Question 1

(a) $s - m = b + r - Dj$

$s - 0 = 10 + 3 - (2 \times 6)$

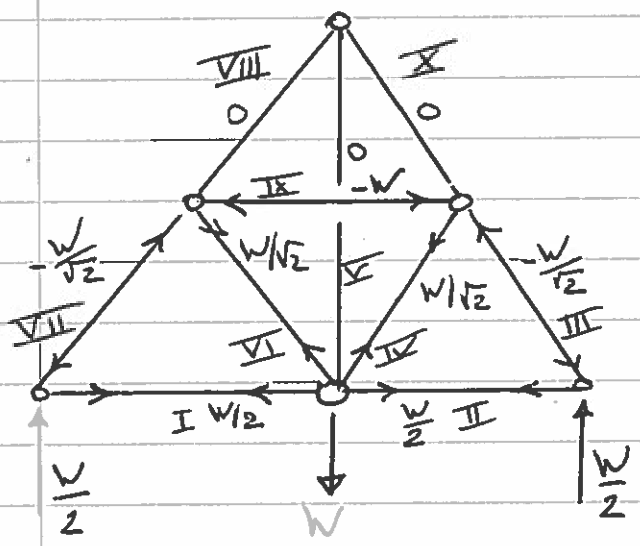
$= 1$ redundancy

→ Alternatively, removing one member, say member V or IX will make the structure statically determinate.

$\therefore \quad \underline{\underline{s = 1}}$

(b) Choose V as redundant.

Particular solution with $t_V = 0$



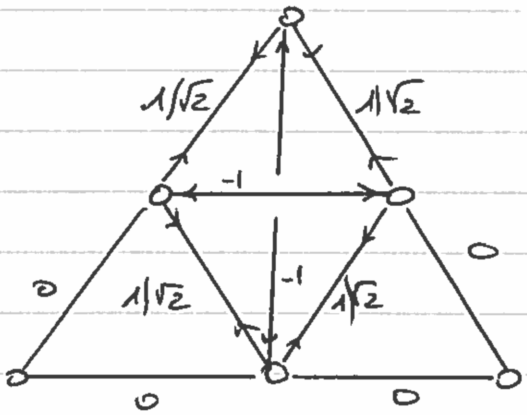
$$\underset{\sim}{t_0} = \frac{W}{2} \cdot \begin{bmatrix} 1 \\ 1 \\ -\sqrt{2} \\ \sqrt{2} \\ 0 \\ \sqrt{2} \\ -\sqrt{2} \\ 0 \\ -2 \\ 0 \end{bmatrix}$$

Lengths:

$$= \frac{L}{\sqrt{2}} \left[\sqrt{2} \quad \sqrt{2} \quad 1 \quad 1 \quad \sqrt{2} \quad 1 \quad 1 \quad 1 \quad \sqrt{2} \quad 1 \right]^T$$

State of self-stress.   JBI Q1/2017/2

$$\underset{\sim}{s} = \frac{1}{\sqrt{2}} \begin{bmatrix} 0 \\ 0 \\ 0 \\ 1 \\ -\sqrt{2} \\ 1 \\ 0 \\ 1 \\ 1 \\ -\sqrt{2} \end{bmatrix}$$



Elastic solution: $\underset{\sim}{t} = \underset{\sim}{t_0} + x . \underset{\sim}{s}$

Bar extension: $\underset{\sim}{e} = \underset{\sim}{F} . \underset{\sim}{t}$

where $\underset{\sim}{F}$ = flexibility matrix:

$$\underset{\sim}{F} = \frac{L}{\sqrt{2}AE} \begin{bmatrix} \sqrt{2} & & & & & & & & & \\ & \sqrt{2} & & & & & & & & \\ & & 1 & & & & & & & \\ & & & 1 & & & & & & \\ & & & & \sqrt{2} & & & & & \\ & & & & & 1 & & & & \\ & & & & & & 1 & & & \\ & & & & & & & 1 & & \\ & & & & & & & & \sqrt{2} & \\ & & & & & & & & & 1 \end{bmatrix}$$

Bar extension: $\underset{\sim}{e} = \underset{\sim}{F}\,\underset{\sim}{t}$

$$\underset{\sim}{e} = \frac{WL}{2\sqrt{2}AE}\begin{bmatrix}\sqrt{2}\\ \sqrt{2}\\ -\sqrt{2}\\ \sqrt{2}\\ 0\\ \sqrt{2}\\ -\sqrt{2}\\ 0\\ -2\sqrt{2}\\ 0\end{bmatrix} + \frac{x.L}{2AE}\cdot\begin{bmatrix}0\\0\\0\\1\\-2\\1\\0\\1\\-2\\1\end{bmatrix}$$

compatibility for $\underset{\sim}{e} \Rightarrow \underset{\sim}{e}\cdot\underset{\sim}{s} = 0$

$$\therefore \frac{WL}{2\sqrt{2}A.E}\cdot\frac{1}{\sqrt{2}}\left(\sqrt{2}+\sqrt{2}+4\right) + \frac{x.L}{2AE}\cdot\frac{1}{\sqrt{2}}\left(1+2\sqrt{2}+1+1+2\sqrt{2}+1\right)$$

$$\frac{WL}{4AE}\left(2\sqrt{2}+4\right) + \frac{xL}{2\sqrt{2}AE}\left(4\sqrt{2}+4\right) = 0$$

$$\Rightarrow x = -\frac{W}{\sqrt{2}}\frac{\left(2\sqrt{2}+4\right)}{\left(4\sqrt{2}+4\right)} = \underline{\underline{-\frac{W}{2}}}$$

$\Rightarrow$ bar forces $\left(\underset{\sim}{t} = \underset{\sim}{t_0} + x.\underset{\sim}{s}\right)$

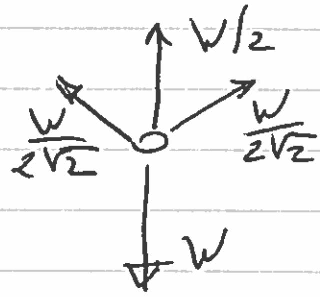
$$= \frac{W}{2}\begin{bmatrix}1\\1\\-\sqrt{2}\\ \sqrt{2}\\ 0\\ \sqrt{2}\\ -\sqrt{2}\\ 0\\ -2\\ 0\end{bmatrix} - \frac{W}{2\sqrt{2}}\begin{bmatrix}0\\0\\0\\1\\-\sqrt{2}\\1\\0\\1\\-\sqrt{2}\\1\end{bmatrix} = \frac{W}{2}\begin{bmatrix}1\\1\\-\sqrt{2}\\1/\sqrt{2}\\1\\1/\sqrt{2}\\-\sqrt{2}\\-1/\sqrt{2}\\-1\\-1/\sqrt{2}\end{bmatrix}$$

Alternative simple method: IB/2017/21/4

consider joint A
vertical component of stiffness of members IV and VI

$$\frac{L}{\sqrt{2}AE}\cdot\frac{1}{\sqrt{2}} = \frac{L}{2AE}$$

This is half that of member V
∴ Vertical
W is distributed as shown:



from this solve the members
by resolving at joints.

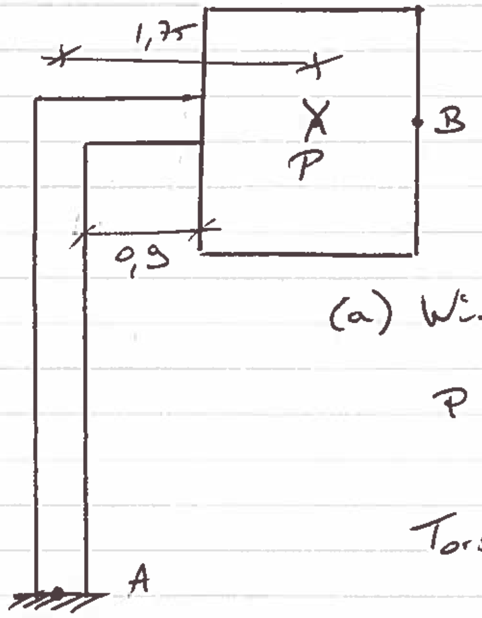
(c) Vertical displacement: $\delta_v = \underset{\sim}{e}\cdot\underset{\sim}{t}$

$$= \frac{WL}{2AE}\begin{bmatrix}1\\1\\-1\\1/2\\1\\1/2\\-1\\1/2\\-1\\-1/2\end{bmatrix}\cdot\frac{1}{2}\begin{bmatrix}1\\1\\-\sqrt{2}\\1/\sqrt{2}\\1\\1/\sqrt{2}\\-\sqrt{2}\\-1/\sqrt{2}\\-1\\-1/\sqrt{2}\end{bmatrix} = \frac{WL}{4AE}\cdot\left(4+2\sqrt{2}+\frac{4}{2\sqrt{2}}\right).$$

$$= \underline{\underline{\frac{WL}{4AE}\cdot\left(4+3\sqrt{2}\right)}}$$

Question 2

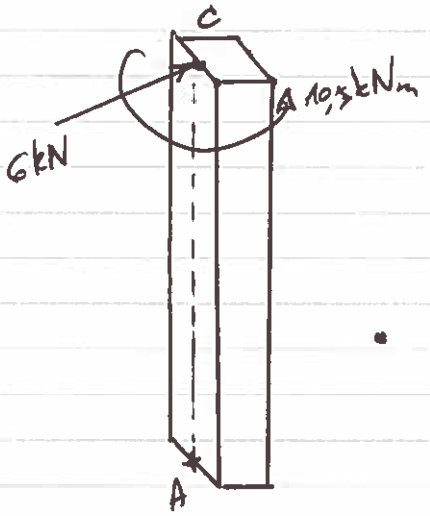
IB/2017/Q2/1



(a) Wind load on sign: P

$$P = 2m \times 1{,}5m \times 2kPa = 6kN$$

Torsion : $6kN \times 1{,}75m = 10{,}5\,kNm$.



deflection :

- bending AC
- bending CB
- torsion AC.

- bending in AC:

$$\delta_{AC} = \frac{6.10^3 \cdot 5^3}{3EI} = \frac{250\,000}{EI}$$

- bending in CB:

=

$$w = 2m \times 2kPa = 4kN/m$$

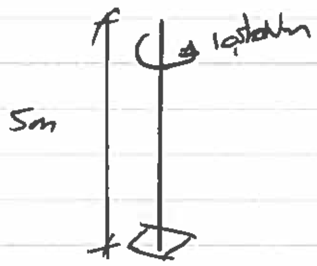
$$\therefore \delta_{CB} = \frac{wL^4}{8EI} - \left[\frac{wL'^4}{8EI} + \frac{w.L'^3}{6EI}.L''\right]$$

$$= \frac{4.10^3 \cdot 2{,}4^4}{8EI} - \left[\frac{4.10^3 \cdot 0{,}9^4}{8EI} - \frac{4.10^3 \cdot 0{,}9^3}{6EI} \cdot 1{,}5\right]$$

$$= \frac{1}{EI}\left(16\,588{,}8 - 328{,}05 - 729\right)$$

$$= \frac{15531{,}75}{EI}$$

• Torsion in AC :



$$\phi = \frac{T \cancel{L}}{G.J} \qquad G = \frac{E}{2(1+\nu)}$$

$$= \frac{210.10^9}{2(1+0{,}3)} = 81{,}6 \text{ GPa}$$

$$\phi = \frac{10{,}5.10^3}{GJ} \text{ Nm}$$ ← rotation per unit length

$$\therefore \delta = \frac{10{,}5.10^3}{GJ} . 5 . 2{,}5 = \frac{131{,}25.10^3}{GJ}$$

∴ Total deflection :

$$= \frac{250\,000}{EI} + \frac{15531}{EI} + \frac{131{,}25.10^3}{GJ}$$

$$= \frac{265\,531}{EI} + \frac{131{,}25.10^3}{GJ}$$

$E = 210.10^9 \text{ N/m}^2$

$G = 81.10^9 \text{ N/m}^2$

I for thin walled square (or derive equation)

$$I = \frac{2}{3} t . L^3 = 5{,}3.10^{-3} t \text{ m}^4$$

$$J = \frac{4 . A_e^2}{\int \frac{ds}{t}} = \frac{4.(0{,}2^2)^2 . t}{0{,}8} = 8.10^{-3} t \text{ m}^4$$

IB/2d7/Q2)3

$$\delta = \frac{265531}{210.10^3 . 5{,}3.10^{-3}\, t} + \frac{131{,}25.10^3}{81.10^3 . 8.10^{-3}\, t}$$

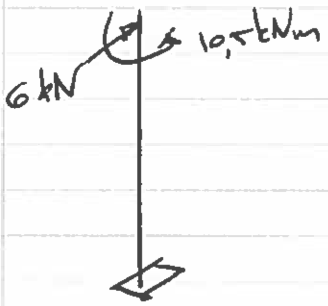
$$= \frac{2{,}3723.10^{-4}}{t}\, m + \frac{2{,}025.10^{-4}}{t}\, m$$

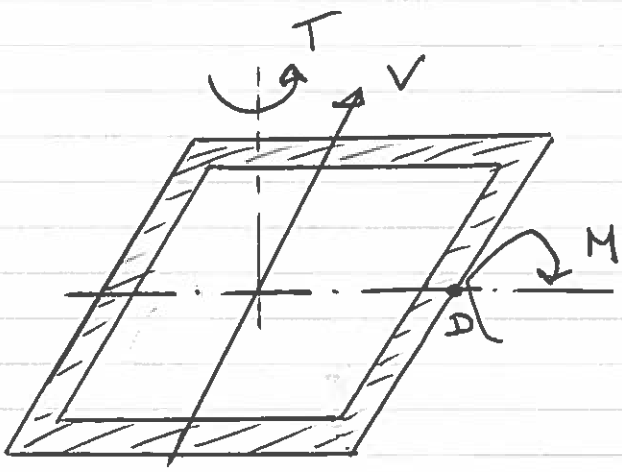
$$= \frac{4{,}3973.10^{-4}}{t}\, m$$

$\rightarrow \delta = 0{,}15\, m \Rightarrow t = \frac{4{,}3973.10^{-4}}{0{,}15}\, m = 0{,}00293\, m$

$\simeq \underline{\underline{3mm}}$

b)





∴ At base: $T = 10{,}5\, kNm$
$M = 6\, kN . 5m = 30\, kNm$
$V = 6\, kN$

$$I = \frac{2}{3} b^3 . t = \frac{2}{3} . 0{,}2^3 . 0{,}01 = 5{,}33.10^{-5}\, m^4$$

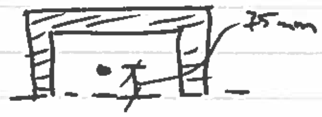
- Compressive stress due to bending:
  - in A: $\sigma = \frac{M.y}{I} = \frac{30.10^3 . 0{,}1}{5{,}33.10^{-5}} = 56{,}6\, MPa$
  - in D: $\sigma = 0\, MPa$

- Shear stress due to shear force:

At D: $$\tau_v = \frac{V.\,A_c.\,\bar{y}}{I.\,2t}$$

$$= \frac{6.10^3 N \,.\, 0{,}8.\frac{0{,}01}{2}\,.\,0{,}075}{5{,}33.10^{-5}.\,2.\,0{,}01}$$

$$= 1{,}66 \text{ MPa}$$



$$\bar{y} = \frac{[200\times10\times100 + 2(100\times10\times50)]}{400\times10} = 75\text{mm}$$

At A: $\tau_v = 0$

- Shear stress due to torsion at A & at D:

$$\tau_T = \frac{T}{2A_c.\,t} = \frac{10{,}5.10^3}{2.\,0{,}2^2.\,0{,}01}$$

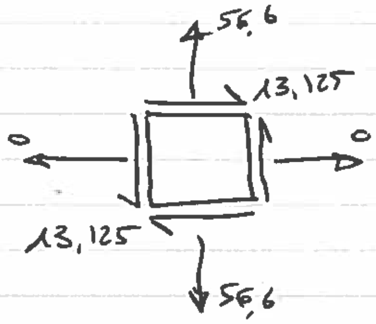
$$= 13{,}125 \text{ MPa}$$

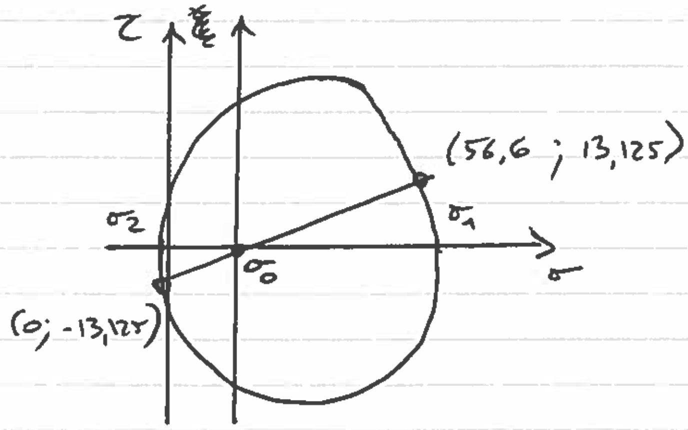
$\therefore$ Total shear stress:

at A: 13,125 MPa

at D: 14,792 MPa

At A:





$$\sigma_0 = \frac{56,6}{2} = 28,33 \text{ MPa}$$

$$\sigma_1 = 28,33 + \sqrt{28,53^2 + 13,125^2} = 59,55 \text{ MPa}$$

$$\sigma_2 = 28,33 - \sqrt{28,33^2 + 13,125^2} = -2,892 \text{ MPa}$$

von Mises:

$$(\sigma_1 - \sigma_2)^2 + (\sigma_2 - \sigma_3)^2 + (\sigma_3 - \sigma_1)^2 = 2\sigma_y^2$$

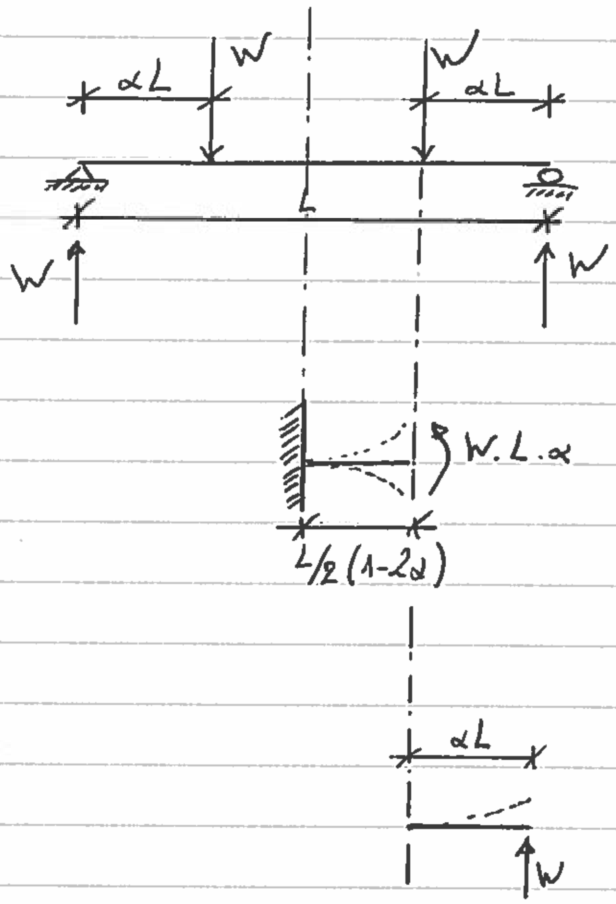
moment starts to yield:

$$= \sqrt{\frac{2 \cdot 460^2}{(59,55 + 2,892)^2 + 2,89^2 + 59,55^2}}$$

$$= 7,53 \quad (\times 2 \text{ kPa} = \underline{\underline{15,07 \text{ kPa}}})$$

Question 3

(a)



Through derivation of bending moment line or using databook:

$$\therefore \theta_{B_1} = \frac{M.l}{EI}$$

$$= W\alpha L . \frac{L}{2}(1-2\alpha) . \frac{1}{EI}$$

$$= \frac{\alpha W . L^2 (1-2\alpha)}{2EI}$$

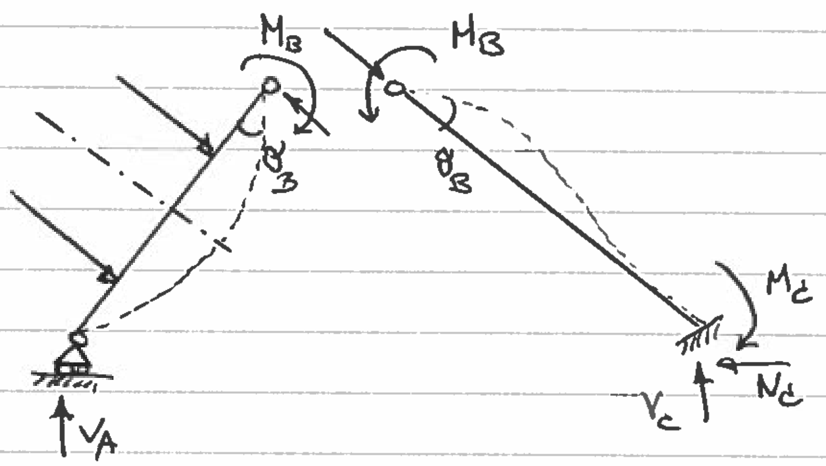
$$\theta_{B_2} = \frac{W . l^2}{2.E.I}$$

$$= \frac{W . \alpha^2 . L^2}{2EI}$$

$$\therefore \theta_B = \theta_{B_1} + \theta_{B2}$$

$$= \frac{\alpha W . L^2}{2EI} . (1-2\alpha+\alpha) = \frac{\alpha . W . L^2 (1-\alpha)}{2EI}$$

(b) i) insert pin at point B:



BC: $\theta_B = \dfrac{M_B \cdot L}{EI}$

AB: $\theta_B = -\dfrac{M_B \cdot L}{3EI} + \dfrac{W\alpha \cdot L^2}{2EI}(1-\alpha)$

Compatibility of rotations at B:

$$\frac{M_B L}{EI} = -\frac{M_B \cdot L}{3EI} + \frac{W\alpha L^2}{2EI}(1-\alpha)$$

$$\therefore \quad M_B = \frac{3W\alpha L(1-\alpha)}{8}$$

- Moments around B for AB:

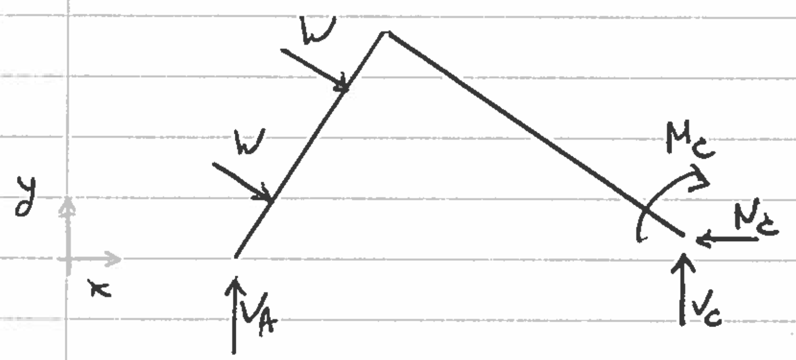
$$-M_B - \frac{V_A \cdot L}{\sqrt{2}} + 2 \cdot W \cdot \frac{L}{2} = 0$$

sub for M_B:

$$-\frac{3W\alpha L(1-\alpha)}{8} - \frac{V_A \cdot L}{\sqrt{2}} + WL = 0$$

$$\therefore \quad V_A = \sqrt{2}\, W \left(1 - \frac{3}{8}\alpha(1-\alpha)\right)$$

- Consider free body:



Vertical equilibrium

$$\Sigma F_y = 0$$

$$V_c = \frac{2W}{\sqrt{2}} - V_A$$

$$= \sqrt{2} \cdot W - V_A$$

IB/2017/Q3/3

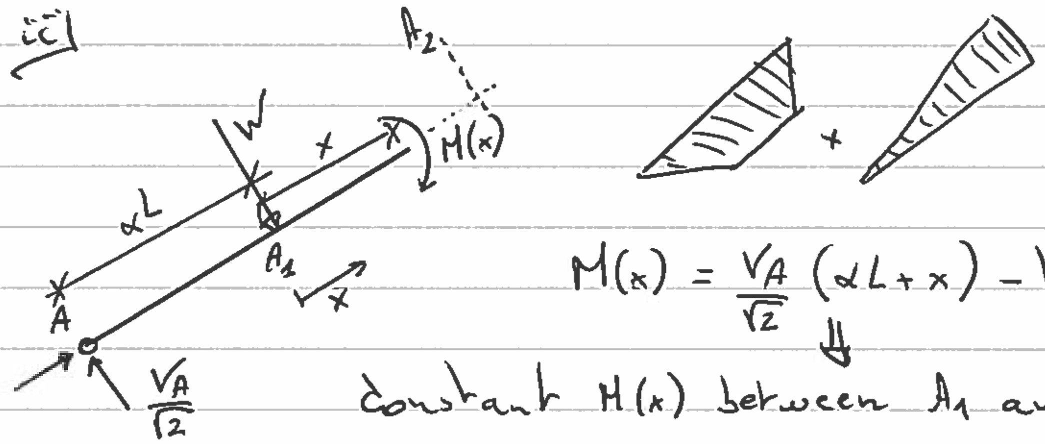
$$\therefore\ V_C = \frac{3\sqrt{2}}{8} W.\alpha.(1-\alpha)$$

$\Sigma F_x = 0 \qquad H_C = \frac{2W}{\sqrt{2}} = \sqrt{2}\,W$

and also:

$$M_C = M_B = \frac{3W\alpha L(1-\alpha)}{8}$$

ii c)



$$M(x) = \frac{V_A}{\sqrt{2}}(\alpha L + x) - W.x$$

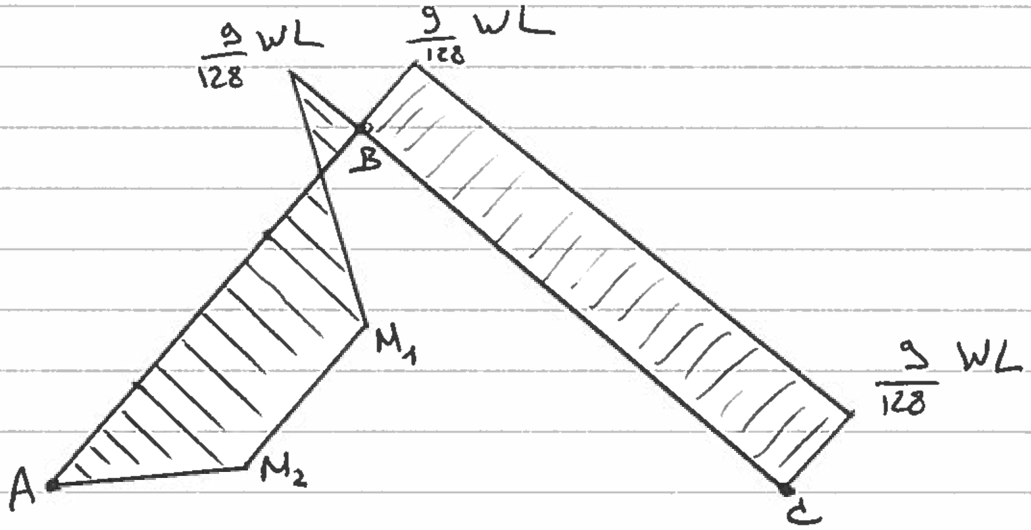
$\Downarrow$

constant M(x) between A_1 and A_2:

$$A_1 \leq x \leq A_2: \quad M(x) = \frac{V_A}{\sqrt{2}}\alpha L - M_B$$

$$= W\alpha L\left(1 - \frac{3}{8}\alpha(1-\alpha)\right) - M_B$$

$$M_B = \frac{3W\alpha L(1-\alpha)}{8} = \frac{3WL}{4.8}\left(\frac{3}{4}\right) = \frac{9}{128}WL$$



IB/2017/Q3/4

$$M_1 = \frac{WL}{4}\left(1 - \frac{3}{8}\cdot\frac{1}{4}\cdot\frac{3}{4}\right) - \frac{9}{128}WL\cdot\frac{3}{4}$$

$$= \frac{WL}{4}\left(1 - \frac{9}{128}\right) - \frac{WL}{4}\left(\frac{27}{128}\right)$$

$$= \frac{WL}{4}\left(1 - \frac{36}{128}\right) = \frac{WL}{4}\left(\frac{23}{32}\right) = \underline{\underline{\frac{96}{256}WL}}$$

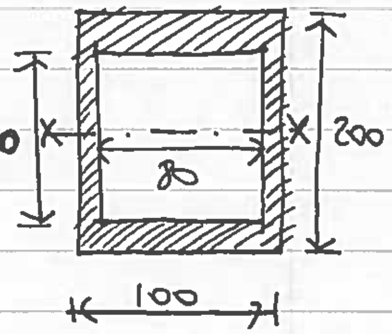
$$M_2 = \frac{WL}{4}\left(1 - \frac{9}{128}\right) - \frac{9}{128}WL\left(\frac{1}{4}\right)$$

$$= \frac{WL}{4}\left(1 - \frac{9}{128}\right) - \frac{WL}{4}\left(\frac{9}{128}\right)$$

$$= \underline{\underline{\frac{55}{256}WL}}$$

4 a) $Z_e = I_{xx}/y = \left(100 \times 200^3/12 - 80 \times 160^3/12\right)/100$

2 $= \underline{\underline{3.94 \times 10^5 \text{ mm}^3}}$

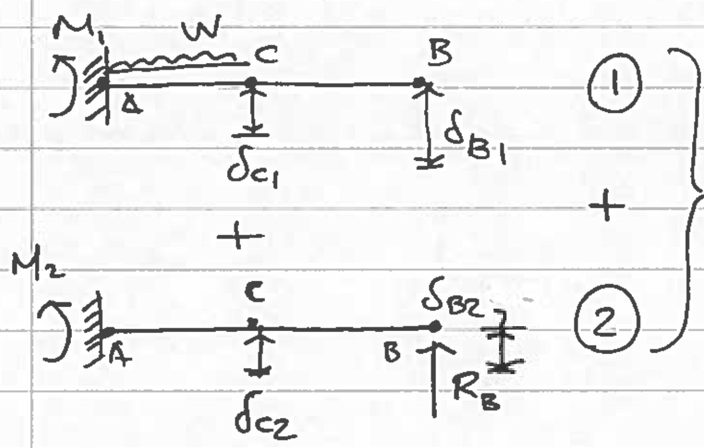


2 $Z_p = \sum |Ay| = 2(100 \times 20 \times 90) + 4(80 \times 10 \times 40)$

$= \underline{\underline{4.88 \times 10^5 \text{ mm}^3}}$

b) ELASTIC BENDING MOMENT CAPACITY (AT FIRST YIELD):

$M_e = Z_e \sigma_y = 3.94 \times 10^5 \times 355 = 139.87 \text{ kNm}$



STANDARD DATABOOK CASES

COMPATIBILITY : $\delta_{B1} + \delta_{B2} = 0$

$M_1 = WL/4$

$\delta_{C1} = W\left(\frac{L}{2}\right)^3 \frac{1}{8EI} = WL^3/64EI$

$\delta_{B1} = \underbrace{WL^3/64EI}_{\text{DEFLECTION AT C}} + \left(\underbrace{W\left(\frac{L}{2}\right)^2 \frac{1}{6EI}}_{\text{ROTATION AT C}} \times \frac{L}{2}\right) = 7WL^3/192EI$

$\delta_{B2} = -R_B L^3/3EI$

COMPATIBILITY $\Rightarrow \delta_{B1} + \delta_{B2} = 0$

$\therefore R_B L^3/3EI = 7WL^3/192EI$

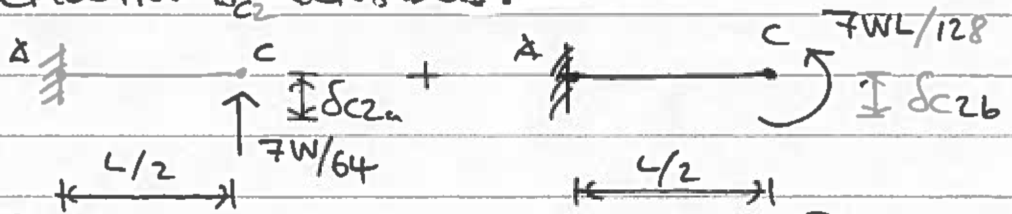
$\therefore R_B = 7W/64 \Rightarrow M_2 = -7WL/64$

5 AT CLAMPED SUPPORT: $M_e = M_1 + M_2 = WL/4 - 7WL/64 = 9WL/64$

$\therefore$ LOAD AT FIRST YIELD: $W_e = 64 M_e/9L$

$= 64 \times 139.87/9L = \underline{\underline{\dfrac{994.6}{L} \text{ kN [m]}}}$

FOR DEFLECTION δ_{c2} CONSIDER :



$$= -\left[\frac{7W}{64}\left(\frac{L}{2}\right)^3\frac{1}{3EI} + \frac{7WL}{128}\left(\frac{L}{2}\right)^2\frac{1}{2EI}\right] = -\frac{35\,WL^3}{3072EI}$$

$$\delta_c = \delta_{c1} + \delta_{c2} = WL^3/64EI - 35WL^3/3072EI$$

$$= 13WL^3/3072EI$$

$\therefore$ DEFLECTION δ AT FIRST YIELD AT CLAMPED SUPPORT :

$$\delta_c = \frac{13 \times 994.6 \times 10^3 \times L^3}{L \times 3072 \times 210 \times 10^3 \times 3.94 \times 10^7} \quad \text{(ALL IN N; mm)}$$

$$= 5.09 \times 10^{-10}\, L^2 \text{ (mm)}$$

$$= \underline{\underline{5.09 \times 10^{-4}\, L^2 \text{ (m)}}}$$

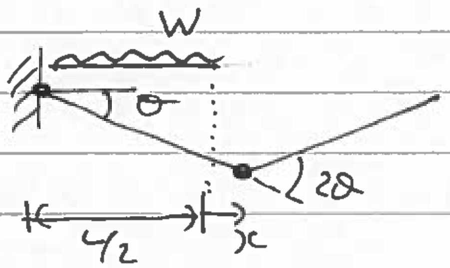
c) MOMENT AT CLAMPED SUPPORT $M = 9WL/64$ (FROM PART (b))

PLASTIC MOMENT CAPACITY $M_p = Z_p \sigma_y = 4.88 \times 10^5 \times 355 = 173.24$ kNm

$\therefore$ LOAD AT PLASTIC MOMENT : $W_p = 64M_p/9L$

$$= 64 \times 173.24/9L = \underline{\underline{\frac{1231.9 \text{ kN}}{L}}} \text{ [m]}$$

d)



WHEN $x = 0$

$$\frac{WL\theta}{4} = 3M_p\theta$$

$$\therefore W = 12M_p/L$$

NOTE FOR $0 < x < L/2$

$$W > 12M_p/L$$

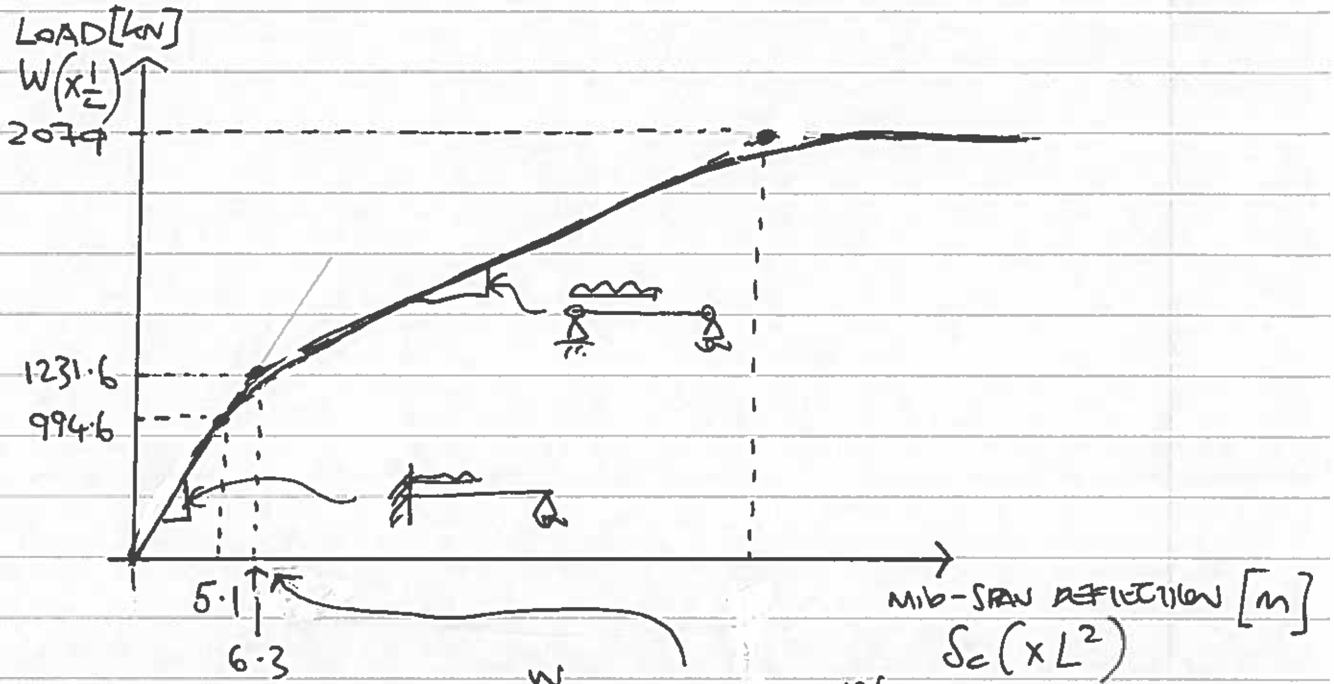
$\therefore$ PLASTIC HINGE AT $x = 0$

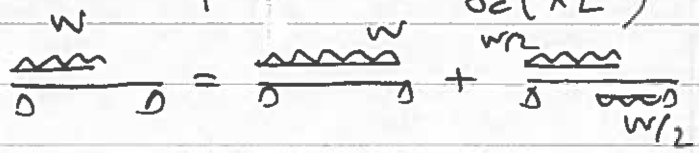
PROVIDES LOWEST UPPER BOUND.

$$\therefore W = 12 \times 173.24/L$$

$$= \underline{\underline{\frac{2079 \text{ kN}}{L}}} \text{ [m]}$$

e)



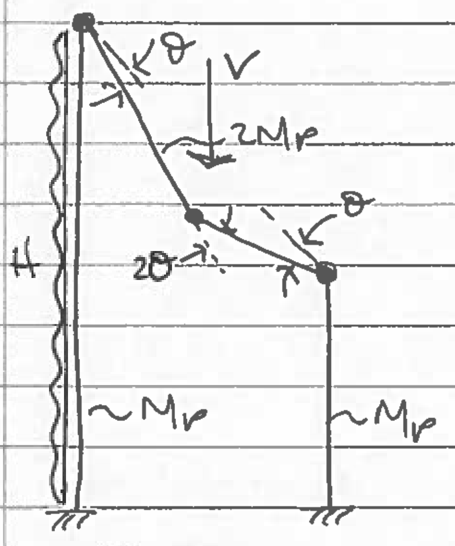


$$= 5WL^3/384EI + 0$$

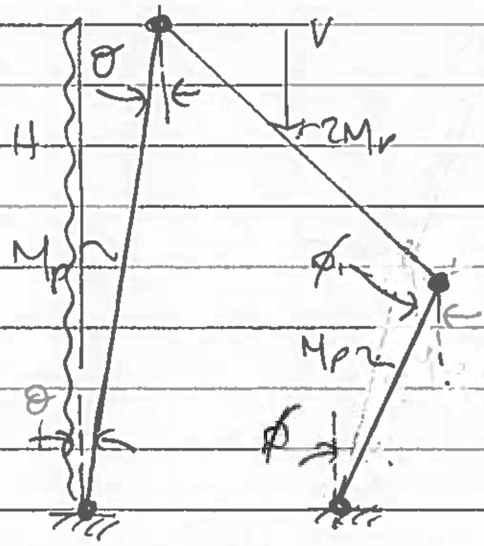
$$= \frac{5 \times 1232 \times 10^3 L^3}{384 \times L \times 210 \times 10^9 \times 3.94 \times 10^{-5}}$$

$$= \underline{\underline{19.4 \times 10^{-4}}}\ L^2$$

5 a) & b)



I BEAM



$2L\theta = L\phi$

$\therefore \phi = 2\theta$

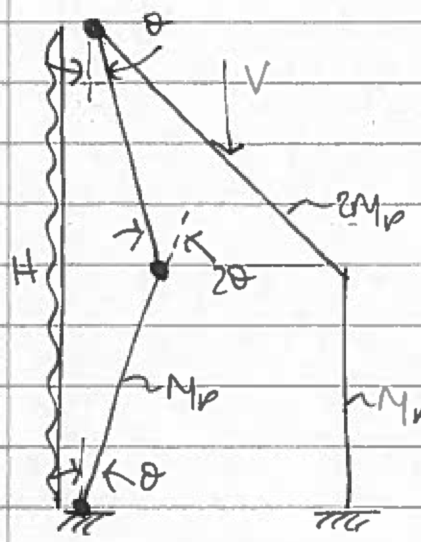
II SWAY

$V\frac{L}{2}\theta = \left[(2M_p)2\theta + M_p 2\theta\right]$

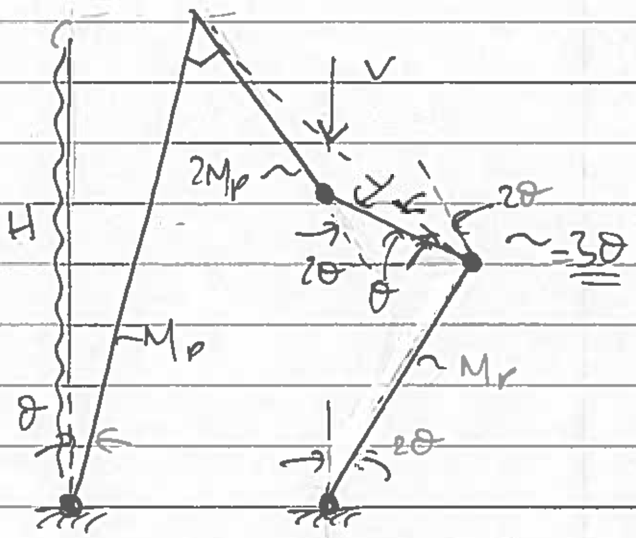
$\therefore V = 12M_p/L$

$2HL\theta/2 = 6M_p\theta$

$\therefore H = 6M_p/L$



III COLUMN



IV COMBINED (B+S)

$HL\theta/2 = 4M_p\theta$

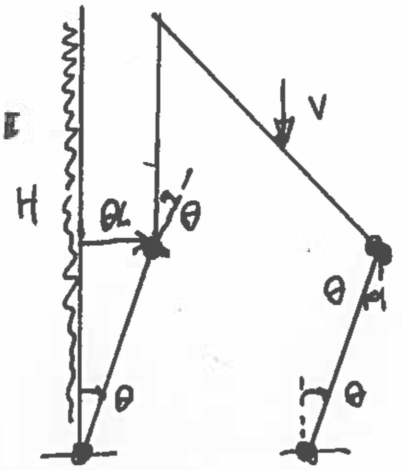
$\therefore H = 8M_p/L$

$HL\theta + VL\theta/2 = M_p(2\theta + 3\theta + \theta) + 2M_p 2\theta$

$\therefore 2H + V = 20M_p/L$

V

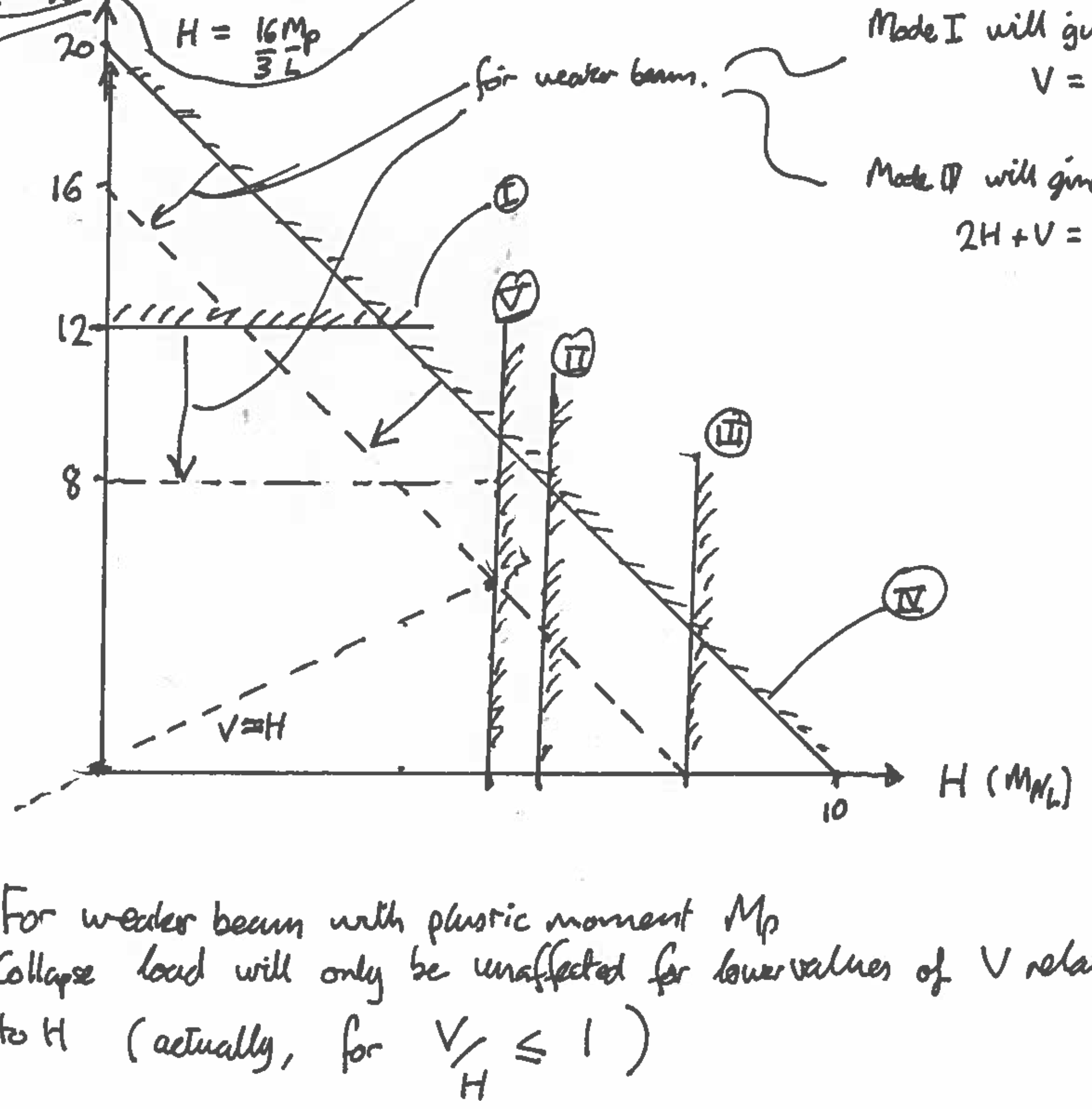
(combined II C+S)



Alternative Mechanisms with same pin positions are plausible (e.g ) but none are critical.

(b,c) $\frac{H}{2}\cdot\frac{\theta L}{2} + \frac{H}{3}\cdot\theta L = 4M_p\theta$

$H = \frac{16}{3}\frac{M_p}{L}$



Mode I will give $V = 8\frac{M_p}{L}$

Mode II will give $2H + V = 16\frac{M_p}{L}$

For weaker beam with plastic moment M_p
Collapse load will only be unaffected for lower values of V relative to H (actually, for $V/H \le 1$)

6 a) YIELD LINES DIVIDE SLABS INTO RIGID PLANAR REGIONS WHERE EACH REGION ROTATES ABOUT ITS UNIQUE AXIS. THE BENDING MOMENT NORMAL TO A YIELD LINE IS EQUAL TO THE PLASTIC BENDING MOMENT CAPACITY OF THE PLATE IN QUESTION.

IN ORDER TO SATISFY COMPATIBILITY:

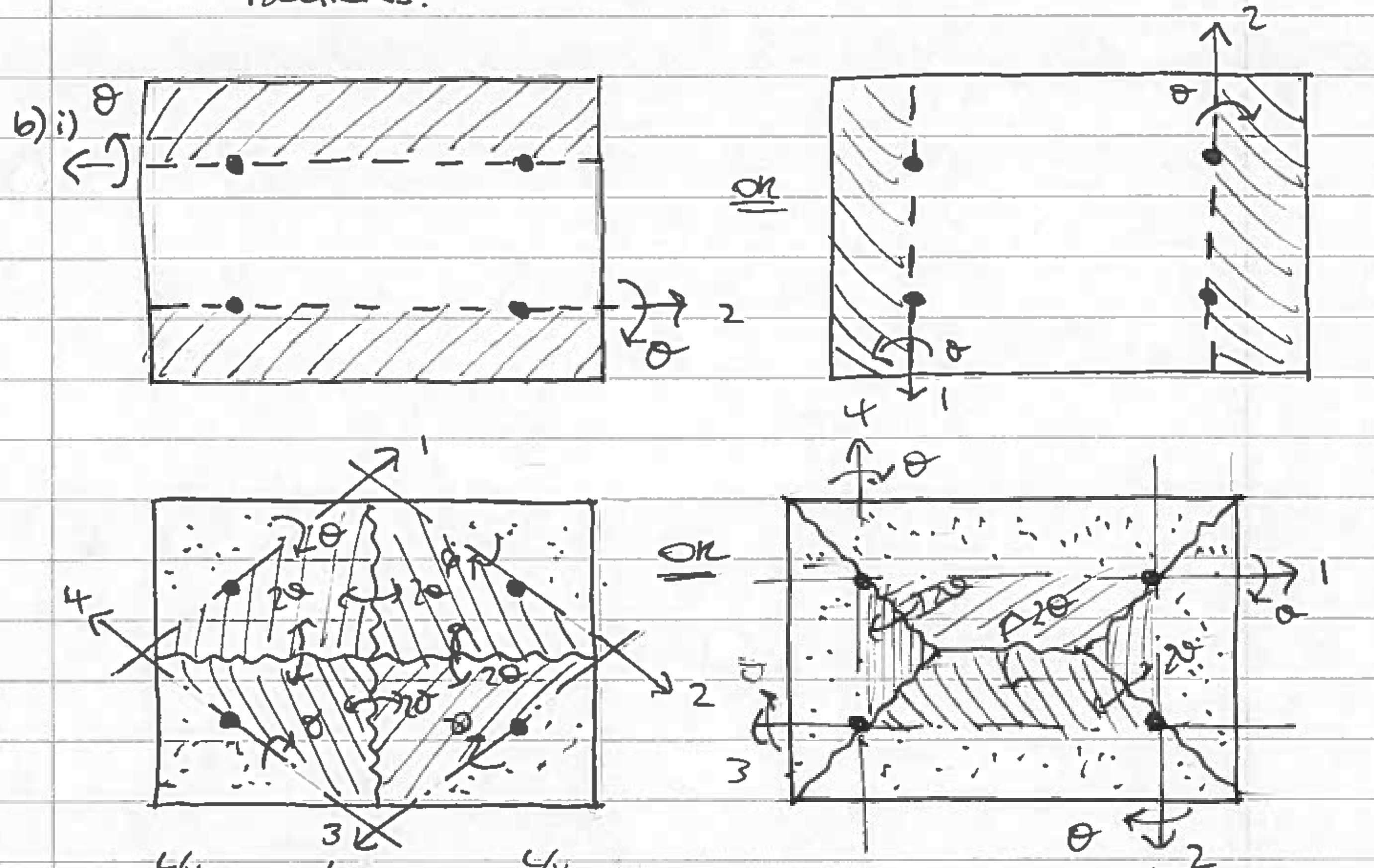
3

(i) YIELD LINES ARE STRAIGHT

(ii) A YIELD LINE BETWEEN REGIONS PASSES THROUGH THE INTERSECTION OF THE AXES OF ROTATION OF THE TWO REGIONS.

b) i)

2



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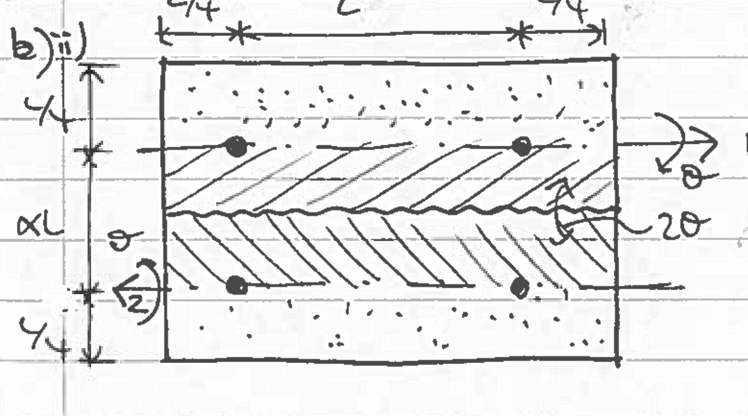
b) ii)

3



$m\frac{3L}{2}\cdot 2\theta$

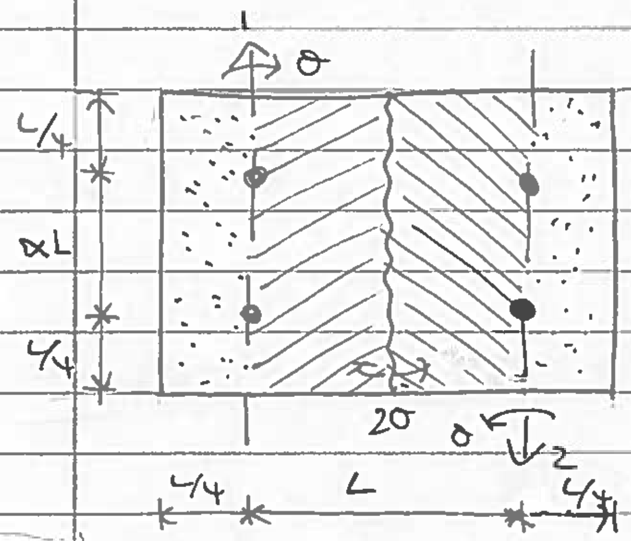
$= 2\Big[w\frac{3L}{2}\cdot\frac{\alpha L}{2}\cdot\frac{\alpha L\theta}{2}\cdot\frac{1}{2}$

$w\frac{3L}{2}\cdot\frac{L}{4}\cdot\frac{L\theta}{4}\cdot\frac{1}{2}\Big]$

$$\therefore mL\theta = wL^3\theta\left(\frac{\alpha^2}{8} - \frac{1}{32}\right)$$

$$\therefore w = \frac{32m}{L^2(4\alpha^2-1)} \qquad \text{(b)}$$

or $W = \dfrac{24m}{(2\alpha-1)}$



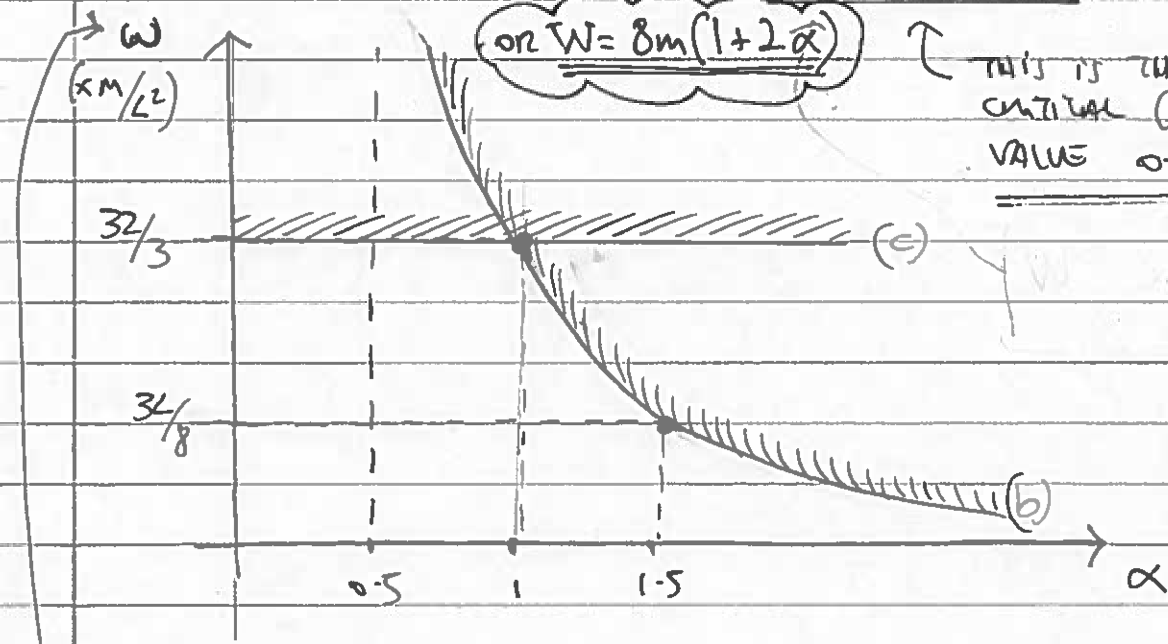
$$mL\left(\alpha+\tfrac{1}{2}\right)2\theta = 2\left[wL\left(\alpha+\tfrac{1}{2}\right)\frac{L}{2}\cdot\frac{L\theta}{2}\cdot\frac{1}{2} - wL\left(\alpha+\tfrac{1}{2}\right)\cdot\frac{L}{4}\cdot\frac{L\theta}{4}\cdot\frac{1}{2}\right]$$

$$\therefore m = \frac{wL^2}{8} - \frac{wL^2}{32}$$

$$\therefore w = \frac{32m}{3L^2} \quad \text{— (c)}$$

or $W = 8m(1+2\alpha)$

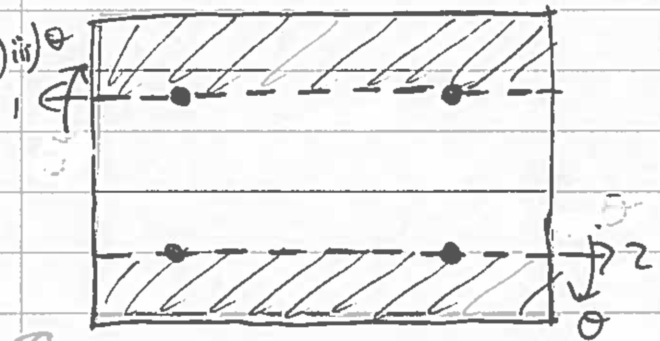
THIS IS THE CRITICAL (LOWEST) VALUE $0.5 \leq \alpha \leq 1$



$\therefore$ OPTIMUM VALUE OF α (TO MAXIMISE w) IS $\alpha \leq 1$

NOTE: $W = \dfrac{3wL^2}{4}(1+2\alpha)$

b) iii)



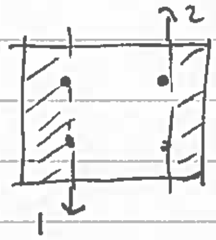
$$2m\frac{3L}{2}\cdot\theta = 2\left[\frac{3L}{2}\cdot\frac{L}{4}w\cdot\frac{L\theta}{4}\cdot\frac{1}{2}\right]$$

$$\therefore mL\theta = wL^3\theta/32$$

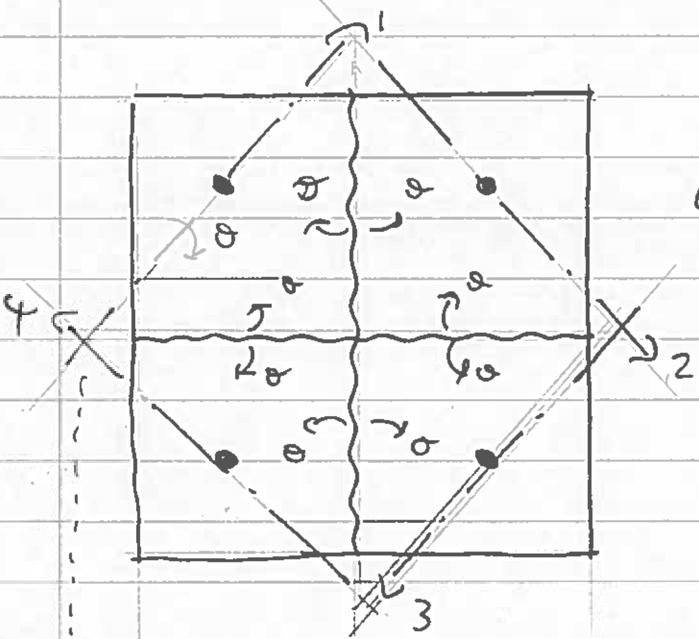
$$\therefore w = 32m/L^2 \quad \text{— (d)}$$

or $\overline{W} = 72m$

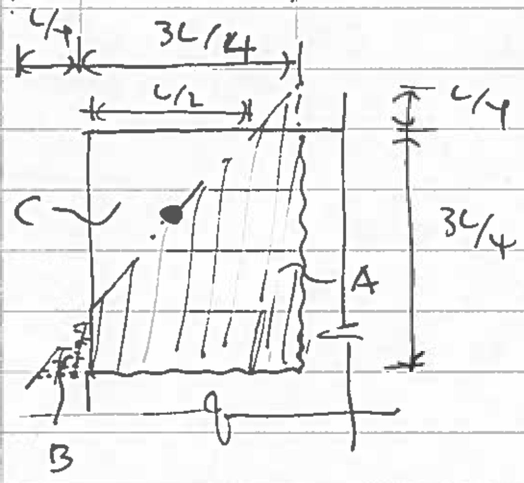
NOTE THIS IS EQUIVALENT TO:



WHEN $\alpha = 1$.



$$4\left(2m\theta\,3L/4\right) = 4\Big[\overbrace{L\cdot\frac{L}{2}\cdot w\cdot\frac{L\theta}{\sqrt{2}}\cdot\frac{1}{3}}^{A} \overbrace{-2\frac{L}{4}\cdot\frac{L}{4}\cdot\frac{1}{2}\cdot w\cdot\frac{L\theta}{4\sqrt{2}}\cdot\frac{1}{3}}^{B} \underbrace{-\frac{L}{2}\cdot\frac{L}{2}\cdot\frac{1}{2}\cdot w\cdot\frac{L\theta}{2\sqrt{2}}\cdot\frac{1}{3}}_{C}\Big]$$

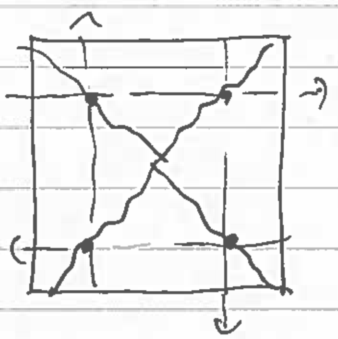


$$\therefore \frac{3mL\theta}{2} = \frac{wL^3\theta}{6\sqrt{2}} - \frac{wL^3\theta}{192\sqrt{2}} - \frac{wL^3\theta}{48\sqrt{2}}$$

$$\therefore \frac{3m}{2} = \frac{27wL^2}{192\sqrt{2}}$$

$$\therefore w = \frac{32\sqrt{2}m}{3L^2} \quad \text{or } \overline{W} = 8\sqrt{2}m$$

NOTE:



$\Rightarrow w \to \infty$

$\therefore w = 32m/3L^2$ (MECHANISM C DOMINATES)