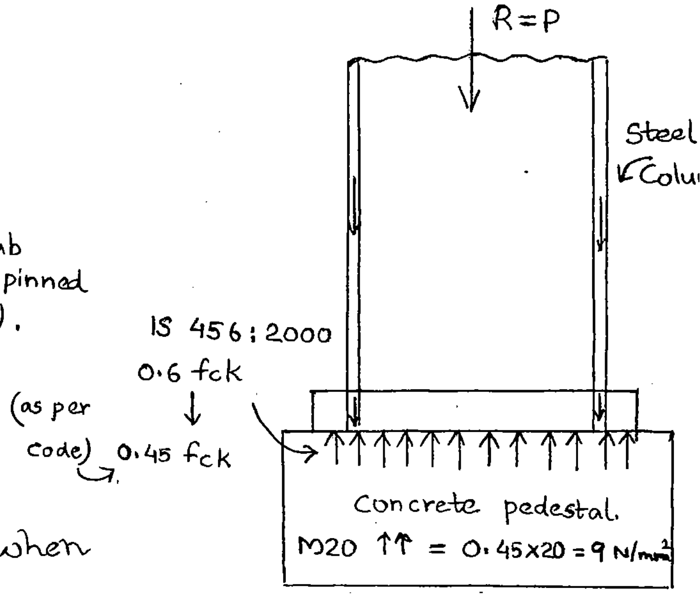
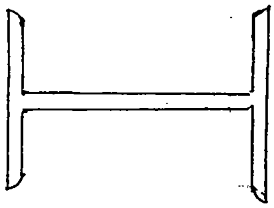
7. COLUMN BASES & COLUMN SPLICES





- Gusset plates are provided when moment is acting on the column.
- Column pl slabs are used when only axial loads act on the column.



→ Types of Column Bases:

- Slab bases :-

  To be provided when column is subjected to direct axial loads only.

- Gusseted base :-

  To be provided, when column is subjected to heavy axial loads and subjected to axial loads with moment.

⊙ Bearing strength of concrete (as per code) = 0.45 fck

$$\frac{P}{A} \leq 0.45\, f_{ck}.$$

$$\therefore\ A = \frac{P}{0.45\, f_{ck}}.$$

Min. base area required to safely transmit the axial load = $\frac{P}{0.45}$

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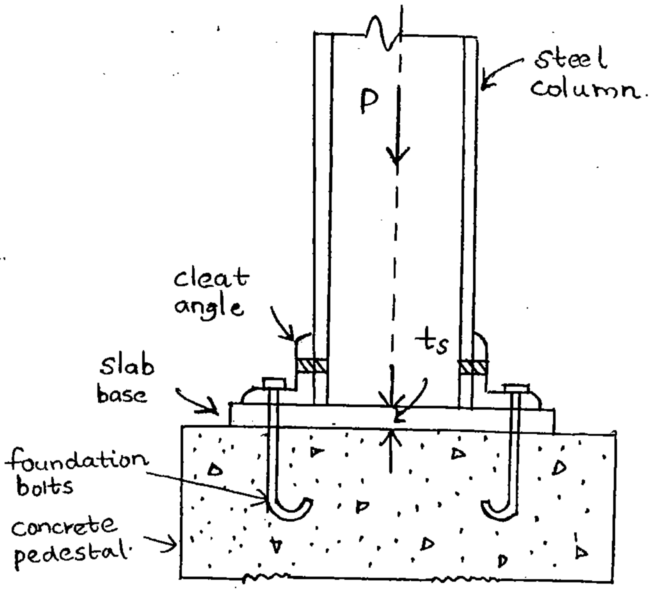
→ Design of Slab base:



L → length of slab base

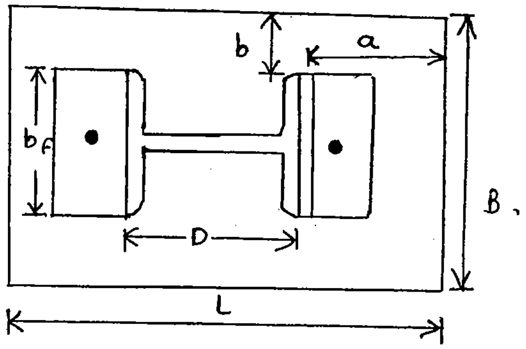
B → width of slab base.

t_s → thickness of slab base.

D → depth of steel column section

b_f → width of column flange

a → bigger projection of slab base beyond the steel column.



b → smaller projection of slab base beyond the steel column.

Step 1: Assume suitable grade of concrete. Bearing strength of concrete taken as 0.45 f_{ck}

Step 2: Area of slab base required = $\frac{\text{Factored column load}}{\text{Bearing strength of concrete}}$

$$A = \frac{P}{0.45 f_{ck}}.$$

– For square slab base,
Side of slab base, $L = B = \sqrt{A}$

– For rectangular slab base,

$$A = L \times B$$

$$A = (D+2a)(b_f+2b)$$

If a & b (projections) are same, the thickness required for slab base will be optimum.

ie, condition for optimum thickness of slab base:

$$a = b$$

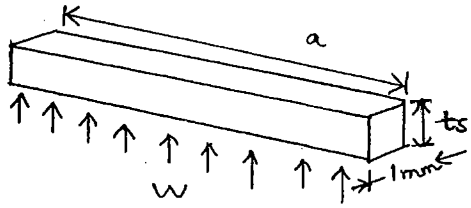
– upward pressure from concrete pedestal is w

$$w = \frac{P}{\text{Provided area of slab base}}$$

Consider 1 mm width of slab base,

Net moment due to upward pressure, $M = \frac{wa^2}{2} - \mu \frac{wb^2}{2}$

$$= \frac{w}{2}\left(a^2 - \mu b^2\right)$$



$$\therefore \quad M = \frac{w}{2}\left(a^2 - 0.3\, b^2\right) \quad ; \quad \mu = 0.3 \text{ for steel.}$$

– Design bending strength of slab base,

$$M_d = Z_p \frac{f_y}{\gamma_{mo}}$$

$$M_d = 1.2\, Z_e \frac{f_y}{\gamma_{mo}}$$

Design condition is :-

$$\frac{w}{2}\left(a^2 - \mu b^2\right) = 1.2\, Z_e \frac{f_y}{\gamma_{mo}}$$

$$= 1.2 \frac{t_s^2}{6} \frac{f_y}{\gamma_{mo}}$$

$$Z_e = \frac{I}{y} = \frac{b t_s^3}{12} \Big/ t_s/2 = \frac{t_s^2}{6}.$$

$\Rightarrow$ Thickness of slab base, $t_s = \sqrt{\dfrac{2.5\, w\left(a^2 - 0.3\, b^2\right) \gamma_{mo}}{f_y}}$

$t_s > t_f$; $t_f \rightarrow$ thickness of column flange.

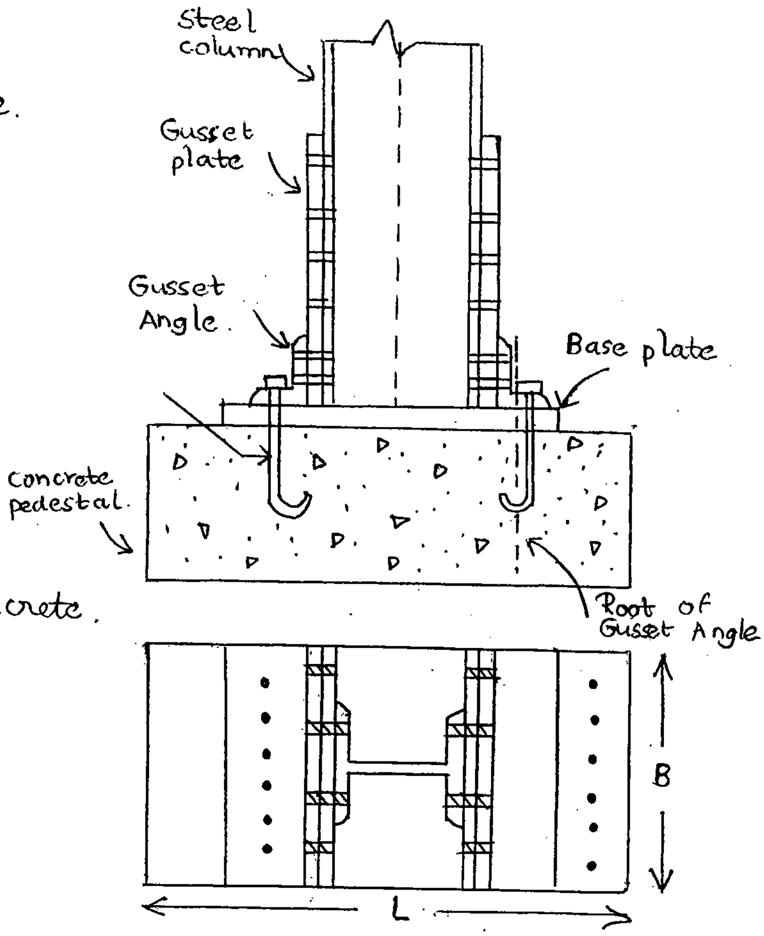
→ Design of Gusseted Base.

$L \rightarrow$ length of base plate

$B \rightarrow$ width of base plate

$P \rightarrow$ Factored column load.

Step 1: Assume suitable grade of concrete.



Bearing strength of concrete $= 0.45\ f_{ck}$.

Area of base plate required,

$$A = \frac{\text{Factored column load}}{\text{Bearing strength of concrete.}}$$

$$\boxed{A = \frac{P}{0.45\,f_{ck}}}$$

L = length of base plate.
= width of base plate parallel to web.

L = depth of steel column + 2* thickness of GP + 2* leg width of gusset angle + 2* min. overhand (for bolted connection)

L = depth of steel column + 2* thickness of GP + 2* min overhang (for welded connection)

$$\text{Width of base plate, } B = \frac{\text{area of base plate}}{\text{length of base plate}}$$

– Upward pressure from concrete pedestal,

$$w = \frac{\text{Factored column load}}{\text{Provided area of base plate.}}$$

– Moment due to upward pressure for 1 mm width of base plate, $M = w \cdot c \cdot \frac{c}{2} = \frac{wc^2}{2}$

– Design bending strength of base plate,

$$M_d = Z_p \cdot \frac{f_y}{\gamma_{mo}} = 1.2\, Z_e \frac{f_y}{\gamma_{mo}}$$

c → cantilever projection beyond the root of gusset angle (for bolted connection)

$$M \leq M_d$$

$$\Rightarrow \quad \frac{wc^2}{2} \leq 1.2 \times \frac{t_s^2}{6} \times \frac{f_y}{\gamma_{mo}}$$

$$t_s = c\sqrt{\frac{2.75\, w}{f_y}}$$

– Thickness of base plate (t_b):

$t_b = t$ – thickness of gusset angle (for bolted connection)

$= t$ (for welded connection)

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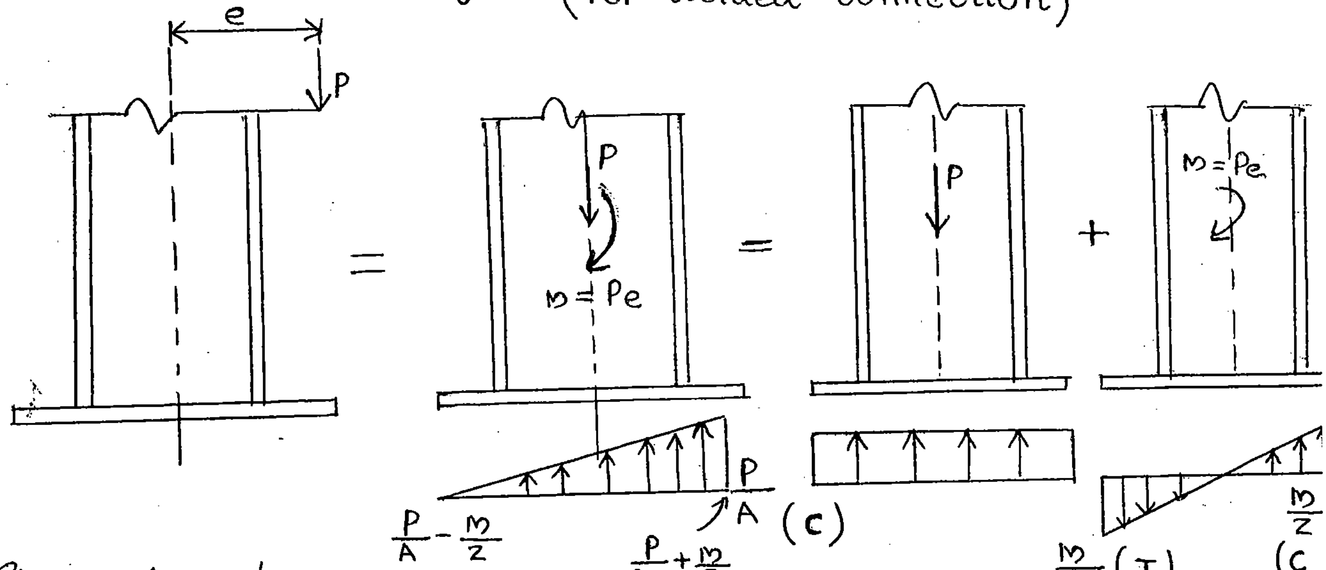
1.



Stress due to direct axial load $= \frac{P}{A} = \frac{P}{L \times B}$ (compression).

Stress due to BM $= \pm \frac{M}{I} y = \frac{6Pe}{BL^2}$

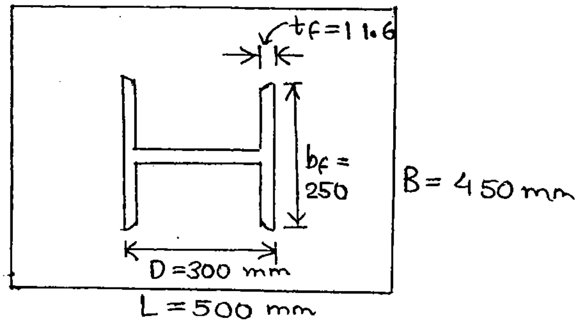
Combined stress due to P & M $= \frac{P}{A} \pm \frac{M}{Z} = \frac{P}{LB}\left(1 \pm \frac{6e}{L}\right)$

3. $a = \frac{L-D}{2} = \frac{500-300}{2}$

$= 100$ mm.

$b = \frac{B-b_f}{2} = \frac{450-250}{2}$

$= 100$ mm.



Thickness of base plate, $t_s = \sqrt{\frac{2.5w(a^2 - 0.3b^2)\gamma_{mo}}{f_y}}$

$= \sqrt{\frac{2.5 \times 9(100^2 - 0.3 \times 100^2) \times 1.10}{250}}$

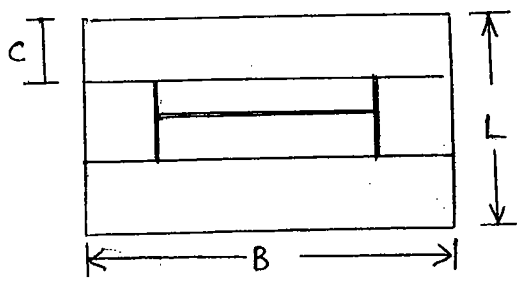
$= \underline{\underline{26.3}}$ mm $(\geq t_f = 11.6$mm$)$.

4. $t = c\sqrt{\frac{2.75\,w}{f_y}}$

For all the 4 options given, area is same.

$\therefore\ w = \frac{P}{A}$ is also same.

$\therefore\ t \propto c$.



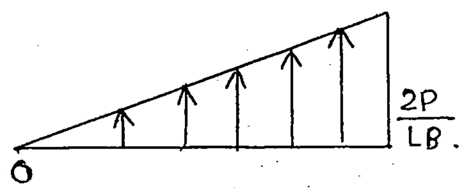
a) $c = \frac{600-140}{2} = 230$ mm

b) $c = \frac{600-400}{2} = 100$ mm.

c) $c = \frac{500-140}{2} = 180$ mm.

d) $c = \frac{720-400}{2} = 160$ mm.

05. Combined stress $= \frac{P}{A} \pm \frac{M}{Z}$.



$= \frac{P}{LB}\left(1 \pm \frac{6e}{L}\right)$.

$= \frac{P}{LB}\left(1 \pm \frac{6}{L} \cdot \frac{L}{6}\right) = 0,\ \frac{2P}{LB}$

06. For Fe 410 grade steel,

$f_u = 410$ MPa , $f_y = 250$ MPa.

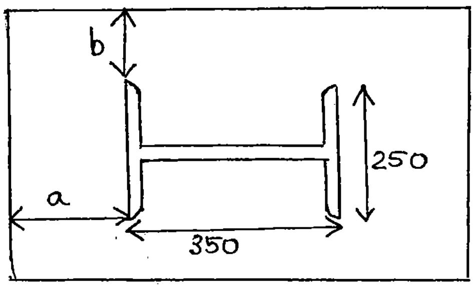
For M25 grade concrete,

$f_{ck} = 25$ MPa.

$D = 350$ mm, $b_f = 250$ mm , $t_f = 11.6$ mm.

$P = 2000$ kN

Area of base plate (slab base) $= \frac{P}{0.45 f_{ck}}$



$= \frac{2000 \times 10^3}{0.45 \times 25}$

$= 177.8 \times 10^3$ mm^2

$A = L \times B = (D+2a)(b_f + 2b)$.

$= (350+2a)(250+2b)$. $(a = b)$.

$177777 = (350+2a)(250+2a)$.

$\Rightarrow a = b = 62.29$ mm $\approx$ 65 mm

Length of base plate, $L = D + 2a$

$= 350 + 2 \times 65 = 480$ mm .

Width of base plate, $B = b_f + 2b$.

$= 250 + 2 \times 65 = 380$ mm

Upward pressure, $w = \frac{P}{\text{provided area of base plate}} = \frac{2000 \times 10^3}{480 \times 380}$

$= 10.96$ N/mm^2

Thickness of base plate, $t_s = \sqrt{\dfrac{2.5\, w\,(a^2 - 0.3 b^2)\,\gamma_{mo}}{f_y}}$

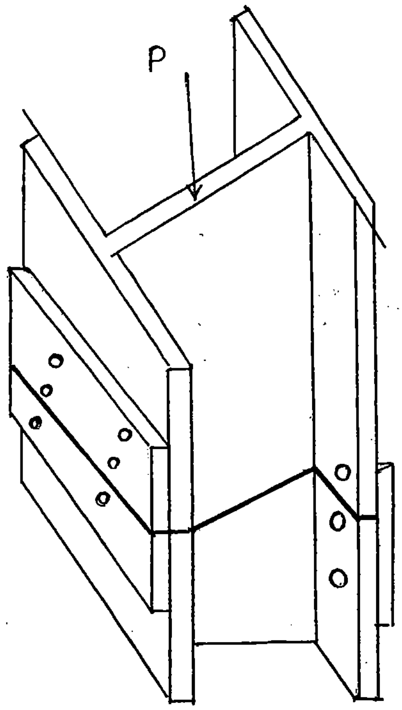
$$= \sqrt{\frac{2.5 \times 10.96\,(65^2 - 0.3 \times 65^2) \times 1.1}{250}}$$

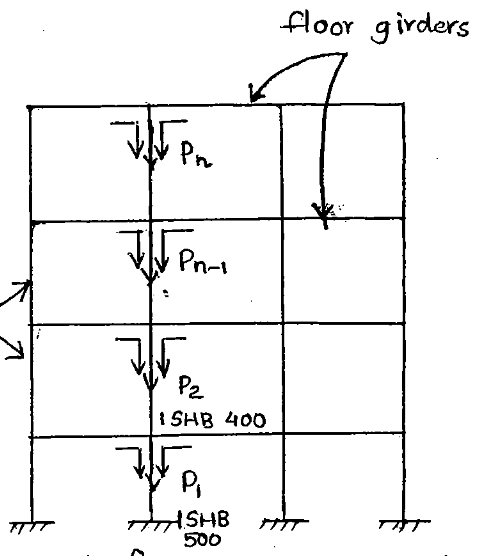
$$= 18.88 \approx \underline{\underline{20\ mm}}\ (> t_f = 11.6\,mm)$$

→ COLUMN SPLICE

$P_1, P_2, \cdots P_{n-1}, P_n$ factored column loads in various columns.

$$P_1 > P_2 > P_3 \cdots > P_{n-1} > P_n.$$

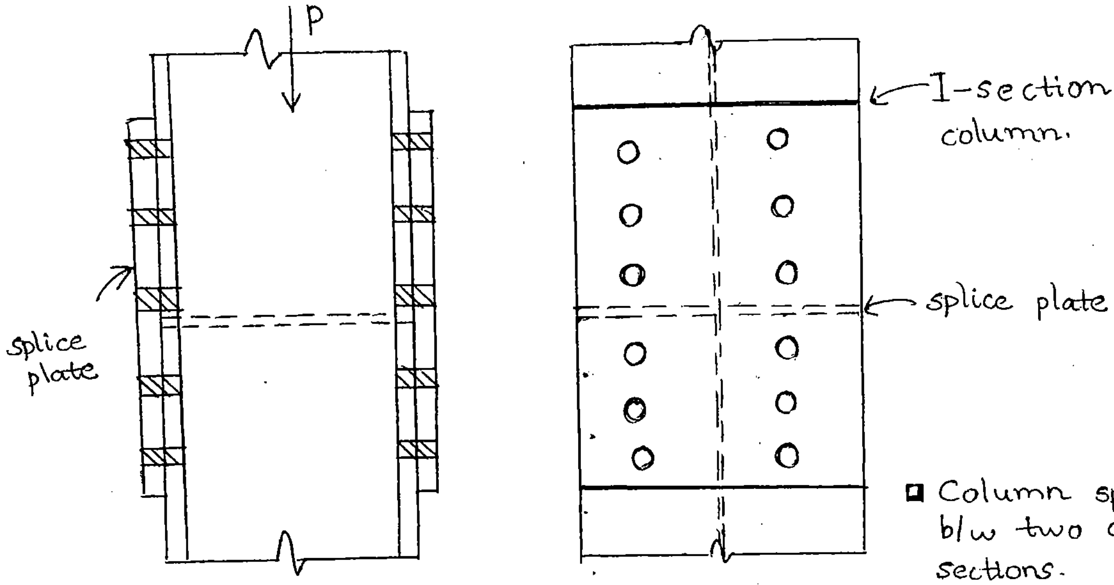




Steel frame for multi-storeye building.

Column splice is a joint for steel column. to be provided for extending length of column section. (length available from Indian Rolling mill is less) and also provided when two different sizes of columns are to be joined.

Column splice is should be designed as a short column and recommended to locate just above floor level.



■ Column splice b/w two column sections.

If end of a column is machined or milled, theoretically no connecting system is required. But in practise, splice must be designed for 50% factored column load.