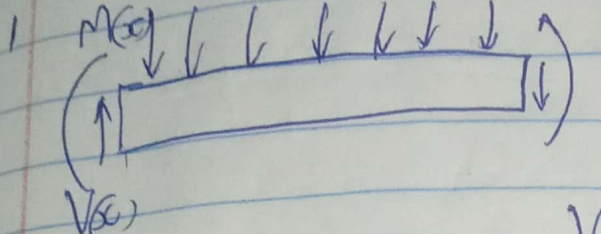
1



$$M(x) + \frac{dM(x)}{dx}dx$$

$$V(x) + \frac{dV(x)}{dx}dx$$

$$\sum F_y = 0 = V(x) - w(x)\,dx - \left(V(x) + \frac{dV(x)}{dx}dx\right) = 0$$

david by dx as $dx \to 0$

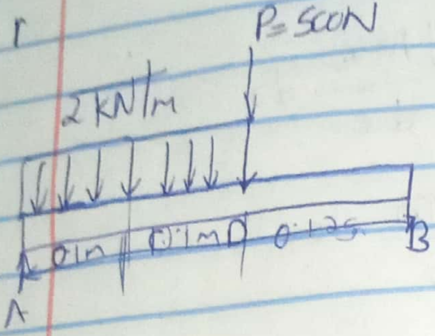
$$\frac{dV(x)}{dx} = w(x)$$

take momemnts about the Right hand edge of the elemat.

$$\sum M_{RH\ edge} = 0 = -M(x) - V(x)\,dx + W(x)\,dx\,\frac{dx}{2} + \left(M(x) + \frac{dM(x)}{dx}dx\right) =$$

devide by dx as $dx \to 0$.

$$\frac{dM}{dx} = V(x)$$



$M_B = 250 \times 0.125 = -31.2$

$M_C = (-500 \times 0.1) = -81.25$

$M_A = 400 \times 0.1 + (-81.25)$

$= -121.25$ Nm

$\Sigma F_V = 0$

$250 + 500 + 400 - F_{AV} = 0$

$F_{AV} = 1150N$

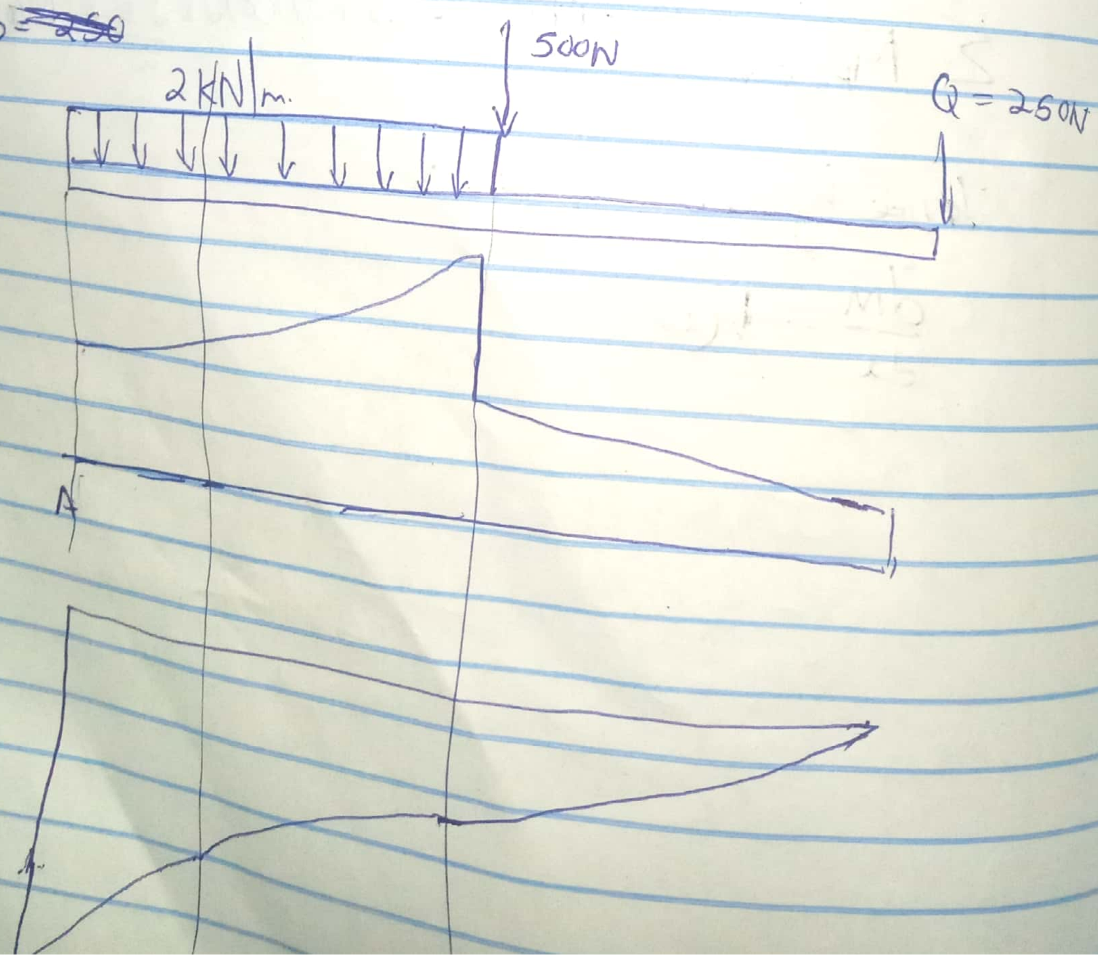
S at $B = 250$

at $D = 250 + 500 = 750N$

after $D = 750 + 2kN = 2750$

$A = 2750 - 1150 = 1600N$

M_D = ~~250~~



2000 x 0.2

Beam AB: two concentrated load P & Q
normal stress due to bending on bottom edg
= + 55MPa at D & + 37.5MPa at F.
@ Draw shear & bending-moment diagrams

soln

$I = \frac{1}{12}(24)(60)^3 = 432 \times 10^3 \, mm^4$ $\quad c = 30$

$S = \frac{I}{c} = 14.4 \times 10^3 \, mm^3 = 14.4 \times 10^{-6} \, m^3$ $\quad M = S\sigma$

At D. $\quad M_D = (14.4 \times 10^{-6})(55 \times 10^6) = 792 \, N \cdot m$

At F $\quad M_F = (14.4 \times 10^{-6})(37.5 \times 10^6) = 540 \, N \cdot m$

Using free body FB $\quad +\circlearrowleft \sum M_F = 0 \quad -540 + 0.3B = 0$

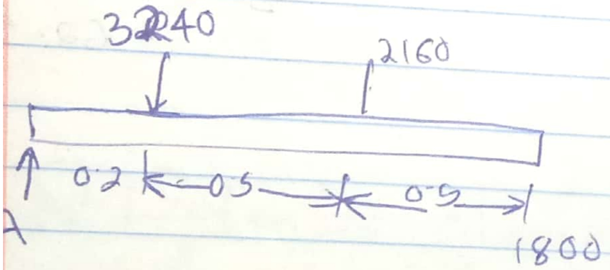
$B = \frac{540}{0.3} = 1800N$

Using free body DEFB $\quad +\circlearrowleft \sum M_D = 0 \quad -792 - 3Q(0.8)(1800) = 0$

$Q = 2160N$

Using entire beam $\quad +\circlearrowleft \sum M_A = 0 \quad -0.2P - (0.7)(2160) + (1.2)(1800) = 0$

$P = 3240N$



$+\uparrow \sum F_y = 0 \quad A - 3240 - 2160 + 1800$

$A = 3600N$

A to C^- $\quad V = 3600$

C^+ to E^- $\quad V = 3600 - 3240 = 360$

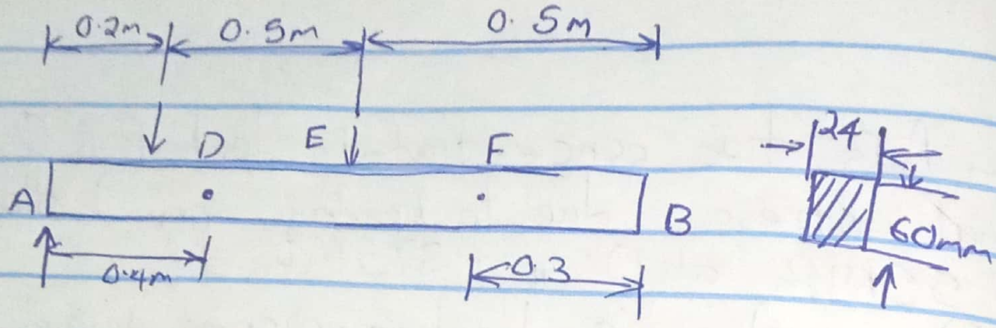
E^+ to B $\quad = -180N$

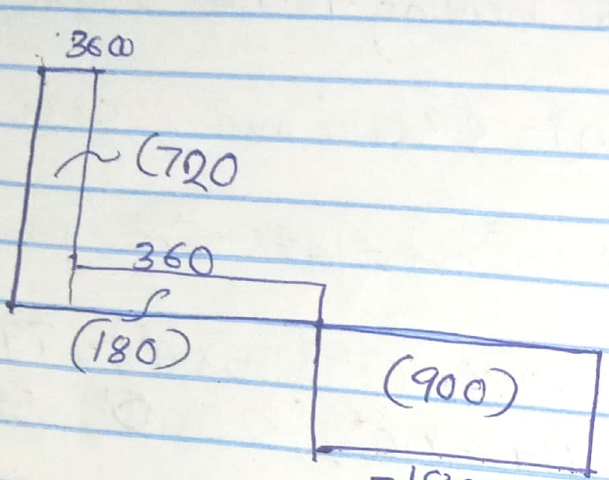
$M_A = 0$

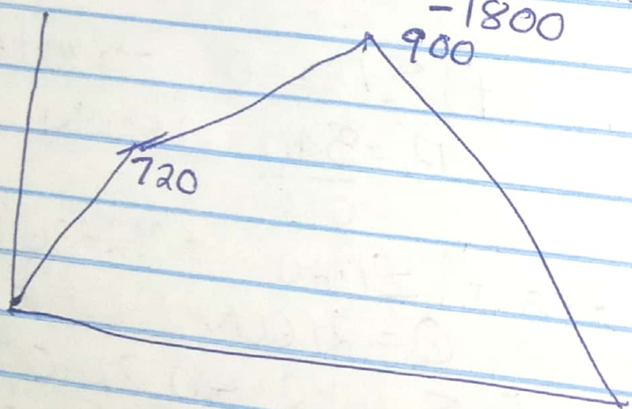
$M_C = 0 + 720 = 720$

$M_E = 720 + 180 = 900$

$M_B = 900 - 900 = 0$







$$\sigma_{max} = \frac{|M|_{max}}{S} = \frac{900}{14.4 \times 10^{-6}}$$

$$= 62.5 \times 10^{6}$$

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Shear $V = 80kN$

(a) plot shear stress distribution acting on beam.

$$I = \frac{1}{12}(0.015)(0.200^3) + 2\left[\frac{1}{12}(0.3)(0.02)^3 + 0.3(0.02)(0.11)^2\right]$$

$$I = 155.6(10^{-6})m^4$$

$$Q_B = \bar{y}'A' = (0.110)(0.3)(0.02) = 0.66(10^{-3})m^3$$

$$\tau_B = \frac{VQ_B}{It_B} = \frac{80kN(0.66)(10^{-3})m^3}{155.6(10^{-6})m^4(0.300)} = 1.13MPa$$

From t $t_B = 0.015$ & $Q_B = Q_B$

$$\tau_B = \frac{VQ_B}{It_B} = \frac{80kN(0.66)(10^{-3})m^3}{155.6(10^{-6})m^4(0.015)}$$

$$= 22.6Mpa$$

$$Q_C = \Sigma y'A' = (0.110)(0.300)(0.02) + (0.05)(0.15)(0.1)$$

$$= 0.735$$

$$\tau_{max} = \frac{VQ_C}{It_C} = \frac{80kN(0.735(10^{-3})m^3)}{155.6(10^{-6})m^4(0.015)} = 25.2MP$$

(b) Determine shear force by the web

$I = 155.6(10^{-6})m^4$

$t = 0.3m$

$A' = 0.3(0.12 - y)m^2$

$\bar{y}' = y + \frac{1}{2}(0.12 - y)$

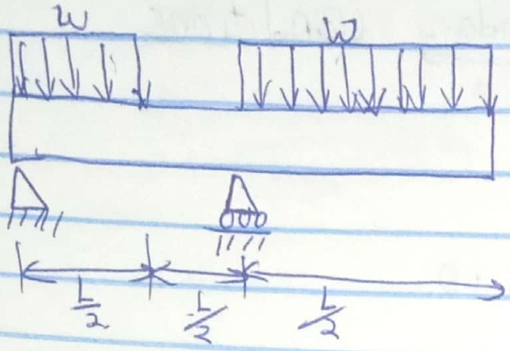
$= \frac{1}{2}(0.12 + y)m$

$$Q = y'A' = (0.15)(0.120)^2 - y^2)m^2$$

$$\tau = \frac{VQ}{It} = \frac{80kN(0.15)(0.12 - y^2)m^3}{(155.6)(10^{-6})(0.3)m}$$

$$= 257((12)^2 - y^2)Mp$$

4



Ground Reactions

$$\Sigma M_A = 0$$

$$0 = \left(\frac{wL}{2} \times \frac{L}{4}\right) - R_c(L) + \left(\frac{wL}{2} \times \frac{5}{4} L\right)$$

$$R_c = \frac{\frac{wL^2}{8} + \frac{5wL^2}{8}}{L} \qquad R_c = \frac{3}{4} wL$$

$$\Sigma F_y = 0$$

$$R_{Ay} + R_{cy} - \frac{wL}{2} - \frac{wL}{2} = 0 \qquad R_{Ay} = \frac{1}{4} wL$$

Bending moment equation

$$\Sigma M_o = 0$$

$$M(x) = R_{Ay}(x)^1 + R_{cy}(x-L)^1 - \frac{wL}{2}\left(x - \frac{L}{4}\right) - w(x-L)\left(\frac{x-L}{2}\right)$$

$$M(x) = \frac{1}{4} wL(x)^1 + \frac{3}{8}(wL)(x-L)^1 - \frac{wL}{2}\left(x - \frac{L}{4}\right) - \frac{w}{2}(x-L)^2$$

Elastic curve equation

$$\Sigma I \theta = \frac{1}{8} wL(x)^3 + \frac{3}{8}(wL)(x-L)^2 - \frac{wL}{4}\left(x - \frac{L}{4}\right)^2 - \frac{w}{6}(x-L)^3 + c$$

$$\Sigma I \theta = \frac{1}{24}(wL)(x)^3 + \frac{3}{24} wL(x-L)^3 - \frac{wL}{12}\left(x - \frac{L}{4}\right)^3 - \frac{w}{24}(x-L)^4 + Cx + D$$

Kinematic Boundary Conditions

At $x=0$, $V=0$

At

$EI \times 0 = 0 + 0 - 0 - 0 + D$

$D = 0$

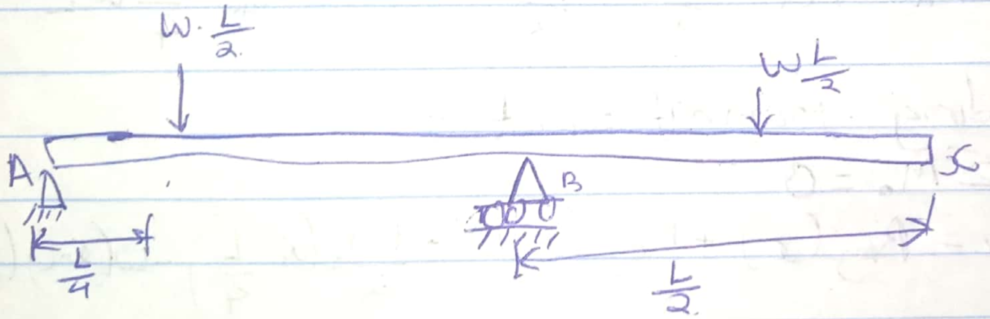
At $x = L$ $V=0$ at point C

$$EI \times 0 = \frac{1}{24} wL^4 + \frac{0.9}{256} wL^4 - 0 + CL - 0$$

$$CL = \frac{-5}{768} wL^4 \qquad C = \frac{-5wL^3}{768}$$

Elastic curve equation

$$\frac{wL(x)^3}{24} - \frac{3wL}{24}(x-L)^3 - \frac{wL}{12}\left(x-\frac{L}{4}\right)^3 - \frac{w}{24}(x-L)^4 - \frac{5wL^3}{768}x$$



At B

$$V_B = \frac{wL}{24}\left(\frac{L}{2}\right)^3 - \frac{3wL}{24}\left(\frac{L}{2}-L\right)^3 - \frac{wL}{12}\left(\frac{L}{2}-\frac{L}{4}\right)^3 - \left(\frac{w}{24}\left(\frac{L}{2}-L\right)^4\right)$$

$$-\frac{5wL^4}{768 \times 2} + \frac{wL^4}{196} + \frac{wL^4}{64} - \frac{wL^4}{768} - \frac{wL^4}{384} - \frac{5wL^4}{1536}$$

$$V_B = \frac{1021}{75264} wL^4$$

At point D

$$\frac{wL}{24}\left(\frac{3}{2}L\right)^3 - \frac{3wL}{24}\left(\frac{3}{2}L-L\right)^3 - \frac{wL}{12}\left(\frac{3}{2}L-\frac{L}{2}\right)^3 - \frac{w}{24}\left(\frac{3}{2}L-L\right)^4$$

$$-\frac{5wL^3}{768}\left(\frac{3}{2}L\right)$$

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$$V_c = \frac{9 wL^4}{64} - \frac{w L^4}{64} - \frac{125}{768} wL^4 - \frac{wL^4}{384} - \frac{5}{512} wL^4$$

$$V_c = \frac{-77}{1536} w L^4$$