

Question 1

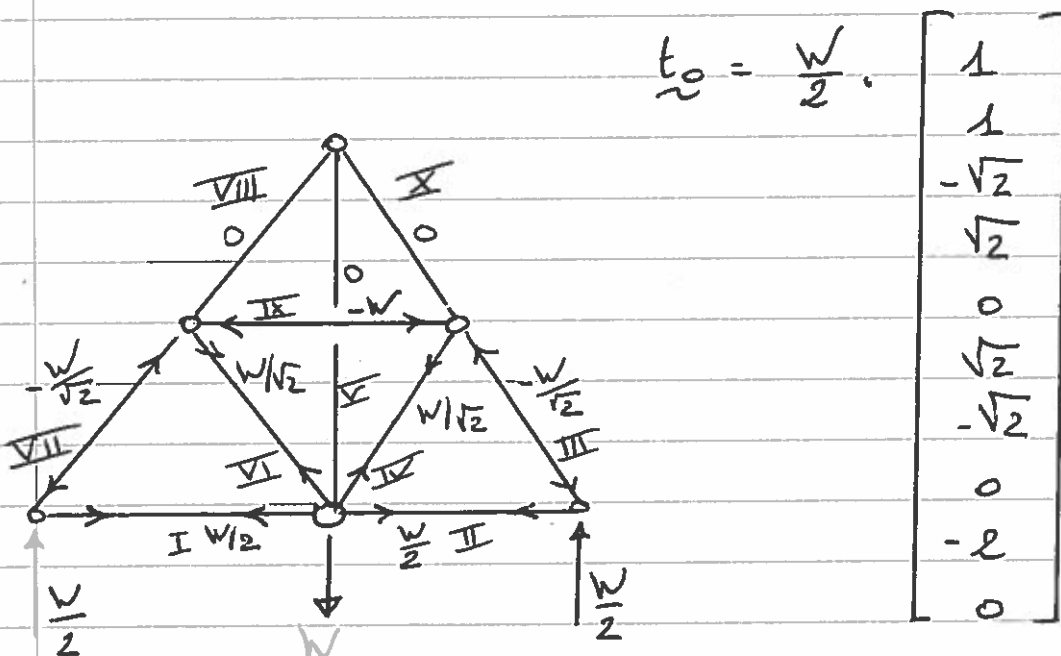
IB/2017/21/1

$$\begin{aligned}
 (a) \quad S - m &= b + r - D_j \\
 S - 0 &= 10 + 3 - (2 \times 6) \\
 &= 1 \text{ redundancy}
 \end{aligned}$$

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

$$\therefore \underline{S = 1}$$

(b) Choose ~~V~~ as redundant.
Particular solution with $t_{\del{V}} = 0$



Lengths:

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

IB/2017/21/3

Bar extension: $\underline{e} = \underline{F} \underline{t}$

$$\underline{e} = \frac{WL}{2\sqrt{2}AE} \begin{bmatrix} \sqrt{2} \\ \sqrt{2} \\ -\sqrt{2} \\ \sqrt{2} \\ 0 \\ \sqrt{2} \\ -\sqrt{2} \\ 0 \\ -2\sqrt{2} \\ 0 \end{bmatrix} + \frac{\alpha \cdot L}{2AE} \begin{bmatrix} 0 \\ 0 \\ 0 \\ 1 \\ -2 \\ 1 \\ 0 \\ 1 \\ -2 \\ 1 \end{bmatrix}$$

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

$$\therefore \frac{WL}{2\sqrt{2}AE} \cdot \frac{1}{\sqrt{2}} (\sqrt{2} + \sqrt{2} + 4) + \frac{\alpha \cdot L}{2AE} \cdot \frac{1}{\sqrt{2}} (1 + 2\sqrt{2} + 1 + 1 + 2\sqrt{2} + 1)$$

$$\frac{WL}{4AE} (2\sqrt{2} + 4) + \frac{\alpha L}{2\sqrt{2}AE} (4\sqrt{2} + 4) = 0$$

$$\Rightarrow \alpha = -\frac{W}{\sqrt{2}} \frac{(2\sqrt{2} + 4)}{(4\sqrt{2} + 4)} = -\frac{W}{2}$$

\Rightarrow bar forces ($\underline{t} = \underline{t}_0 + \alpha \cdot \underline{s}$)

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

Alternative simple method:

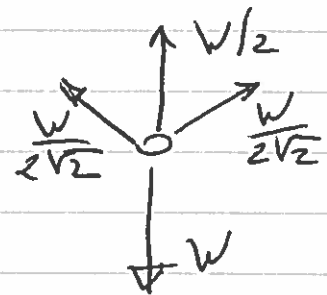
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consider joint A
vertical component of stiffness of members IV and VI

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

This is half that of member I
 \therefore Vertical

W is distributed as shown:



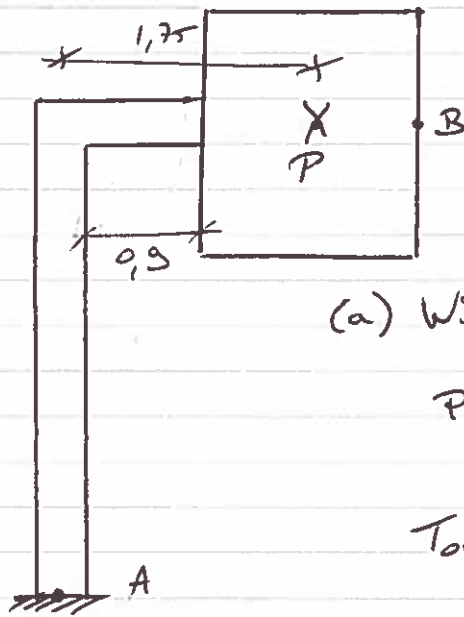
from this solve the members
by resolving at joints.

(c) Vertical displacement: $\delta_v = \frac{e}{L} \cdot t$

$$= \frac{WL}{2AE} \begin{bmatrix} 1 \\ 1 \\ -1 \\ 1/2 \\ 1 \\ 1/2 \\ -1 \\ 1/2 \\ -1 \\ -1/2 \end{bmatrix} \cdot \frac{1}{2} \begin{bmatrix} 1 \\ 1 \\ -\sqrt{2} \\ 1/\sqrt{2} \\ 1 \\ 1/\sqrt{2} \\ -\sqrt{2} \\ -1/\sqrt{2} \\ -1 \\ -1/\sqrt{2} \end{bmatrix} = \frac{WL}{4AE} \cdot \left(4 + 2\sqrt{2} + \frac{4}{2\sqrt{2}} \right)$$
$$= \frac{WL}{4AE} \cdot (4 + 3\sqrt{2})$$

Question 2

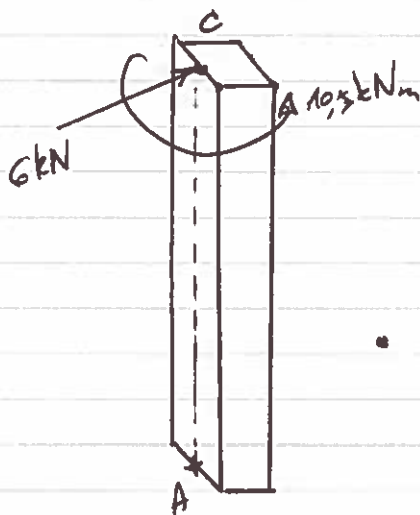
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(a) Wind load on sign: P

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

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



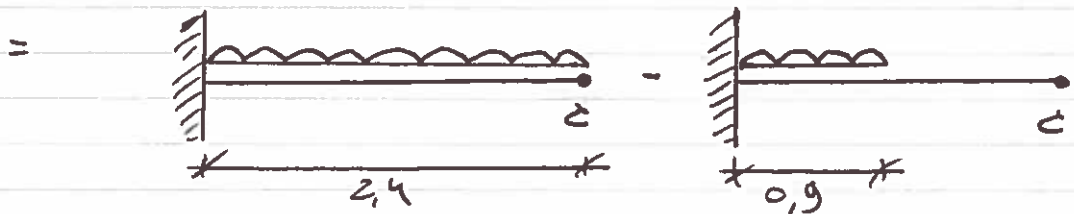
deflection:

- bending AC
- bending CB
- torsion AC

• Bending in AC:

$$\delta_{AC} = \frac{6 \cdot 10^3 \cdot 5^3}{3EI} = \frac{250000}{EI}$$

• Bending in CB:



$$w = 2\text{m} \times 2\text{kPa} = 4\text{kN/m}$$

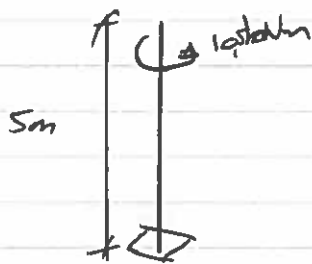
$$\therefore \delta_{CB} = \frac{wL^4}{8EI} - \left[\frac{wL'^4}{8EI} + \frac{w \cdot L'^3 \cdot L''}{6EI} \right]$$

$$= \frac{4 \cdot 10^3 \cdot 2,4^4}{8EI} - \left[\frac{4 \cdot 10^3 \cdot 0,9^4}{8EI} + \frac{4 \cdot 10^3 \cdot 0,9^3 \cdot 1,5}{6EI} \right]$$

$$= \frac{1}{EI} (16588,8 - 388,05 - 729)$$

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

• Torsion in AC :



$$\phi = \frac{T L}{G J}$$

$$G = \frac{E}{2(1+\nu)}$$

$$= \frac{26 \cdot 10^9}{2(1+0,3)} = 81,6 \text{ GPa}$$

$$\phi = \frac{10,5 \cdot 10^3}{G J} \text{ Nm} \quad \leftarrow \text{rotation per unit length}$$

$$\therefore \delta = \frac{10,5 \cdot 10^3}{G J} \cdot 5 \cdot 2,5 = \frac{131,25 \cdot 10^3}{G J}$$

∴ Total deflection:

$$= \frac{250000}{EI} + \frac{15531}{EI} + \frac{131,25 \cdot 10^3}{G J}$$

$$= \frac{265531}{EI} + \frac{131,25 \cdot 10^3}{G J}$$

$$E = 26 \cdot 10^9 \text{ N/m}^2$$

$$G = 81 \cdot 10^9 \text{ N/m}^2$$

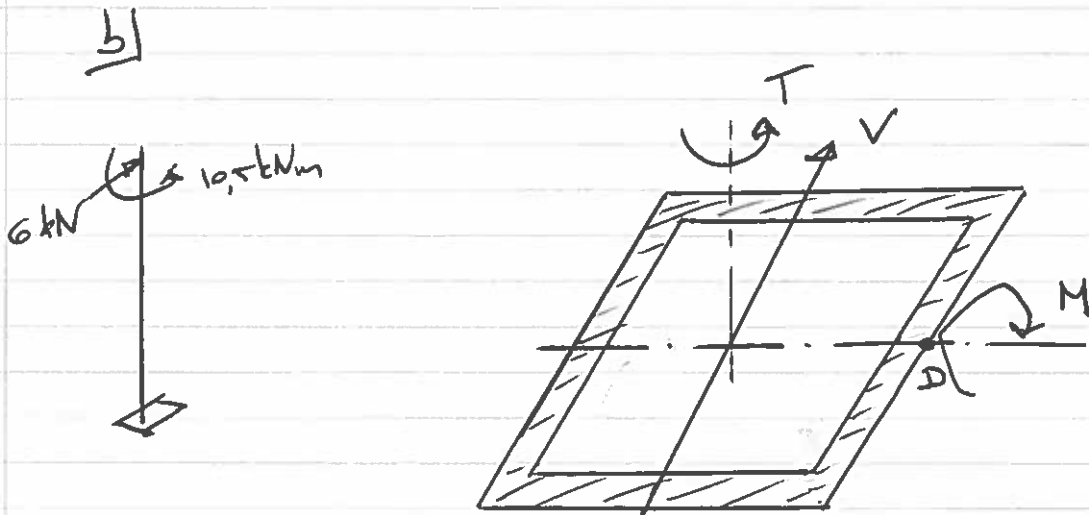
$$I = \frac{2}{3} t \cdot L^3 = 5,3 \cdot 10^{-3} t \text{ m}^4$$

I for thin walled square
(or derive equation)

$$J = \frac{4 \cdot A_e^2}{\int \frac{ds}{t}} = \frac{4 \cdot (0,2^2)^2 t}{0,8} = 8 \cdot 10^{-3} t \text{ m}^4$$

$$\begin{aligned} \delta &= \frac{265531}{210 \cdot 10^9 \cdot 5,3 \cdot 10^{-3} t} + \frac{131,25 \cdot 10^3}{81 \cdot 10^9 \cdot 8 \cdot 10^{-3} t} \quad \text{IB/2d7/2-2/3} \\ &= \frac{2,3723 \cdot 10^{-4} \text{ m}}{t} + \frac{2,025 \cdot 10^{-4} \text{ m}}{t} \\ &= \frac{4,3973 \cdot 10^{-4} \text{ m}}{t} \end{aligned}$$

$$\rightarrow \delta = 0,15 \text{ m} \Rightarrow t = \frac{4,3973 \cdot 10^{-4} \text{ m}}{0,15} = 0,00293 \text{ m} \approx \underline{\underline{3 \text{ mm}}}$$



$$\begin{aligned} \therefore \text{At base: } T &= 10,5 \text{ kNm} \\ M &= 6 \text{ kN} \cdot 5 \text{ m} = 30 \text{ kNm} \\ V &= 6 \text{ kN} \end{aligned}$$

$$I = \frac{2}{3} b^3 t = \frac{2}{3} \cdot 0,2^3 \cdot 0,01 = 5,33 \cdot 10^{-5} \text{ m}^4$$

Compressive stress due to bending:

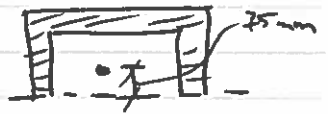
$$\rightarrow \text{in A: } \sigma = \frac{M \cdot y}{I} = \frac{30 \cdot 10^3 \cdot 0,1}{5,33 \cdot 10^{-5}} = 56,6 \text{ MPa}$$

$$\rightarrow \text{in D: } \sigma = 0 \text{ MPa}$$

IB/2017/02/4

• Shear stress due to shear force:

$$\begin{aligned} \text{At D: } \tau_D &= \frac{V \cdot A_c \cdot \bar{y}}{I \cdot 2t} \\ &= \frac{6 \cdot 10^3 \text{ N} \cdot 0,8 \cdot \frac{0,01}{2} \cdot 0,075}{5,33 \cdot 10^{-5} \cdot 2 \cdot 0,01} \\ &= 1,66 \text{ MPa} \end{aligned}$$



$$\begin{aligned} \bar{y} &= \frac{[200 \times 10 \times 100 + 2(100 \times 10 \times 50)]}{400 \times 10} \\ &= 75 \text{ mm} \end{aligned}$$

At A: $\tau_V = 0$

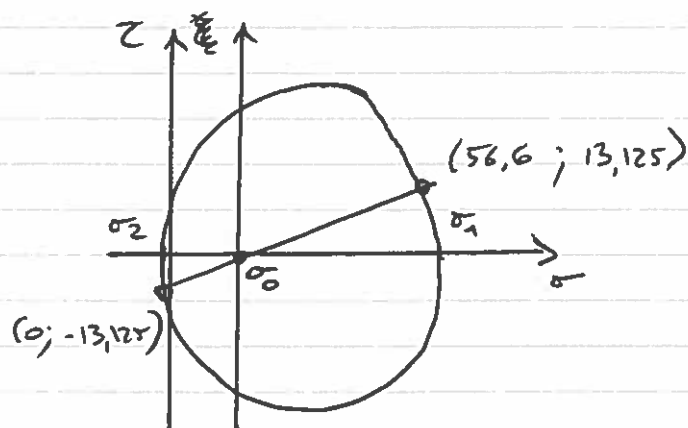
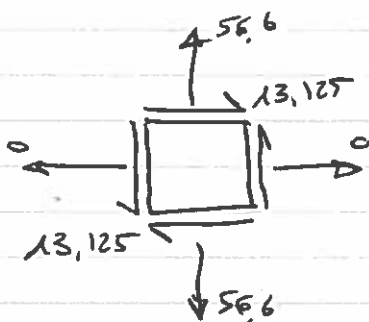
• Shear stress due to torsion at A & at D:

$$\begin{aligned} \tau_T &= \frac{T}{2A_c t} = \frac{10,5 \cdot 10^3}{2 \cdot 0,2^2 \cdot 0,01} \\ &= 13,125 \text{ MPa} \end{aligned}$$

∴ Total shear stress:

at A: 13,125 MPa
at D: 14,792 MPa

At A:



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

IB/2017/22/5

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

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

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:

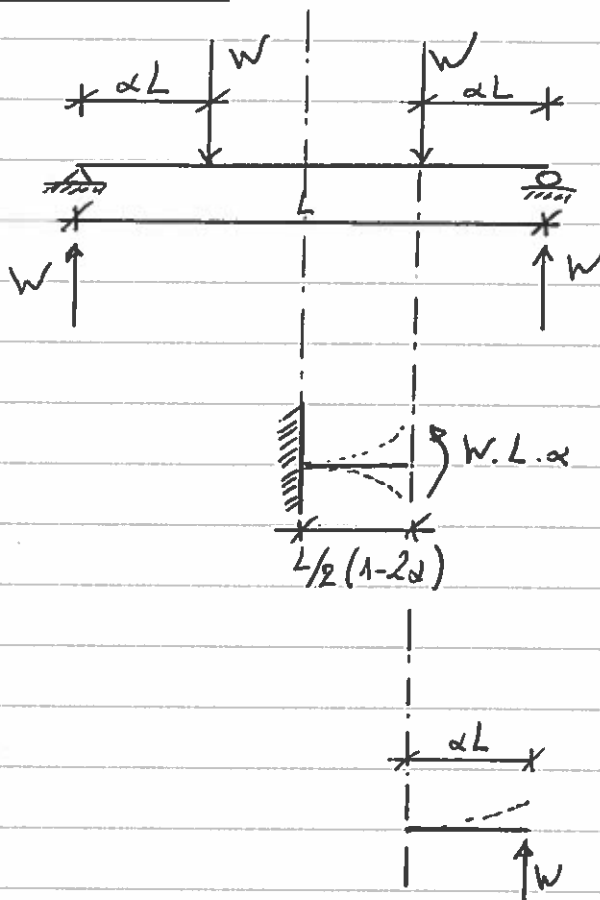
$$= \sqrt{\frac{2.460^2}{(59,55 + 2,892)^2 + 2,892^2 + 59,55^2}}$$

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

Question 3

IB/2017/23/1

(a)



Through derivation of bending moment line or using databook:

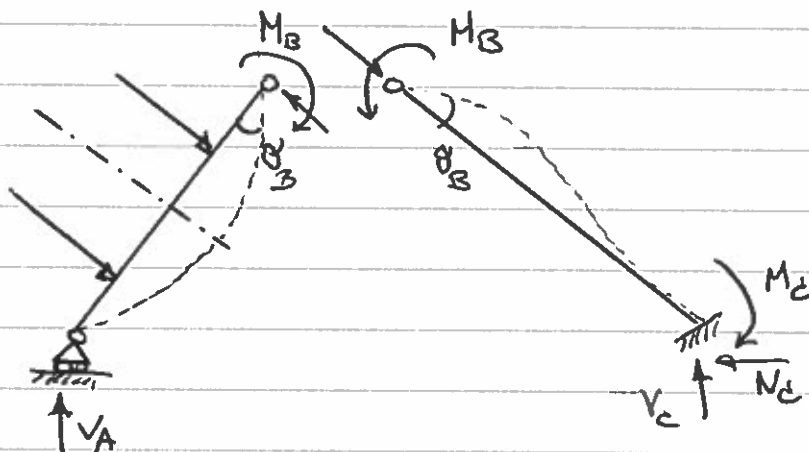
$$\begin{aligned} \therefore \theta_{B_1} &= \frac{M.L}{EI} \\ &= W\alpha L \cdot \frac{L}{2} (1-2\alpha) \cdot \frac{1}{EI} \\ &= \frac{\alpha W.L^2(1-2\alpha)}{2EI} \end{aligned}$$

$$\begin{aligned} \theta_{B_2} &= \frac{W.L^2}{2.EI} \\ &= \frac{W.\alpha^2.L^2}{2EI} \end{aligned}$$

$$\therefore \theta_B = \theta_{B_1} + \theta_{B_2}$$

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

(b) i) insert pin at point B:



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

IB/2017/23/2

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

Compatibility of rotations at B:

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

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

• Moments around B for AB:

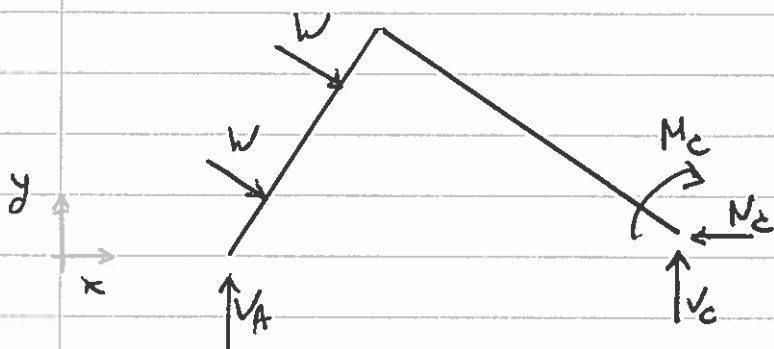
$$-M_B - \frac{V_A \cdot L}{\sqrt{2}} + 2 \cdot W \cdot \frac{L}{2} = 0$$

sub for M_B :

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

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

• Consider free body:



Vertical equilibrium

$$\sum F_y = 0$$

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

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

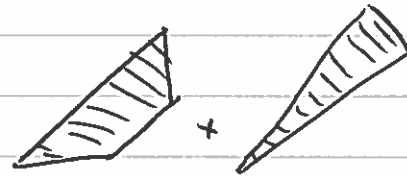
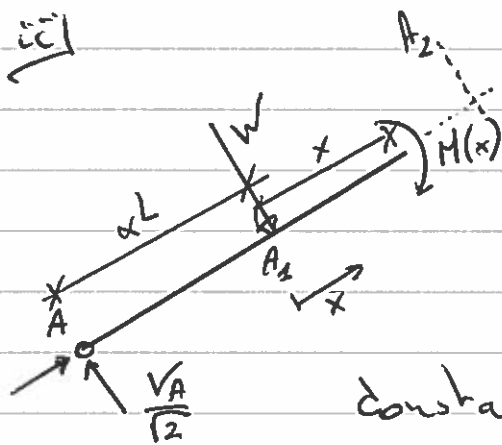
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$$\therefore V_c = \frac{3\sqrt{2} W \alpha (1-\alpha)}{8}$$

$$\sum F_x = 0 \quad H_c = \frac{2W}{\sqrt{2}} = \underline{\underline{\sqrt{2} W}}$$

and also:

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



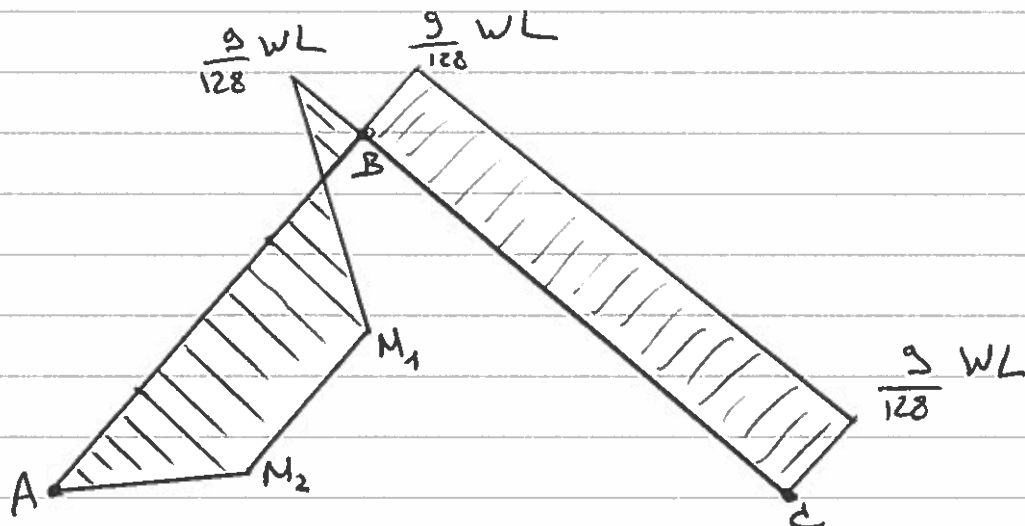
$$M(x) = \frac{V_A}{\sqrt{2}} (\alpha L + x) - W \cdot x$$

constant $H(x)$ between A_1 and A_2 :

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

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

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



IB/2017/23/4

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

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

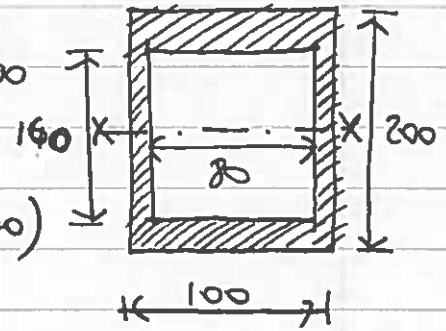
$$= \frac{WL}{4} \left(1 - \frac{36}{128} \right) = \frac{WL}{4} \left(\frac{23}{32} \right) = \underline{\underline{\frac{96}{256} WL}}$$

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

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

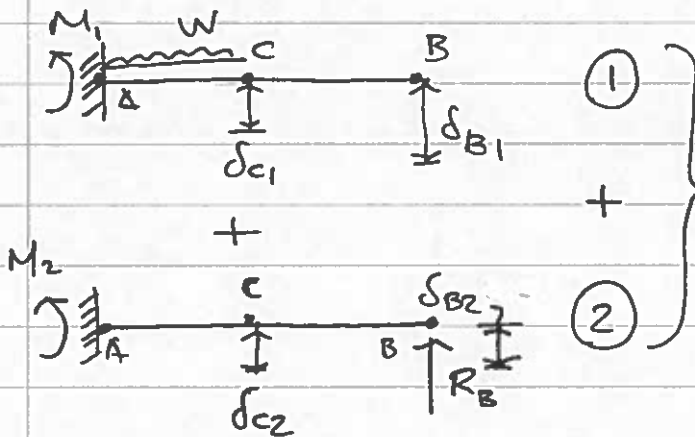
$$= \underline{\underline{\frac{55}{256} WL}}$$

4 a) $z_e = I_{xx}/y = (100 \times 200^3/12 - 80 \times 160^3/12)/100$
 $= \underline{\underline{3.94 \times 10^5 \text{ mm}^3}}$



$z_p = \sum |A y| = 2(100 \times 20 \times 90) + 4(80 \times 10 \times 40)$
 $= \underline{\underline{4.88 \times 10^5 \text{ mm}^3}}$

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

$M_1 = WL/4$

$\delta_{c1} = W \left(\frac{L}{2}\right)^3 \frac{1}{8EI} = WL^3/64EI$

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

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

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

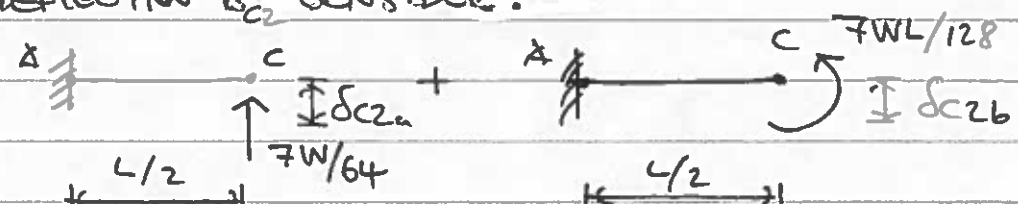
$\therefore R_B L^3/3EI = 7WL^3/192EI$

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

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

\therefore LOAD AT FIRST YIELD: $W_e = 64 M_e / 9L$
 $= 64 \times 139.87 / 9L = \underline{\underline{\frac{994.6 \text{ kN [m]}}{L}}}$

FOR DEFLECTION δ_{c2} CONSIDER:



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

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

$$= \frac{13WL^3}{3072EI}$$

\therefore DEFLECTION δ AT FIRST YIELD AT CLAMPED SUPPORT:

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

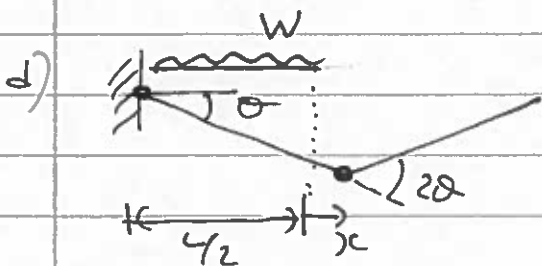
$$= 5.09 \times 10^{-10} L^2 \quad (\text{mm})$$

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

c) MOMENT AT CLAMPED SUPPORT $M = 9WL/64$ (FROM PART (b))
 PLASTIC MOMENT CAPACITY $M_p = Z_p \sigma_y = 4.88 \times 10^5 \times 355 = 173.24 \text{ kNm}$

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

$$= 64 \times 173.24 / 9L = \underline{\underline{\frac{12319 \text{ kN}}{L} \quad [\text{m}]}}$$



WHEN $x=0$

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

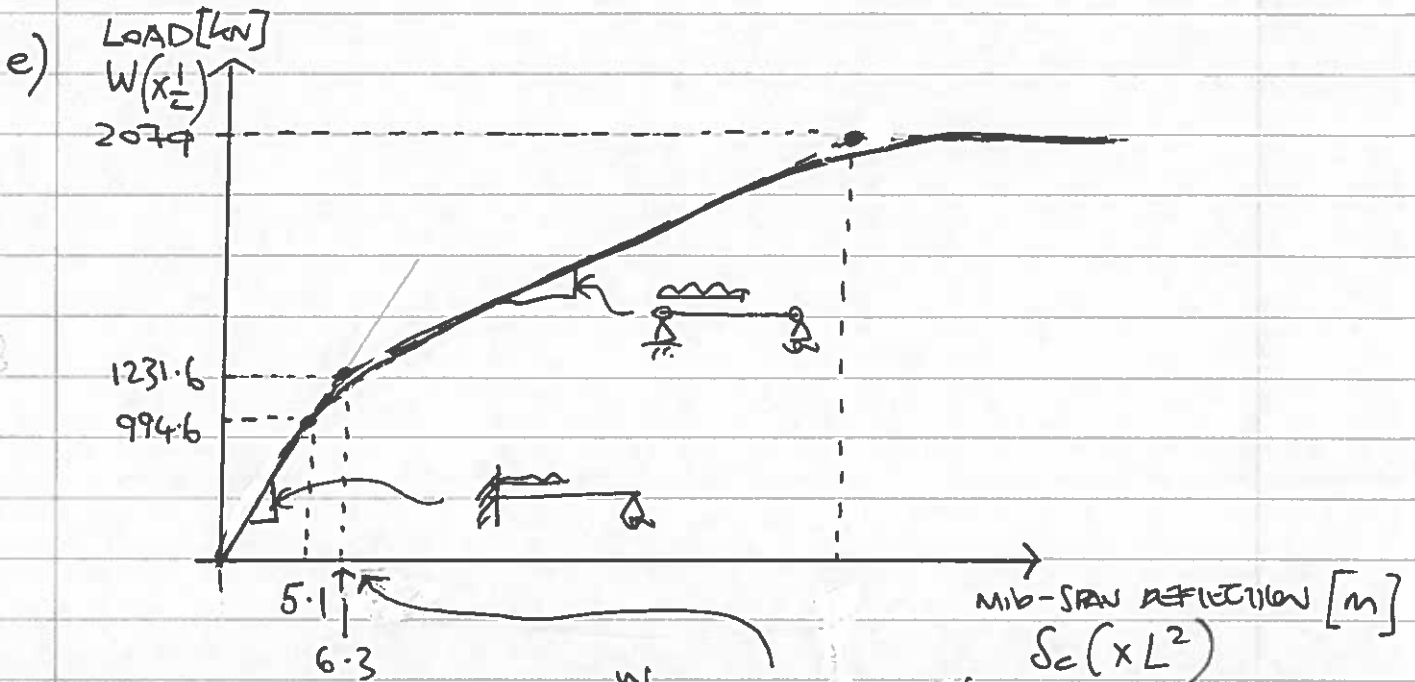
$$\therefore W = 12M_p/L$$

NOTE FOR $0 < x < L/2$

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

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

$W > 12M_p/L$
 \therefore PLASTIC HINGE AT $x=0$
 PROVIDES LOWER UPPER BOUND.



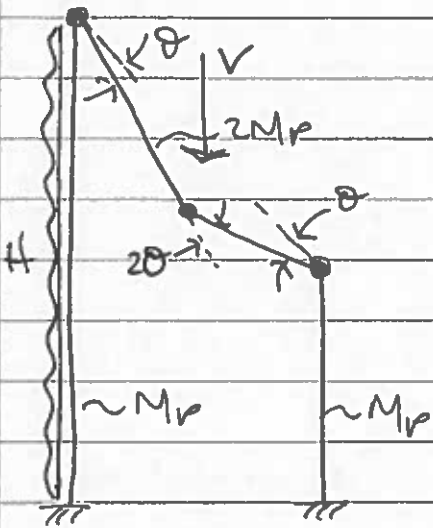
$$\frac{w}{0} \frac{w}{0} = \frac{w}{0} \frac{w}{0} + \frac{w}{0} \frac{w}{0}$$

$$= \frac{5WL^3}{384EI} + 0$$

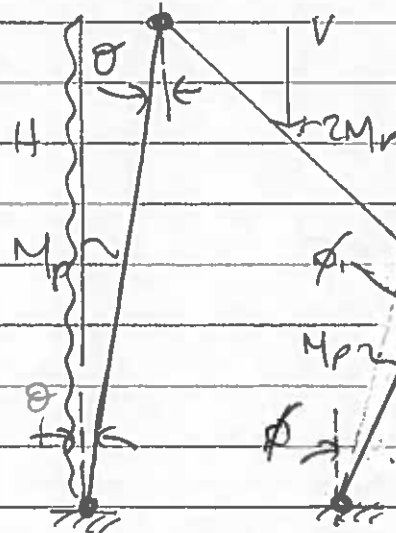
$$= \frac{5 \times 1232 \times 10^3 L^3}{384 \times L \times 210 \times 10^9 \times 3.94 \times 10^{-5}}$$

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

5 a)
b)



I BEAM



II SWAY

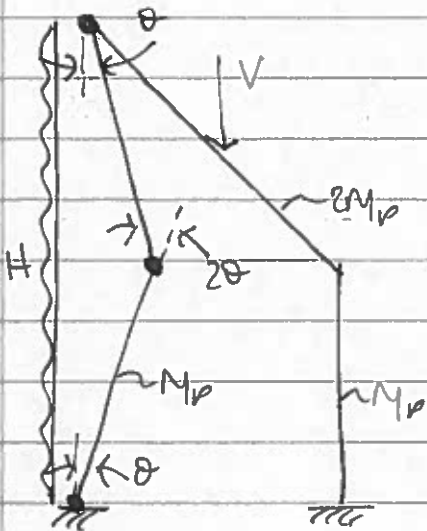
$2L\phi = L\theta$
 $\therefore \phi = 2\theta$

$$\frac{VL\theta}{2} = [(2M_p)\theta + M_p\theta]$$

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

$$24L\theta/2 = 6M_p\theta$$

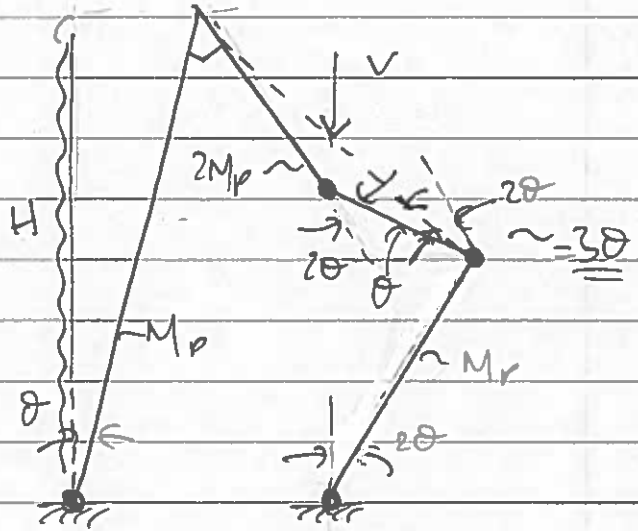
$$\therefore H = 6M_p/L$$



III COLUMN

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

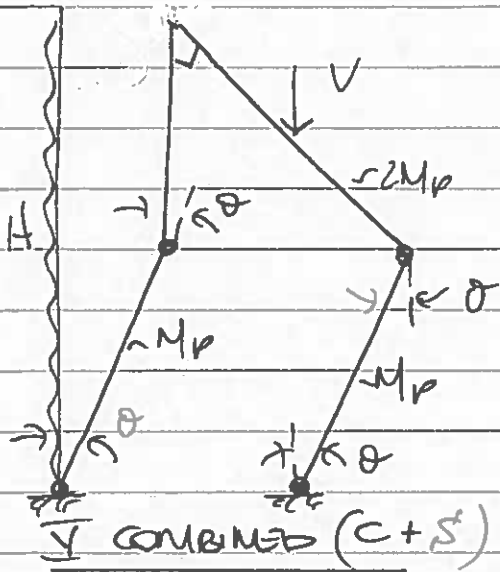
$$\therefore H = 8M_p/L$$



IV COMBINED (B+S)

$$4L\theta + VL\theta/2 = M_p(2\theta + 2\theta + \theta) + 2M_p\theta$$

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



NOTE: 2 ALTERNATIVE COLLAPSE MECHANISMS ARE POSSIBLE:

VI (B+C) $\Rightarrow H+V = 20M_p/L$

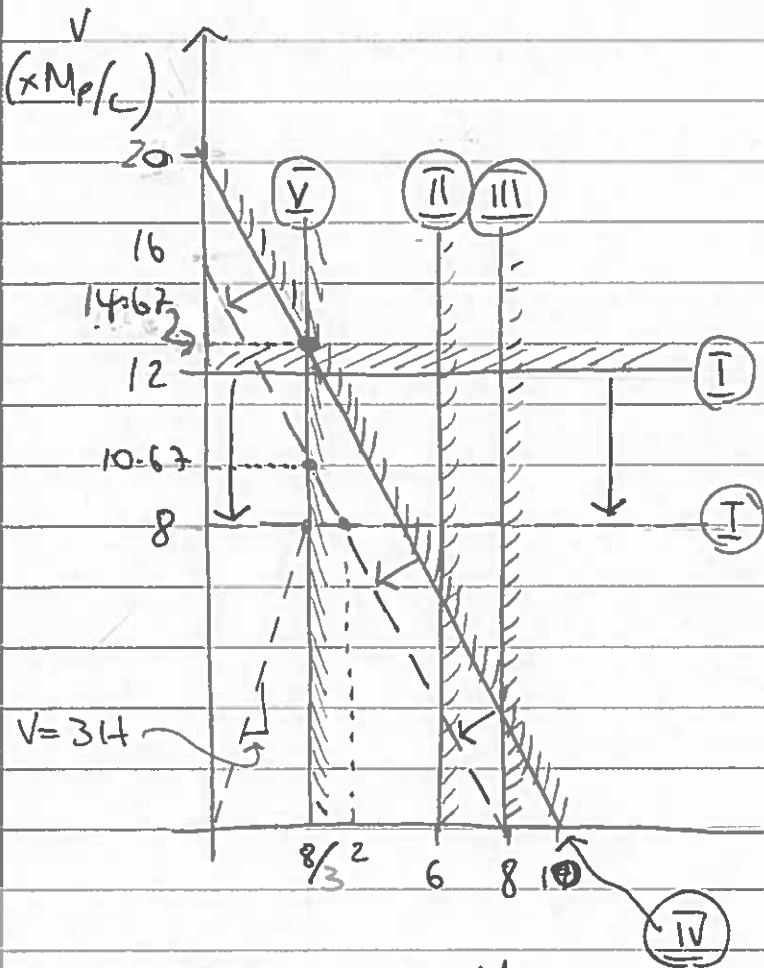
VII (B+C+S) $\Rightarrow 3H+V = 16M_p/L$

BUT BOTH PROVIDE HIGHER ESTIMATES OF H AND V COMPARED TO THOSE OBTAINED FROM I TO V.

$H \cdot 2L \cdot \frac{3}{4} = 4M_p L$

$\therefore H = \underline{\underline{8M_p/3L}}$

b) ~~and~~
c)



ORIGINALLY:

BOUNDED BY I AND V

\therefore COLLAPSE WHEN EITHER $V \geq 12M_p/L$ OR $H \geq 8M_p/L$

(C) \Rightarrow BOUNDED BY NEW POSITION OF I AND ORIGINAL V

$\therefore V \geq 8M_p/L$ OR $H \geq \underline{\underline{8M_p/3L}}$

(C) IF ALL MEMBERS WELDED M_p :

I $\Rightarrow V = 8M_p/L$; IV $\Rightarrow 2H+V = 16M_p/L$

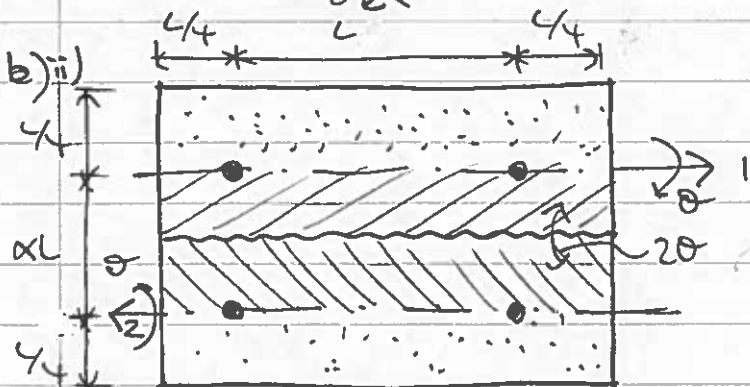
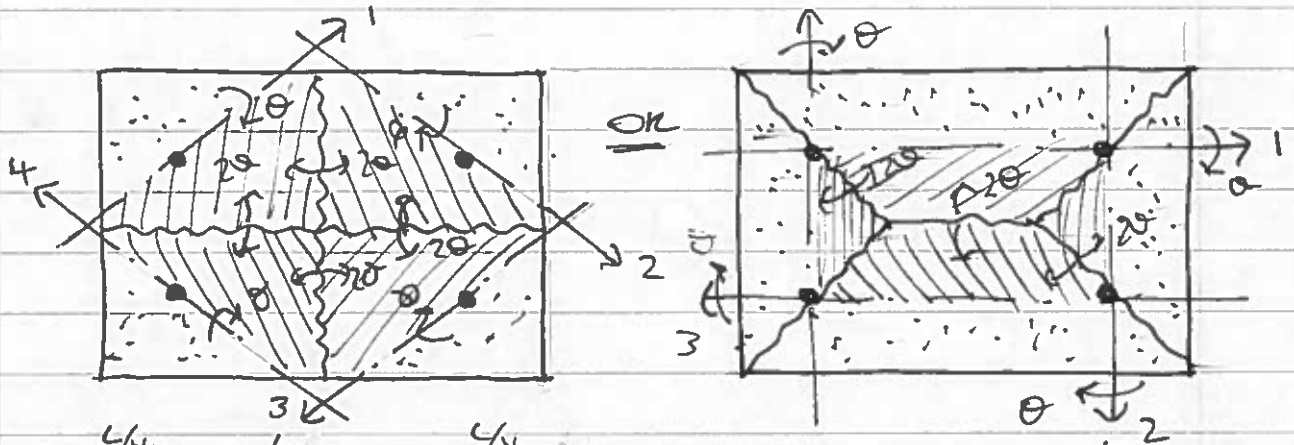
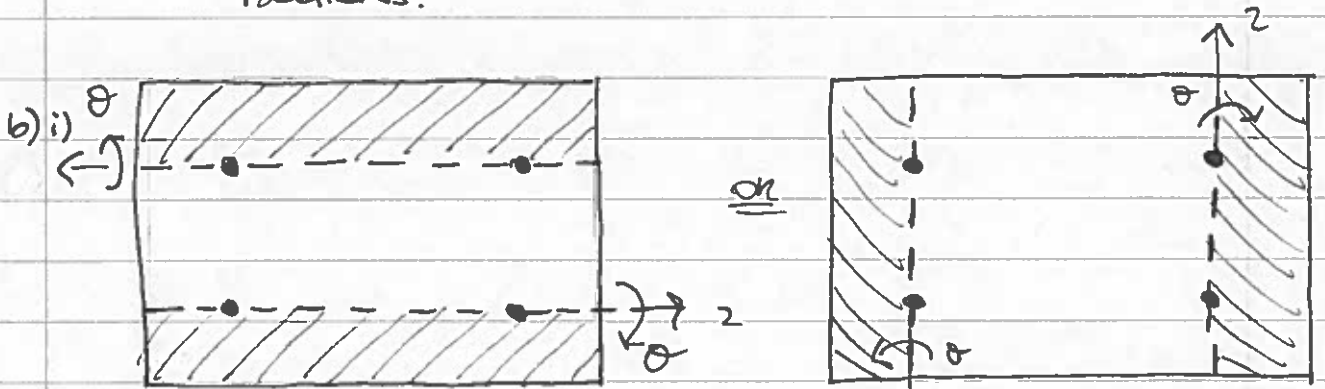
\therefore WHEN $V > 8M_p/L$ COLLAPSE AT $V = 8M_p/L$; WHEN $V < 8M_p/L$ COLLAPSE AT $H = 8M_p/3L$

6 a) YIELD LINES DIVIDE SLABS INTO RIGID PLANE 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 SLAB IN QUESTION.

IN ORDER TO SATISFY COMPATIBILITY:

(i) YIELD LINES ARE STRAIGHT

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



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

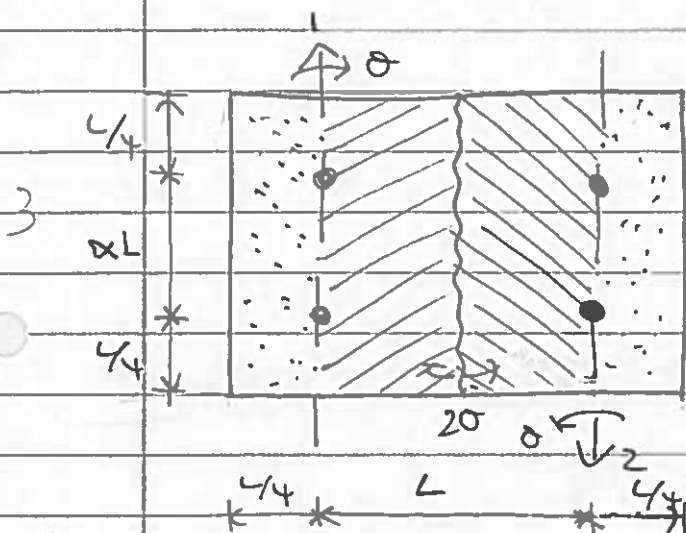
$$= 2 \left[w \frac{3L}{2} \cdot \frac{\alpha L}{2} \cdot \frac{\alpha L \theta}{2} \cdot \frac{1}{2} \right]$$

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

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

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

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



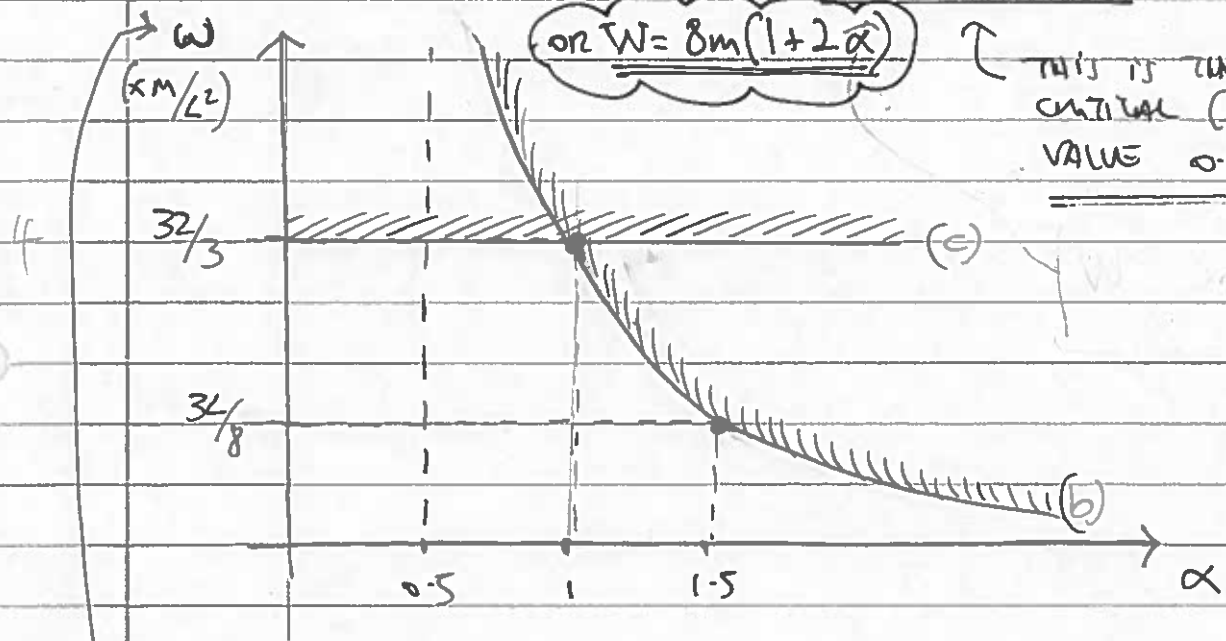
$$mL(\alpha + 1/2)2\theta = 2 \left[wL(\alpha + 1/2) \cdot \frac{L}{2} \cdot \frac{L\theta}{2} \cdot \frac{1}{2} - wL(\alpha + 1/2) \cdot \frac{L}{4} \cdot \frac{L\theta}{4} \cdot \frac{1}{2} \right]$$

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

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

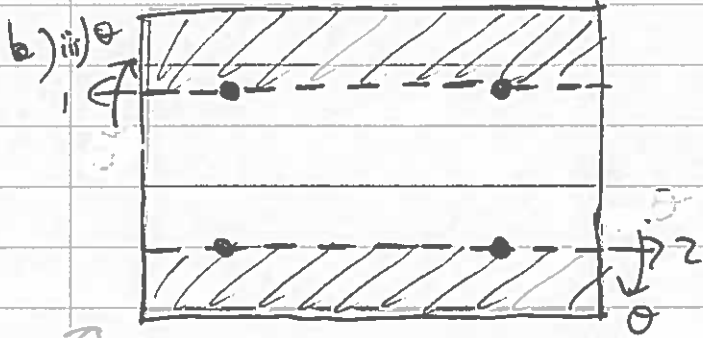
or $W = 8m(1 + 2\alpha)$

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



\therefore OPTIMUM VALUE OF α (TO MAXIMIZE W) IS $\alpha \leq 1$

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



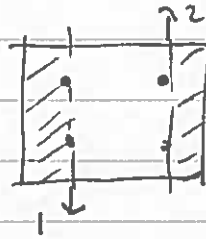
$$2m \frac{3L}{2} \theta = 2 \left[\frac{3L}{2} \cdot \frac{L}{4} \cdot \frac{W}{4} \cdot \frac{L\theta}{2} \cdot \frac{1}{2} \right]$$

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

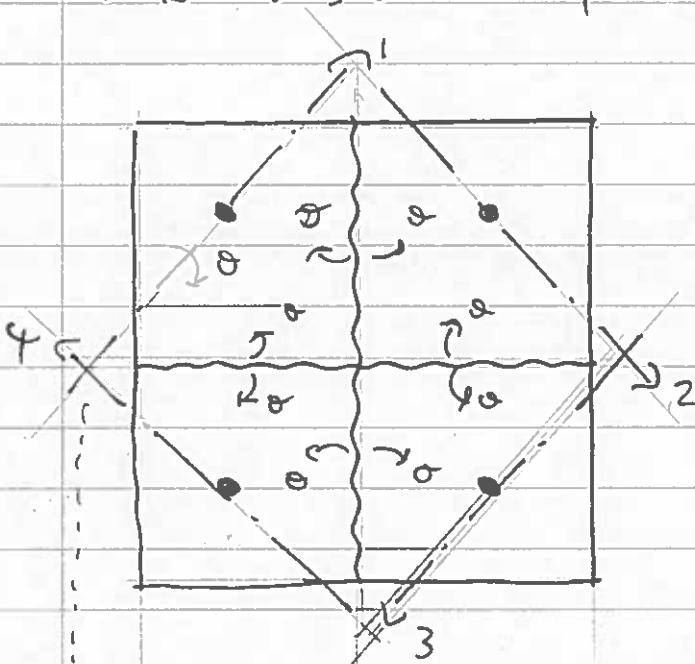
$$\therefore W = 32m/L^2 \quad \text{--- (d)}$$

or W = 72m

NOTE THIS IS EQUIVALENT TO:



with $\alpha = 1$

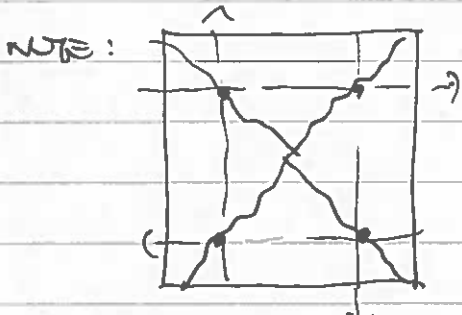
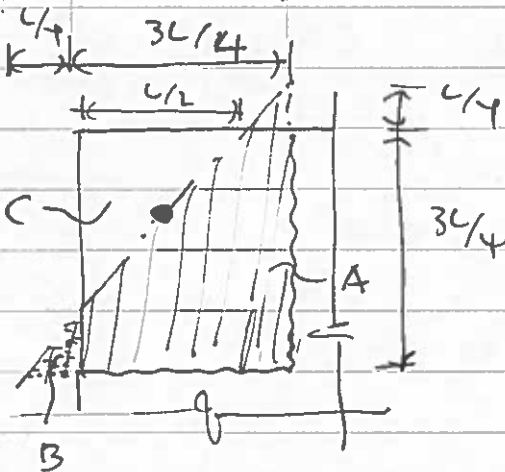


$$4 \left(2m\theta \frac{3L}{4} \right) = 4 \left[\frac{L \cdot L \cdot W \cdot \frac{L\theta}{\sqrt{2}} \cdot \frac{1}{3}}{2} - \frac{2L \cdot L \cdot \frac{1}{4} \cdot W \cdot \frac{L\theta}{4\sqrt{2}} \cdot \frac{1}{3}}{4} - \frac{L \cdot L \cdot \frac{1}{2} \cdot W \cdot \frac{L\theta}{2\sqrt{2}} \cdot \frac{1}{3}}{2} \right]$$

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

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

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



$$\Rightarrow \underline{\underline{W \rightarrow \infty}}$$

$$\therefore \underline{\underline{W = 32m/3L^2}} \quad (\text{MECHANISM C DOMINATES})$$