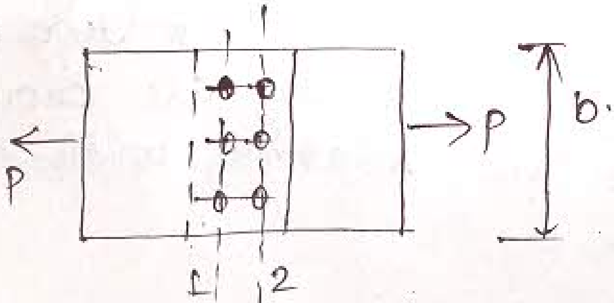
Ajay Kumar Garg Engineering College
Department of Civil Engineering
Solution- Sessional Test-2

Course:	B.tech		Semester:VII
Session:	2017-18		Section: CE-1/CE-2
Subject:	Design of Steel Structures		Sub. Code: Nce-701
Max.Marks:	50		Time: 2 hour.

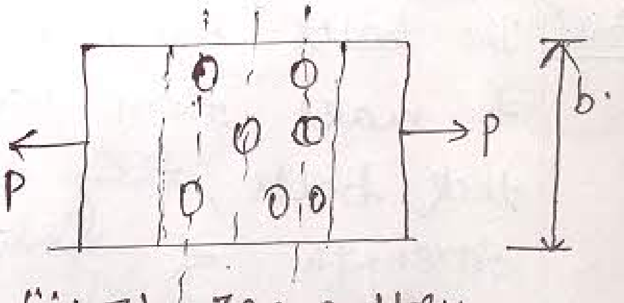
Section-A.

1.(a) Draw the pattern of riveted joints.

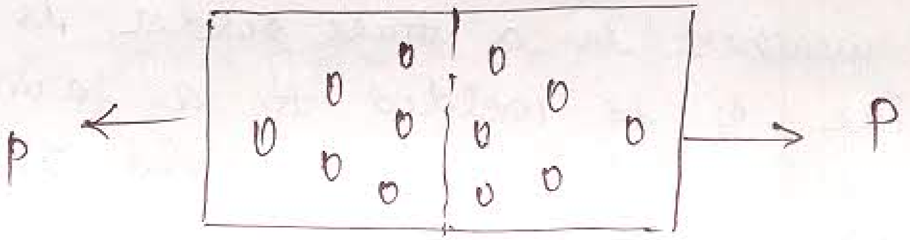
Ans:



(i) chain Riveted



(ii) zig-zag-pattern.



(iii) Diamond pattern

1.(b) Write down the types of bolted joints.

Ans: There are two types of bolted joints.

(i) Lap joint.

(ii) Butt joint.

1.(c) Define pitch & Gauge distances.

Ans: pitch → It is the c/c distance of bolts in a row along the direction of load acting.

~~Pitch~~ : Gauge : It is the dist b/w the two consecutive bolts of adjacent rows & is measured at right angle to the direction of load.

1.d Define tension member.

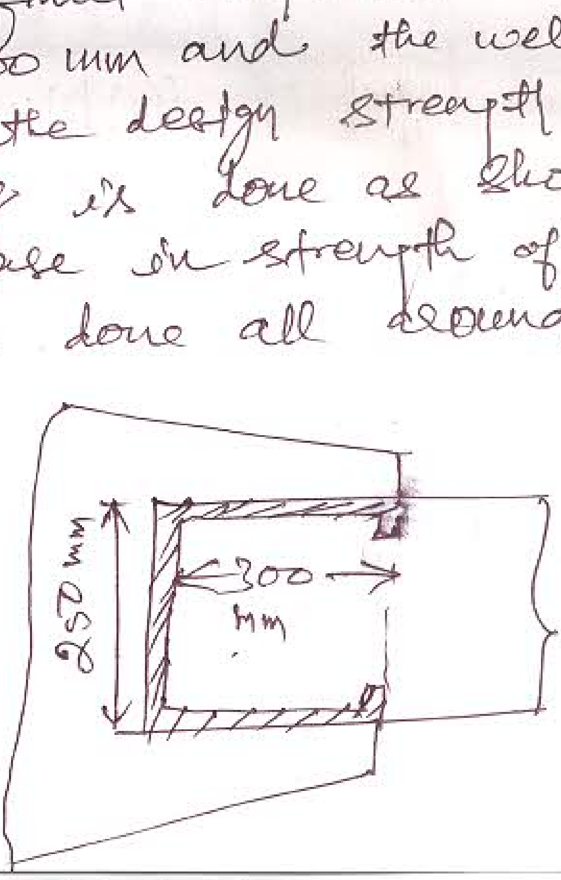
Ans : A tension member is one which is intended to resist axial tension & it is also called as 'ties' & or 'Hangers'.

1.e What do you mean by tacking of bolts?

Ans : The bolts that are used to connect two direction to make them work in unison are known as tack bolts, they have no relation with the strength of joint.

Section - B

2.(a) A tie member in a truss girder is 250 mm × 14mm in size. It is welded to a 10 mm thick gusset plate by a fillet weld. The overlap of the member is 300 mm and the weld size is 6mm. Determine the design strength of the joint, if the welding is done as shown in fig. What is increase in strength of the joint, if welding is done all around. Assume shop welding.



Ans: 2(a). For Fe 410 grade steel, $f_u = 410$ MPa, $f_y = 250$ MPa

$\gamma_{mw} = 1.25$, effective weld length:

$l_w = 2 \times 300 + 250 = 850$ mm.

Effective Throat thickness, $t_t = KS = 0.7 \times 6 = 4.2$ mm.

Design strength of the weld, $P_{dw} = l_w t_t \dfrac{f_u}{\sqrt{3}\gamma_{mw}}$

$= 850 \times 4.2 \times \dfrac{410}{\sqrt{3} \times 1.25} \times 10^{-3} = 676.05$ KN.

when welding is alaround:

effective length of weld, $l_{w1} = 2 \times (300 + 250)$

$= 1100$ mm.

Design strength of weld, $l_{w1} = $

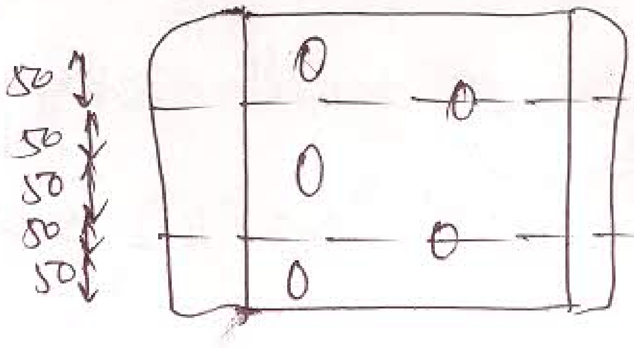
$P_{dw_1} = l_w t_t \cdot \dfrac{f_u}{\sqrt{3}\gamma_{mw}}$

$= 1100 \times 4.2 \times \dfrac{410}{\sqrt{3} \times 1.25} \times 10^{-3} = 874.89$ KN.

$\therefore$ Increase in strength $= 874.89 - 676.05 = 198.84$ KN

Q.2(b) Determine the strength & efficiency of lap joint as shown in figure. The bolts are of 20 mm diameter & of grade 4.6. The two plates to be jointed are 10 mm & 12 mm thick.

Soln:



P.T.O.

$f_u = 410 MPa$; $f_{ub} = 400 MPa$, $A_{nb} = 245 mm^2$

d_h or $d_0 = 22$ mm.

$\gamma_{mb} = 1.25$, $\gamma_{m_1} = 1.25$

Strength of bolt in single shear

$$V_{dsb} = A_{nb} \frac{f_{ub}}{\sqrt{3}\gamma_{mb}} = \frac{245 \times 400}{\sqrt{3} \times 1.25} \times 10^{-3}$$

$$= \underline{45.26 \text{ KN}}$$

Strength of joint per pitch length in shear –

$$= 2 \times 45.26 = \underline{90.52 \text{ KN}}$$

Strength of bolt in bearing,

$$V_{dpb} = 2.5 \, k_b \, d \, t \, f_u / \gamma_{mb}$$

k_b least of $\left\{ e/3d_0, \; \frac{p}{3d_0} - 0.25, \; \frac{f_{ub}}{f_u} \; \& \; 1. \right\}$

$\underline{k_b = 0.50}$

$$V_{dpb} = 2.5 \times 0.50 \times 20 \times 10 \times \frac{410}{1.25} \times 10^{-3} = \underline{82.0 \text{ KN}}$$

Strength of joint per pitch length in bearing.

$$= 2 \times 82.0 = \underline{160.0 \text{ KN}}$$

The net tensile strength of the joint per pitch length. $T_{dn} = 0.9 \frac{f_u}{\gamma_{m_1}} A_n = 0.9 \frac{f_u}{\gamma_{m_1}} (p - d_h) t$

$$= 0.9 \times \frac{410}{1.25} \times (100 - 22) \times 10 \times 10^{-3} = \underline{230.25 \text{ KN}}$$

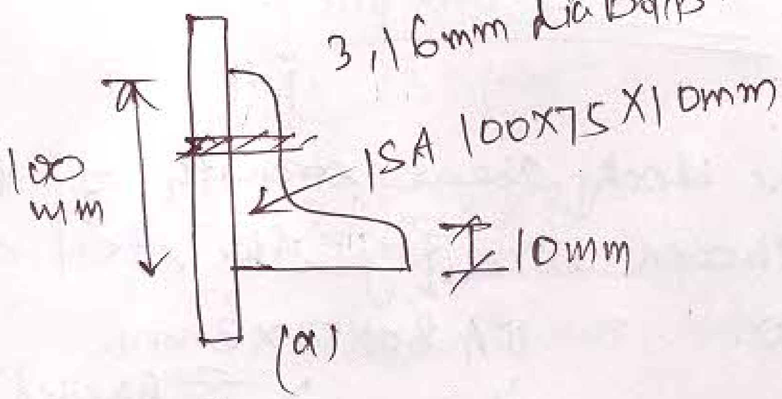
Hence strength of joint per pitch length $= 90.52$ KN

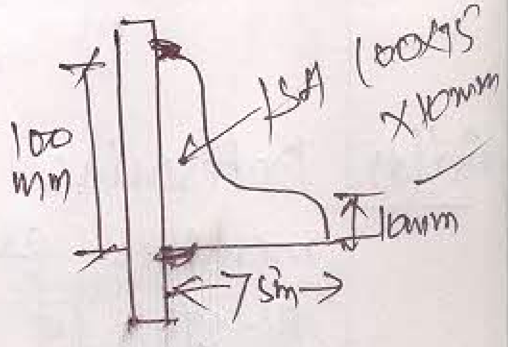
Strength of Solid plate per pitch length -

$$= 0.9 \times \frac{410}{1.25} \times 100 \times 10 \times 10^{-3} = 295.2\ kN.$$

$\therefore$ Efficiency of the joint $= \frac{90.52}{295.2} \times 100 = 30.66\%$ Ans.

Q2(C) :- Determine the effective net area for section shown in fig. The angles are connected as shown in fig. The steel is of grade fe410, the bolts have been punched.





Soln :- $f_y = 250$ MPa, $d = 16mm$, $d_h = 20mm$

(a) Effective net area of connected leg

$$= \left(100 - 20 - \frac{10}{2}\right) \times 10 = 750 mm^2$$

Net area of outstanding leg

$$= \left(75 - \frac{10}{2}\right) \times 10 = 700 mm^2$$

Total net area $= 750 + 700 = 1450 mm^2$

$\therefore$ effective net area $= \alpha A_n$

$$= 0.7 \times 1450 = 1015 mm^2$$

(b) Net area of connected leg $= \left(100 - \frac{10}{2}\right) \times 10$

$= 950\ mm^2$

Net area of outstanding leg $= \left(75 - \frac{10}{2}\right) \times 10$

$= 700\ mm^2$

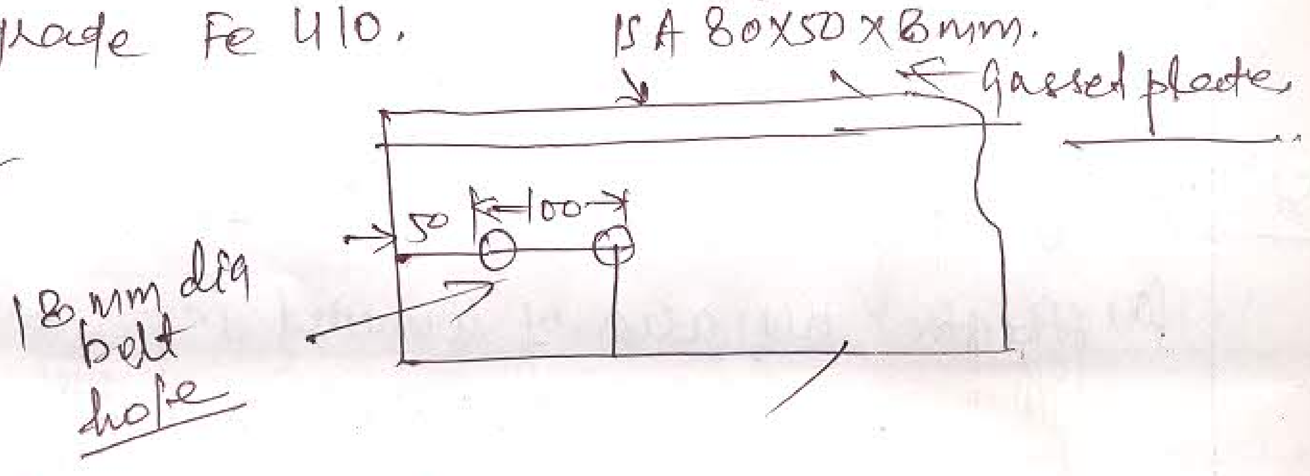
Total net area $= 950 + 700 = 1650\ mm^2$

$\therefore$ Effective net area, $A_n = 0.8 \times 1650$

$= 1320\ mm^2$

Ans

Q.(d) Determine the block shear strength of the tension member as shown in fig. The steel is of grade Fe 410.



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

$\gamma_{m0} = 1.1$, $\gamma_{m1} = 1.25$

$A_{vg} = (1 \times 100 + 50) \times 8 = 1200\ mm^2$

$A_{vn} = \left(1 \times 100 + 50 - \left(2 - \frac{1}{2}\right) \times 18\right) \times 8 = 984\ mm^2$

$A_{tg} = 35 \times 8 = 280\ mm^2$

$A_{tn} = \left(35 - \frac{1}{2} \times 18\right) \times 8 = 208\ mm^2$

The block shear strength will be minimum of T_{db1} & T_{db2}.

$$T_{db1} = \frac{A_{vg} f_y}{\sqrt{3}\gamma_{m0}} + \frac{0.9 \times A_{tn} f_u}{\gamma_{m1}}$$

$$= \left[\frac{1200 \times 250}{\sqrt{3} \times 1.1} + \frac{0.9 \times 208 \times 410}{1.25}\right] \times 10^{-3}$$

$$= 218.86\ KN$$

$$T_{db2} = \frac{0.9 A_{vn} f_u}{\sqrt{3}\gamma_{m1}} + \frac{A_{tg} f_y}{\gamma_{m0}}$$

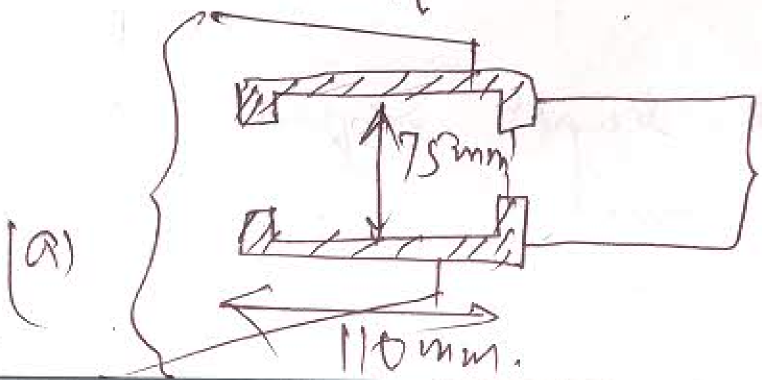
$$= \left[\frac{0.9 \times 984 \times 410}{\sqrt{3} \times 1.25} + \frac{280 \times 250}{1.1}\right] \times 10^{-3}$$

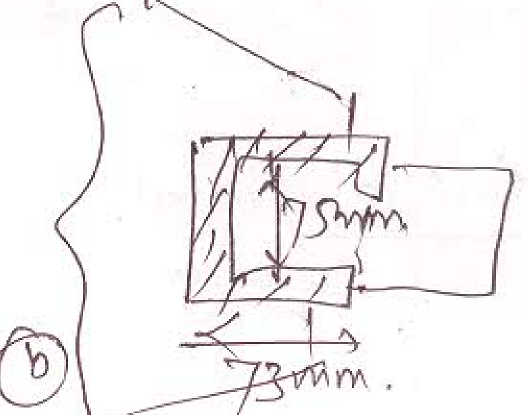
$$= 231.34\ KN$$

$\therefore$ Block Shear Str. = 218.86 KN

Section-C

Q.3(a) A 75mm × 8mm tie member is to transmitt a factored load of 145 KN. Design fillet welds & necessary overlaps for following cases as shown in figure. The steel used is of grade Fe410. Assume gusset plate to be 12 mm thick.





Soln (a) . $f_u = 410$ MPa, $f_y = 250$ MPa, $\gamma_{mw} = 1.25$ (shop), $\gamma_{mw} = 1.50$ (field)

factored load $= 145 \times 10^3$ N.

Minimum size of weld = 5 mm. (for 12 mm thick grip)

Maximum " " " $= 8 - 1.5 = 6.5$ mm (for 8 mm thick section).

let us provide a weld size of 5mm.

Effective throat thickness $= KS = 0.70 \times 5 = 3.5$ mm.

Case (a): Design strength of the weld,

$$P_{dw} = l_w t_t \, f_u / \sqrt{3}\, \gamma_{mw}$$

$$145 \times 10^3 = l_w \times 3.5 \times \frac{410}{\sqrt{3} \times 1.25}$$

$$l_w = 218.77 \approx 220 \text{ mm}$$

length of weld on each side $= \frac{220}{2} = 110$ mm

End returns $= 2 \times 5 = 10$ mm

overlap required = 110 mm.

Total length of weld required =

$2 \times (110 + 2 \times 10) = 260$ mm

Case (b) Total weld length required as found above = 220 mm.

$220 = 2 \times \text{overlap} + 75$

$\Rightarrow$ overlap $= \frac{220-75}{2} = 72.5 = \underline{73 \text{ mm}}$.

Provide overlap of 73 mm.

Total weld length required $= 2\times(73+10)+75$
$= \underline{241 \text{ mm}}$,

Ans.

Q.3: (b) Write down the steps for design of tension member subjected to axial loading.

Ans:

(1) Net area required A_n to carry the factored load T is obtained by:

$$A_n = \frac{T}{0.9 f_u/\gamma_{m1}} \text{ or by } \frac{T}{\alpha f_u/\gamma_{m1}}$$

(2) The total gross area is also determined from its yield strength by

$$A_g = \frac{T}{f_y/\gamma_{m0}}$$

(3) from IS Handbook No. 1, ~~A~~ suitable rolled section provided a cross-sectional area ~~having~~ matching with the computed gross-sectional area is selected.

(4) No. of bolts required to make the connection is calculated, & arranged in suitable pattern.

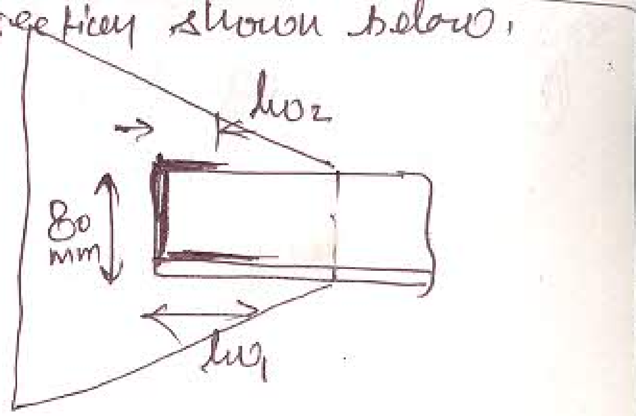
(5) ~~Desig~~ Design strength T_d of the trial section is calculated. This will be minimum of the strengths T_{dg}, T_{dn} & T_{db}. The design strength > factored design load.

(6) The slenderness ratio is checked as per IS specification.

Q.2(c) Design the fillet weld for angle section shown below.

Soln: Total weld length

$= l_{w_1} + l_{w_2} + 80mm$



The strength of weld required = Design strength of the member.

$= 222.27$ KN

Design strength of weld $= T_{dw} = l_w t_e \frac{f_u}{\sqrt{3}\gamma_{mw}} = 1 \times 4.2 \times \frac{410}{\sqrt{3} \times 1.5} = 662.79$ KN

Equating the strength of weld

$(l_{w_1} + l_{w_2} + 80) \times 662.79 = 222.27 \times 10^3$

$l_{w_1} + l_{w_2} = 256$ mm.

NOW, Taking moment about top edge of Angle section

$662.79 \times 80 \times \frac{80}{2} + 662.79 \times l_{w_1} \times 80 = 222.27 \times 10^3 \times (80 - 27.3)$

$l_{w_1} = 181$ mm

Hence, $l_{w_2} = 256 - 181 = 75$ mm