Design of Gusset plate

Design a gusseted base for a column ISHB 350 @ 710 N/m with two plates 450 mm × 20 mm carrying a factored load of 2500 kN. The column ~~ISHB~~ is to be supported on concrete pedestal with M_{20} grade concrete.

Solution:-

Column ISHB 250 @ 710 ~~kN~~ N/m

Factored load: $P_u = 2500\,kN = 2500 \times 10^3\,N$

plate size = 450 mm × 20 mm.

For M_{20} grade concrete $f_{ck} = 20\,N/mm^2$

ii) properties of ISHB 350 @ 710 N/m.

$A = 9221\,mm^2$ $\quad b_f = 250\,mm$

$h = 350\,mm$ $\quad t_w = 10.1\,mm$

$t_f = 11.6\,mm$

iii) Bearing strength of concrete $= 0.45 f_{ck}$ (As per IS 456 – 2000)

$= 0.45 \times 20 = 9.00\,N/mm^2$

∴ Required area of Baseplate = A

$$A = \frac{P_u}{\text{Bearing strength}} = \frac{2500 \times 10^3}{9.00}$$

$$A = 277.78 \times 10^3\,mm^2$$

Assuming ISA 150 × 150 × 15 mm and 16 mm gusset plate

Width of Baseplate required $= 350 + 2(20 + 16 + 150)$

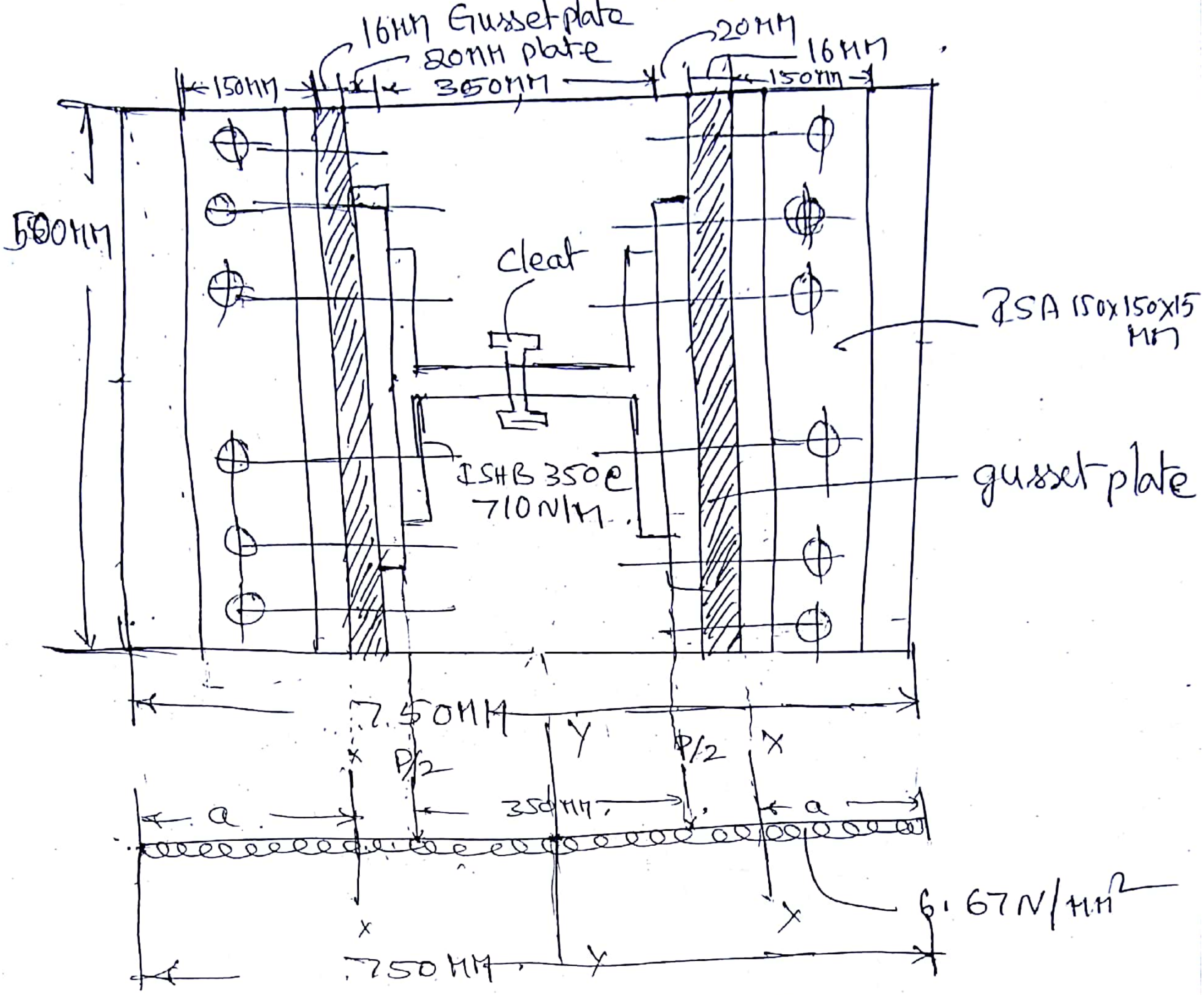
$= 722\,mm$ say $750\,mm$

$$\text{Length of Base plate} = \frac{277.78 \times 10^3}{750}$$

$= 370.37\,mm$ say $500\,mm$

Sized the plate = 750 X 500 MM

P = Pressure under Baseplate = $\frac{2500 \times 10^3}{750 \times 500}$ = 6.67 N/MM²



$a = \frac{750 - 2(20+16) - (350)}{2} = 164 mm$

$= \frac{750 - 422}{2} = \frac{328}{2} = 164 MM$

∴ BM at the section X-X per mm width

$BM(x-x) = \frac{Wa^2}{2} = \frac{6.67 \times 164^2}{2} = 89.7 \times 10^3 Nmm$

Reaction P/2 due to upward earth pressure

$\frac{P}{2} = \frac{W \times L}{2} = \frac{6.67 \times 750}{2} = 2501.25N$

$\frac{P}{2} = 2501.25N$

B.M at Section Y-Y $= 6.67 \times \frac{375^2}{2} - P/_2 \times \frac{350}{2}$

$= 6.67 \times 375 \times \frac{375}{2} - \frac{2501.25}{2} \times \frac{350}{2}$

$= 89.7 \times 10^3$ N-mm

Bending strength $= \frac{f_y}{\gamma_{mo}} = \frac{250}{1.1} = 227.27 N/mm^2$

~~equating moment of~~

Moment of Resistance for plates $= \frac{1.2 f_y \cdot Z_e}{\gamma_{mo}}$

M.R = B.M

$\frac{1.2 \times f_y \times bt^2/6}{1.1} = 89.7 \times 10^3$ $\left(Z = \frac{bt^2}{6} \text{ where } b = 1mm \right)$

$\frac{1.2 \times 250 \times t^2 \times 1}{1.1 \times 6} = 89.7 \times 10^3$

$t = 44.42 mm \approx$ **56mm** (As per steel table available thickness is 56mm)

∴ provide base plate = 750×500×56mm

Connections:- Assuming ends of Column are faced for Complete bearing and the Connections between gussets plate and Column will be designed for 50% of axial load

Design load $= \frac{1}{2} \times 2500 = 1250 kN$

load on each splice $= \frac{1250}{2} = 625 kN$

Using 20mm diameter shop bolts or rivits

Scanned by CamScanner

$f_u = 400\ N/mm^2$ & $\gamma_{m_1} = 1.25$

Strength of bolt in single shear $= 0.78 \times A \times \frac{f_u}{\sqrt{3} \times \gamma_{m_1}}$

$= 0.78 \times \left(\frac{\pi}{4} \times 20^2\right) \times \frac{400}{\sqrt{3} \times 1.25}$

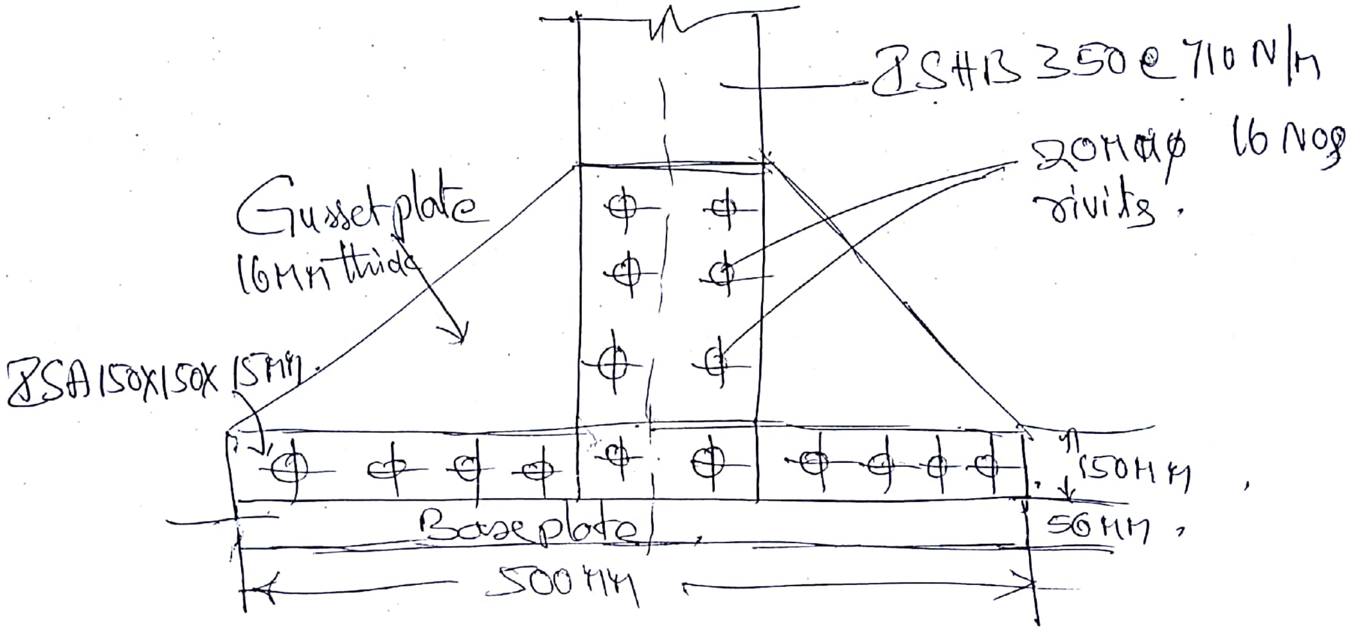
$= 45.27 \times 10^3\ N$

Strength of Bolts (or) rivit $=$ ~~625×10^3~~ $45.27 \times 10^3\ N$

No of Bolts required $= \frac{625 \times 10^3}{45.27 \times 10^3}$

$= 13.8\ NO \approx 16\ NOS.$

Provide 16 Nos of bolts 200 mm ϕ as shown in fig. for connecting column to gusset plate.



Connection details.

Design of Column Splice:-

An ISHB 250 @ 536 N/m Column a factored axial load of 900 KN. The Column ends of Machined. Design the splice Connection

Solution

~~ISHB @ 536N~~

ISHB 250 @ 536N

properties of ISHB 250 are

$h = 250\,MM$

$b_f = 250\,MM$

Factored load on Column = 900 KN

~~Bo~~ rivit size 16 MM ϕ.

Design of splice Connection :-

Here ~~As~~ the axial load is given on Column only flange splice is sufficient to transfer the load.

$$\text{Load transfer on each flange} = \frac{900}{2} = 450\,KN$$

$$\text{load shared by one splice plate} = P = \frac{450}{2} = 225\,KN$$

or $225 \times 10^3\,N$

$$A = \frac{P}{f_y} = \frac{225 \times 10^3}{250} = 900\,MM^2$$

Width of splice plate = Width of Column flange = b_f

$b_f = 250\,MM$

$$\text{Thickness of plate} = \frac{900}{250} = 3.6\,MM \approx 6\,MM$$

∴ provide splice plate of 250 × 6 MM

Connection

16 mm ϕ bolt (or) rivit are given

$$\text{Strength of bolt or rivit in single shear} = \frac{f_y}{\sqrt{3}\,\gamma_{mb}} \times A_g$$

$$= \frac{400}{\sqrt{3} \times 1.25} \times 0.78 \times \frac{\pi}{4}(16)^2$$

$$= 28.975 \times 10^3 \, N$$

d = dia of Bolt or rivit, f_u = 400 MPa

Strength of bolt (or) rivit in bearing $= \frac{2.5 \times K_b \times d \times t \times f_u}{\gamma_{mb}}$

$K_b = 0.45$ (Assume)

$$= \frac{2.5 \times 0.45 \times 16 \times 6 \times 400}{1.25}$$

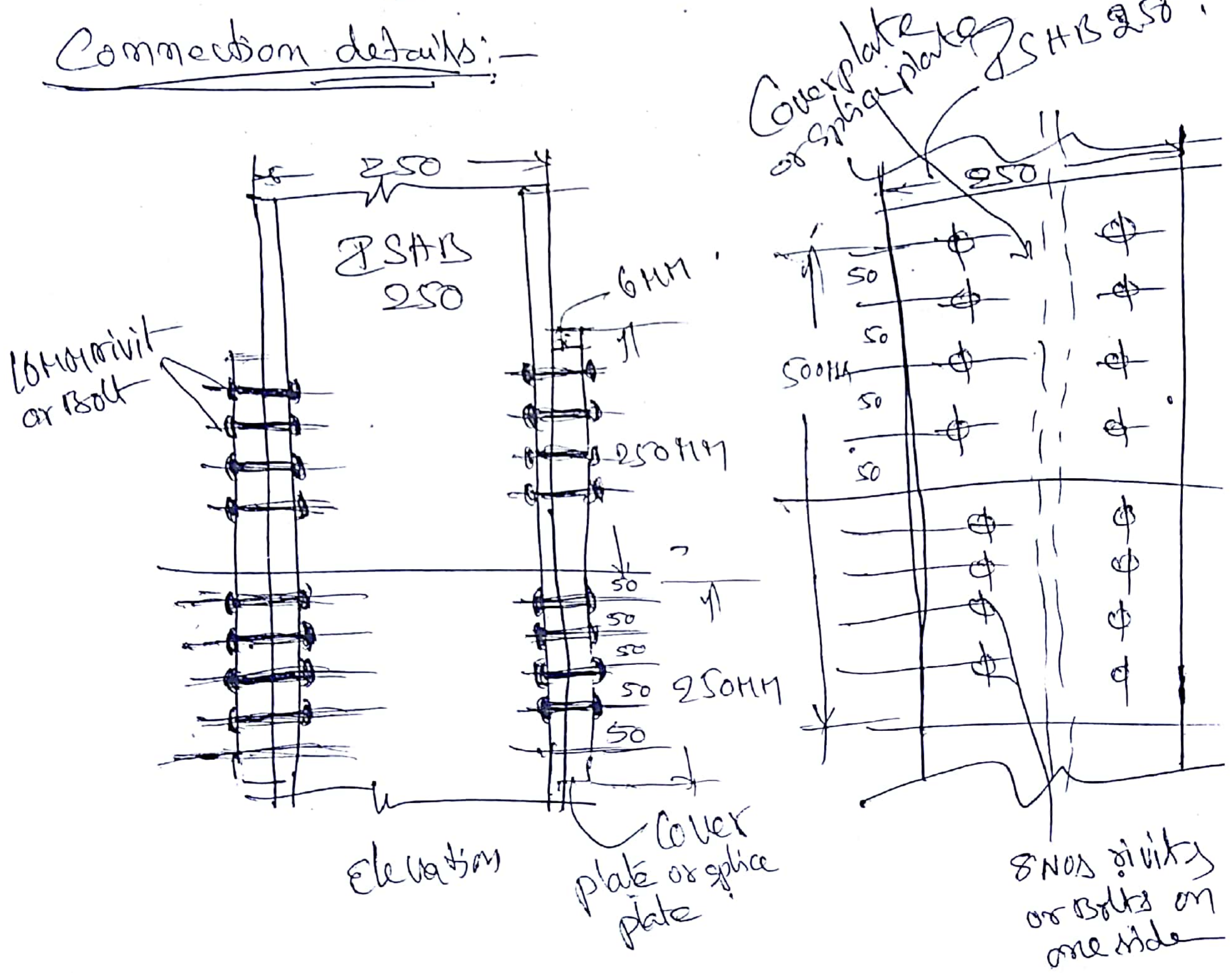
$$= 34.56 \times 10^3 \, N$$

Bolt Value $= 28.975 \times 10^3 \, N$

∴ No of bolts required for connection $= \frac{225 \times 10^3}{28.97}$

$= 7.76$ say 8 NOS

Connection details:—



Q An ISHB 300 @ 618 N/m Column has to be splice at a section. It is subjected to a factored axial load of 500 kN. a factored B.M of 30 kN m and a factored shear force of 100 kN. Design the column splice, connecting ends are machined to provide full bearing.

Solution

Given data:

ISHB 300 @ 618 N/m

properties are $h = 300$ MM

Breadth of flange: $b_f = 250$ MM

Thickness of flange: $t_f = 10.6$ mm

Factored axial load: 500 kN

Factored B.M = 30 kN m (or) 30×10^6 N-mm

Factored shear force = 100 kN = 100×10^3 N

Design of splice:-

① Load transmitted on one splicing plate $= \frac{500}{4} = 125$ kN

Assuming 6mm thick splicing plate.

load transmit to one splicing plate due to B.M

$$B.M = Load \times distance = \frac{30 \times 10^6}{(h+t_p)} = \frac{30 \times 10^6}{(300+6)} = 98.03 \times 10^3 \text{ N}$$

$$\left(load = \frac{B.M}{distance}\right) \quad = \text{or } 98.03 \text{ kN}$$

∴ The total load on one splice plate $= 125 + 98.03$

$= 223.03$ kN

Sectional area required for one splice plate $= \frac{P}{f_y}$

$$= \frac{load}{stress} = \frac{P}{f_y} = \frac{223.03 \times 10^3}{250}$$

$A = 892.12$ mm²

Width of the plate = 250 MM = Width of flange.

Thickness of plate required $= \frac{892.12}{250} = 3.56$ MM ≃ 6 MM

$t_p = 6$ MM

Connection Design :-

Assuming M20 bolts (or) rivits.

pitch = $P = 2.5 \times 20 = 50$ mm

edge dist = $e = 1.5 \times 20 = 30$ mm.

a) Strength of bolt in single shear = $\frac{f_u}{\sqrt{3} \times \gamma_{mb}} \times A_n$.

$f_u = 400$ N/mm²

$A_n = 0.78 \times \frac{\pi}{4} \times 20^2$

$\gamma_{mb} = 1.25$

$$= \frac{400}{\sqrt{3} \times 1.25} \times 0.78 \times \frac{\pi}{4} \times 20^2$$

$$= 45.27 \times 10^3 \text{ N}$$

Bolt Value $= 45.27 \times 10^3$ N

No of bolts required for one splice plate $= \frac{223.03 \times 10^3}{45.27 \times 10^3}$

$= 4.92$ say 6 Nos.

length of plate $= 2 \times 30 + 2 \times 50 = 160$ mm $\times 2 = 320$ mm

∴ provide $320 \times 250 \times 6$ mm splice plate as shown in fig.

Design of splice plate to resist shear

These splice plates are provided on either sides of web of column, to resist the shear at the splice section.

Factored shear = 100 kN.

∴ shear on each splice plate $= \frac{100}{2} = 50$ kN

Height of web between flanges $= 300 - 2t_f$

$= 300 - 2 \times 10.6 = 278.8$ mm

provide width of splice plate = 150mm (Assume) t = Thickness of the splice plate

Design shear stress $= \frac{f_y}{\sqrt{3}\,\gamma_{m0}} = \frac{250}{\sqrt{3} \times 1.10} = 131.2\ N/mm^2$

Equating the maxi shear stress to design shear stress.

$\frac{3}{2} \times$ Average shear stress $= 131.2$

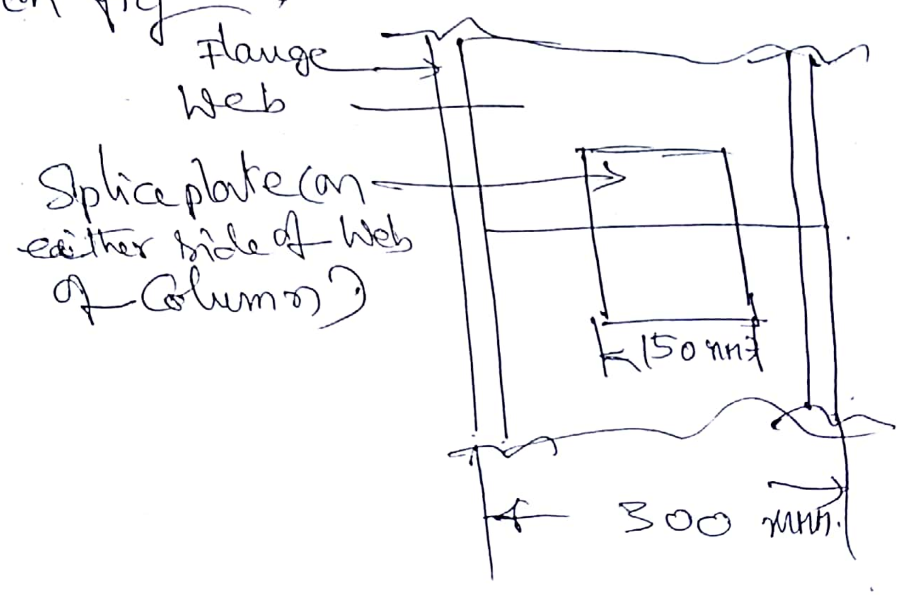
$\frac{3}{2} \times \frac{load}{area} = \frac{3}{2} \times \frac{50 \times 10^3}{150 \times t} = 131.2$

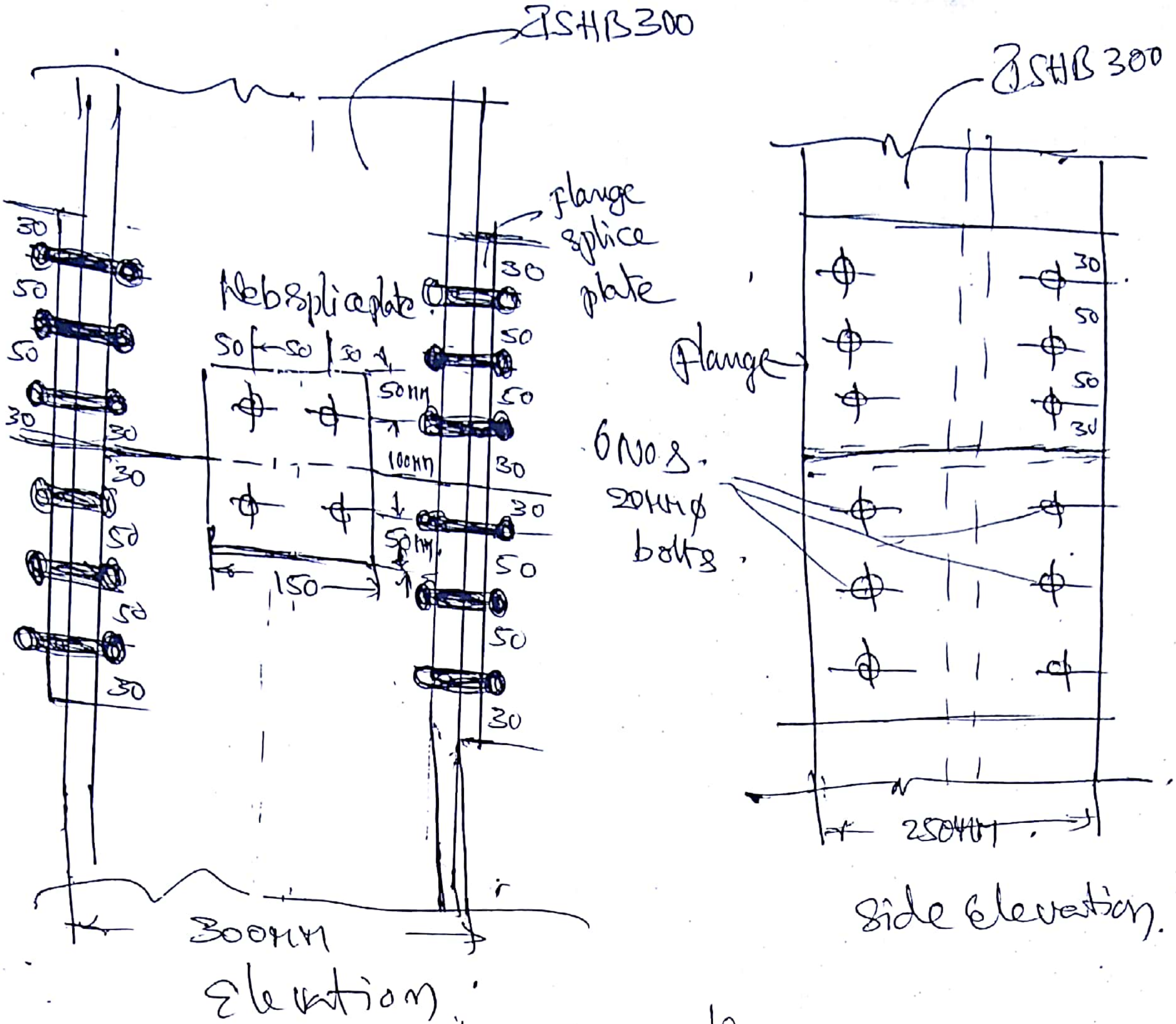
$t = 3.81$ mm say 6mm.

∴ provide 6mm thick splice plate

Design the Connections:-

Connections, minimum two bolts or rivets. as shown on fig.





Splice Connection.