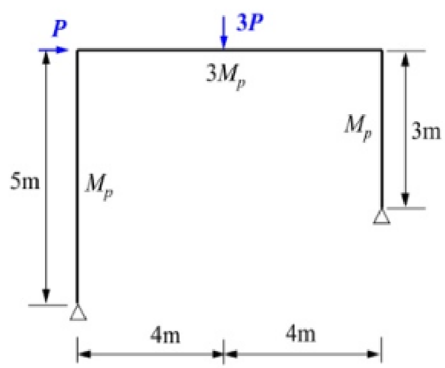
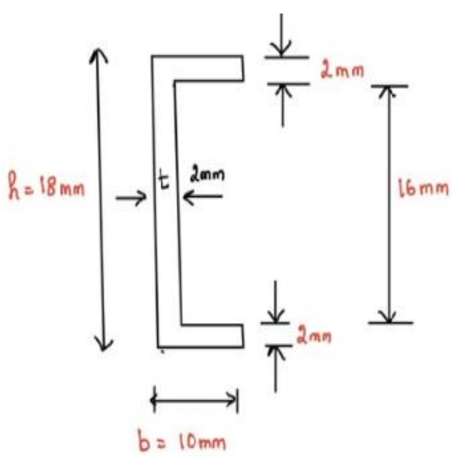
POORNIMA COLLEGE OF ENGINEERING, JAIPUR

DEAPRMENT OF CIVIL ENGINEERING

Campus: PCE Course: B.TECH	Year /Semester: 3rd / 6th	Date: 02/03/2024
Name of Faculty: Balwan	**Name of Lab: Design of Steel Structure**	**Code: 6CE4-04**

Q. No	CO	BL	PO	QUESTIONS	MARKS
1	CO1	1	PO1	Explain various types of bolts used for connection.	10
2	CO2	2	PO1	Compute the true values of collapse load for the portal frame loaded as shown in fig. no. 	10
3	CO2	2	PO2	Determine the plastic and elastic section modulus and shape factor of C section as shown in fig. no. 	10

4	CO3	4	PO2	An l.S.L.C 300 @ 324.7 N/m is used to transmit a force of 575 kN. The channel section is connected to a gusset plate 12 mm thick. Design a fillet weld if the overlap is limited to 300 mm. Use slot welds if required.	15
5	CO4	4	PO11	Design a single bolted double cover butt joint to connect boiler plates of thickness 12 mm for maximum efficiency. Use 16 mm diameter bolts of grade 4.6. Boiler plates are of Fe 410 grade. Find the efficiency of the joint.	15

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Assignment (DoSS)

Q.(1) Explain various types of bolts used for connection.

Ans. 1.) Carriage bolt :- Carriage bolts are used in applications where a smooth finish is required on the surface being connected. They have a smooth, rounded head and a square shank that prevents the bolts from turning when the nut is tightened.

2.) Hex bolts :- It is most common type of bolts used for various applications. They have a hexagonal head and a threaded shank that is fastened with a nut.

3.) Eye bolts :- Eye bolts are with a looped head that is used to attatch cables, ropes or chains for lifting or hanging objects. They are often used in industrial and ~~connecti~~ construction settings.

4.) Lag bolts :- It is also known as lag screws, are heavy duty bolts used for securing heavy object to wood or metal surfaces. They have a coarse thread that provides greater holding power.

5.) U-bolts :- It is used for to secure pipes, tubing and other round objects to flat surfaces. They are commonly used in construction and automotive applications.

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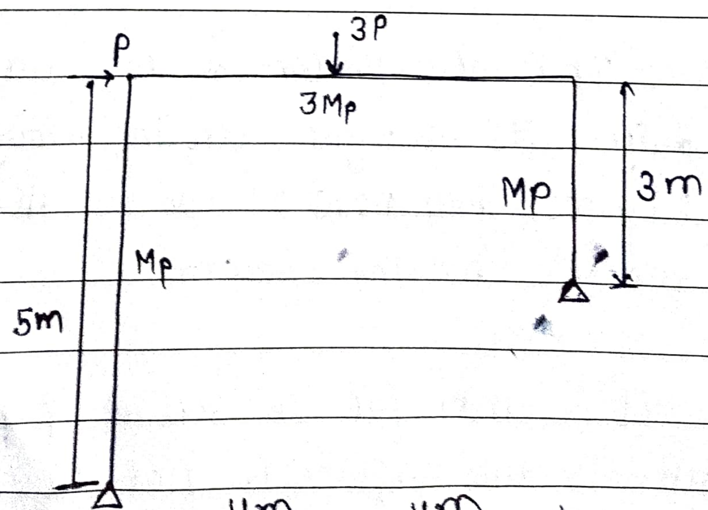
6.) Anchor bolts :- It is used for to secure objects to concrete or masonary surfaces. They have an L-shapped design that is embedded into the surface to provide a secure connections.

7.) Flange bolts :- Flange bolts have a washer like flange under the head that distributes the load over a wider area. This helps to prevent the bolt from loosening due to vibrations or movements.

8.) Stud bolts :- Stud bolts are threaded rods with threads on both ends that are used to connect two separate components. They are often used in conjuction with nuts to create a strong and secure connection.

8.(2) Compute the true value of collapse load for the portal frame loaded as shown in fig.



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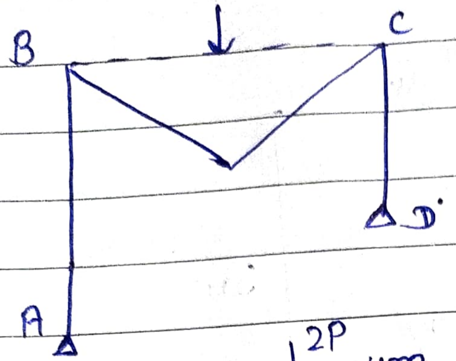
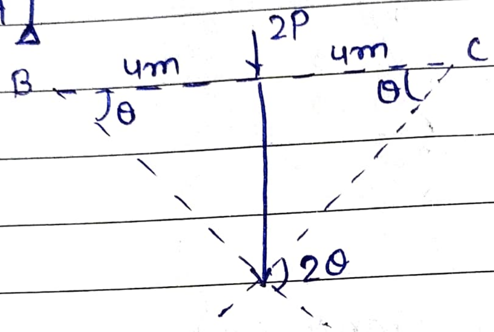
Sol^n.





$$\tan\theta = \frac{\alpha}{3}$$

$$\tan\theta = \theta$$

$$\theta = \frac{x}{3}$$

$$\Rightarrow x = 3\theta$$

Internal work done $= M_p\theta + 2M_p \times 2\theta + M_p\theta$

$= 6M_p\theta$

External work done $= 2P_c \times x = 2P_c \times 3\theta$

$= 6P_c\theta$

$\therefore$ Ext. = Int.

$\Rightarrow 6P_c\theta = 6M_p\theta$

$\Rightarrow P_c = M_p$

$\Rightarrow$ Sway Mechanism :-

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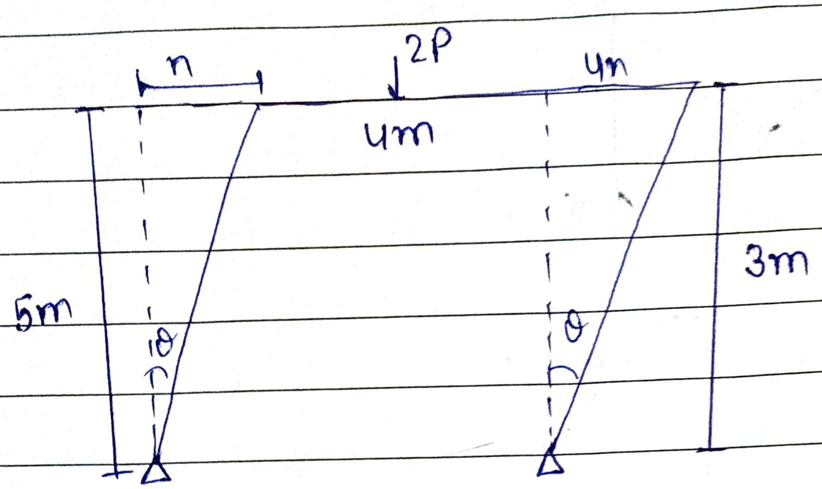


$$\tan\theta = \frac{H}{3}$$

$$\theta = \frac{H}{5} \quad (\because \tan\theta \approx \theta)$$

$\Rightarrow H = 5\theta$

Internal work done = $M_p\theta + M_p\theta = 2M_p\theta$

External work done = $P \times H = P \times 5\theta = 5P\theta$

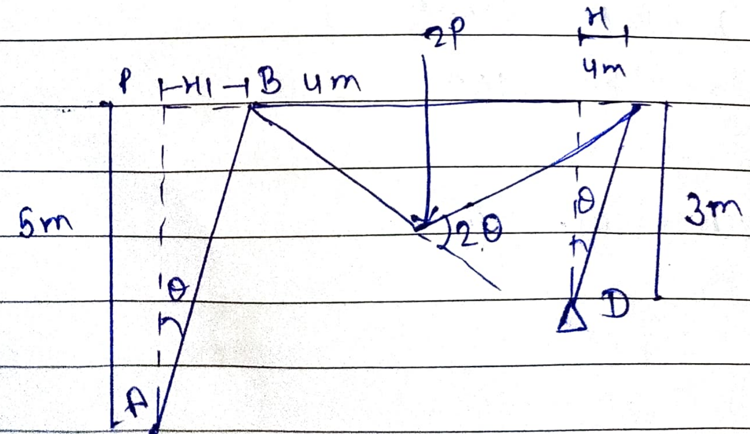
$\therefore$ Internal work done = External work done

$\Rightarrow 2M_p\theta = 5P\theta$

$M_p = \frac{5P}{2} = 2.5P$

$\Rightarrow P = 0.4M_p$

$\Rightarrow$ Combined mechanism :-



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$$\tan\theta = \frac{H_1}{4}$$

$$\theta = \frac{H}{5} \quad (\because \tan\theta \approx \theta)$$

$$\Rightarrow H_1 = 5\theta$$

$$\tan\theta = \frac{H}{4}$$

$$\theta = \frac{H}{4} \quad (\because \tan\theta \approx \theta)$$

$$\Rightarrow H = 4\theta$$

Internal work done $= 2M_p \times 2\theta + M_p(\theta+\theta) = 6M_p\theta$

External work done $= P \times H_1 + 2P \times H$

$= P \times 5\theta + 2P \times 4\theta = 13P\theta$

$\therefore$ Internal work done = External work done

$$6M_p\theta = 13P\theta$$

$$\Rightarrow M_p = \frac{13P}{6} \Rightarrow$$

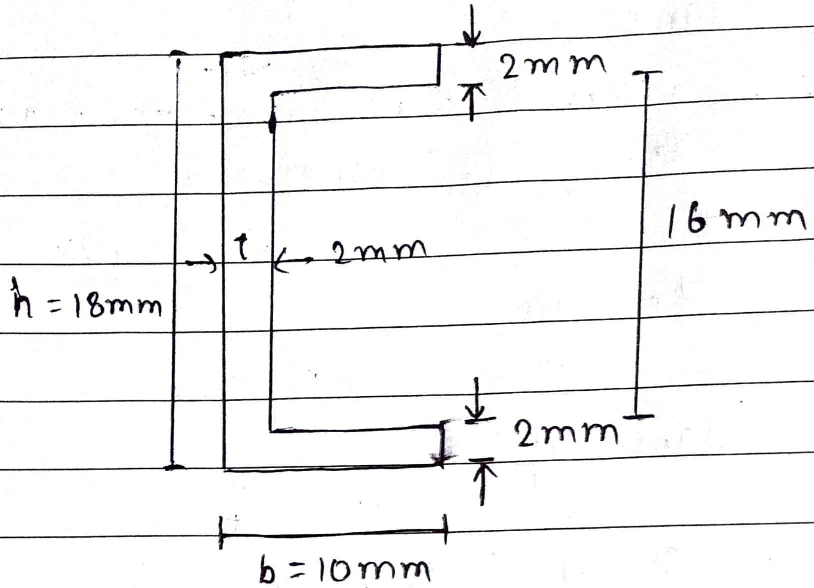
$$P \Rightarrow 0.461 M_p$$

$\therefore$ Combined Mechanism is the real mechanism

True collapse load =

$P = 0.4\ M_p$ (minimum).

Q(3) Determine the plastic and elastic section modulus and shape factor for C section as shown in fig.



Sol^n. Since X-X axis is the axis of symmetry hence it is both equal area axis & centroidal axis
$\bar{y_1}$ & $\bar{y_2}$ are the distance of CG of area above and below equal area axis.

$$\bar{y_1} = \bar{y_2} = \frac{a_1 y_1 + a_2 y_2}{a_1 + a_2}$$

$a_1 = 10 \times 2 = 20mm^2$

$a_2 = 8 \times 2 = 16mm^2$

$y_1 = \frac{8}{2} = 4mm$

$y_2 = \frac{8+2}{2} = 9mm$

$$\therefore \bar{y_1} = \bar{y_2} = \frac{(20 \times 4) + ((16 \times 9)}{(20 + 16)}$$

$= 6.22$

Area of total section $= 2 \times (10 \times 2) + (16 \times 2)$

$= 72 \ mm^2$

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Now plastic section modulus $= \frac{A}{2}(\bar{y_1}+\bar{y_2})$

$$Zp = \frac{72}{2}(6.22 + 6.22)$$

$$Zp = 447.84 \ mm^2$$

MOI of section $= \frac{BD^2}{12} - \frac{bd^2}{12}$

$$I = \frac{10 \times 20^2}{12} - \frac{8 \times 16^2}{12}$$

$$I = 3936 \ mm^4$$

Distance of centroid from extreme fibr

$$y = \frac{20}{2} = 10 \ mm$$

$\therefore$ elastic module section $= \frac{I}{y}$

$$Ze = \frac{3936}{10}$$

$$Ze = 393.6 \ mm^3$$

Shape factor $= \frac{Zp}{Ze}$

$$S = \frac{447.84}{393.6}$$

$$S = 1.1378$$

Q.(4) An I.S.L.C 300 @ 324.7 N/m is used to transmit a force of 575 kN. The channel section is connected to a gusset plate 12 mm thick. Design a fillet weld if the overlap is limited to 300 mm. Use slot weld if required.

Sol^n – Given:- fe = 410 grade

$f_u = 410$ Mpa

$\gamma_{mw} = 1.5$

ISLC 300 @ 324.7 N/m

$A_g = 4211\ mm^2$

$t_f = 11.6$ mm

$t_w = 6.7$ mm

Maximum size of weld = $6.7 - 1.5 = 5.2$ mm

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

Let us provide 5mm size fillet weld

effective throat thickness = KS

$= 0.7 \times 5$

$= 3.5$ mm

Design of strength of weld

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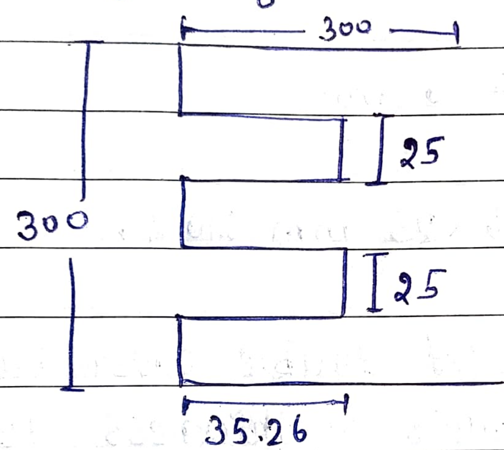
$$P_{dw} = \frac{l_w t_f \times f_u}{\sqrt{3}\,\gamma_{mw}}$$

$$= \frac{1 \times 3.5 \times 410}{\sqrt{3} \times 1.5}$$

strength of weld = 552.33 N/m



length of weld required =

$$l_w = \frac{575 \times 10^3}{552.33} = 1041.04 \text{ mm}$$

Restriction of 300 mm overlap the length of weld that can be provided as

$$= 2 \times 300 + 300$$

$$= 900 \text{ mm} < 1041.04 \text{ mm}$$

Hence provide slot welds,
width of slot = 25 mm

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($3t = 3 \times 6.7 = 20.1$ mm or 25 mm)
which is greater used as width of slot

Let us provide two slots & length of slot be l_1

$1041.04 = 2 \times 300 + 300 + 4 l_1$

$l_1 = 35.26$ mm

Now, provide 35.26×25 mm slots.

Q.(5) Design a single bolted double cover butt joint to connect boiler plate of thickness 12mm for maximum efficiency. Use 16mm ~~thickness~~ dia. bolts of grade 4.6. Boiler plate are of Fe410 grade. Find the efficiency of the joint.

Sol^n -

$Fe = 410$

$f_u = 400$ mPa

$d = 16$ mm

$d_0 = 18$ mm

$f_y = 250$ mpa

$A_{nb} = \frac{\pi}{4} d^2 \times 0.78 = \pi/4 \times (16)^2 \times 0.78 = 157 \text{ mm}^2$

$\gamma_{mb} = 1.25$

$\gamma_{m1} = 1.25$

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Shear strength:-

$t = 12\ mm$

$$V_{dsb} = \frac{2 \times f_u A_{nb}}{\sqrt{3} \times \gamma_{mb}} = \frac{2 \times 400 \times 157 \times 10^{-3}}{\sqrt{3} \times 1.25}$$

$$= 58\ KN$$

Bearing strength:-

$$V_{dsb} = 2.5 \times K_b\, d t \frac{f_y}{\gamma_{mb}}$$

$e = 1.5 \times d_h = 1.5 \times 18 = 30$

$p = 2.25 \times d = 36 = 50$

$$K_b = \frac{e}{3d_h} = \frac{30}{3 \times 18} = 0.55$$

$$\frac{p}{3d_h} - 0.25 = \frac{50}{3 \times 18} - 0.25 = 0.67$$

$$\frac{f_{ub}}{f_u} = 0.975$$

1

$\boxed{K_b = 0.55}$

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$$V_{dsb} = \frac{2.5 \times 0.55 \times 410 \times 10^{-3} \times 8 \times 16}{1.25}$$

$$V_{dsb} = 57.73\ kN$$

Tensile strength -

$$T_{db} = \frac{0.9 f_y A_n}{\gamma_{mb}} = \frac{0.9 f_u (p - d_h) t}{\gamma_{mb}}$$

$$= \frac{0.9 \times 400 \times 10^{-3} (50 - 18) \times 8}{1.25}$$

$$T_{db} = 73.728\ kN$$

$$\text{Strength of solid plate} = \frac{0.9 \times 400 \times 10^{-3} \times (50) \times 8}{\cancel{115.2}\ 1.25}$$

$$= 115.2\ kN$$

$$\text{Efficiency of joint} = \frac{\text{Strength of joint}}{\text{Strength of plate}} \times 100$$

$$= \frac{57.73}{115.2} \times 100$$

$$= 50\ \%$$