Lec21

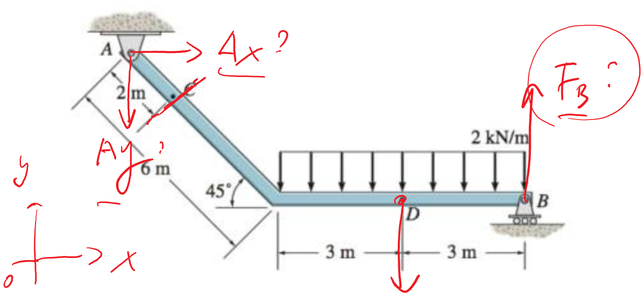
Monday, November 9, 2020 7:56 AM

Lecture Objectives

Internal Forces

1

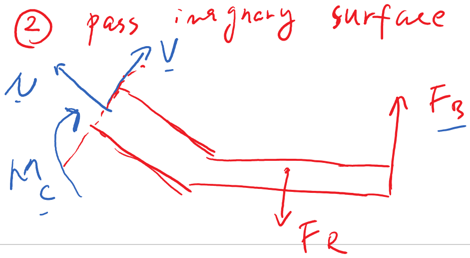
Determine the normal force, shear force, and bending moment at *C*.



$F_R = 2\times 6 = 12\,kN$

① EoE of the structure. → $\Sigma M_A = 0 \Rightarrow F_B = ?$

② pass imaginary surface through the point C



$\Sigma F_x = 0$

$\Sigma F_y = 0$

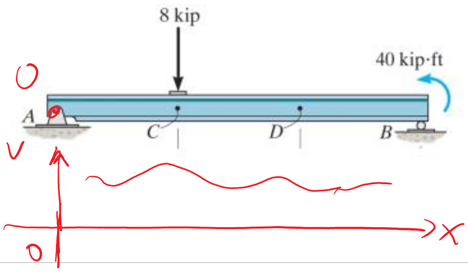
$\Sigma M_C = 0$

Shear and Moment Diagram

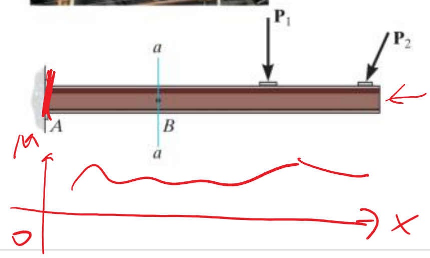
Shear and Moment Diagram

Beams: structural members designed to support loadings applied perpendicular to their axes.

Simply supported beam



Cantilever beam



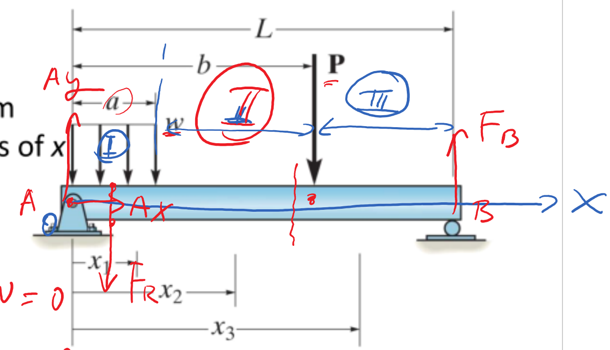
← free end

Shear and Moment Diagram

Goal: provide detailed knowledge of the variations of internal loadings (V and M) throughout the beam

Procedure

1. Find support reactions (free-body diagram of entire structure)
2. Specify coordinates *x*
3. Divide the beam into regions
4. Draw FBD of a segment
5. Apply equations of equilibrium to derive V and M as functions of *x*



① $\Sigma F_x = A_x = 0$

$\Sigma F_y = A_y + F_B - P - aw = 0$

$\Sigma M_A = F_B L - P \cdot b - aw \cdot \frac{a}{2} = 0$

②

③ Region I :

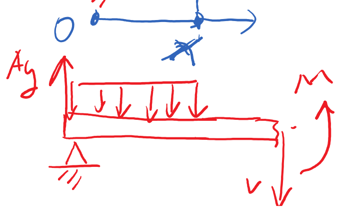
$A_y - w \cdot x - V = 0$

$\Sigma M_A = M - V \cdot x - w \cdot x \cdot \frac{x}{2} = 0$

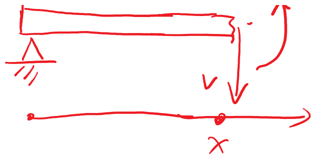
$V = A_y - wx$

$M = \frac{w}{2}x^2 + Vx$

Region II :



Region I:



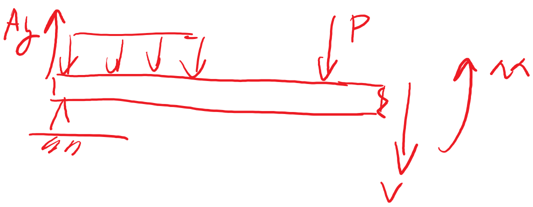
$$\Sigma F_y = A_y - W\cdot a - V = 0$$

$$\Sigma M_A = M - V\cdot x - \frac{a}{2} W\cdot a = 0$$

$$\underline{V = A_y - Wa}$$

$$\underline{M = Vx + \frac{W}{2}a^2}$$

Region II:



$$\Sigma F_y = A_y - P - W\cdot a - V = 0$$

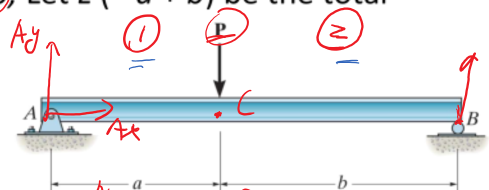
$$\Sigma M_A = M - V\cdot x - P\cdot b - \frac{a}{2} W\cdot a = 0$$

$$\underline{V = A_y - P - Wa}$$

$$M = Vx + Pb + \frac{W}{2}a^2$$

Example

Draw the *V* diagrams for: *a* = *b*; Let *L* (= *a* + *b*) be the total length of the beam.



$A_x = 0$

$A_y = F_B = \frac{P}{2}$

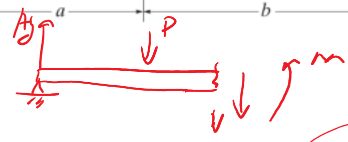
①:

$$\boxed{V = A_y = \frac{P}{2}}$$

$$\Sigma M_A = M - Vx = 0$$

$$M = \frac{P}{2}x$$

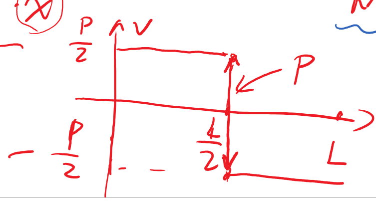
②

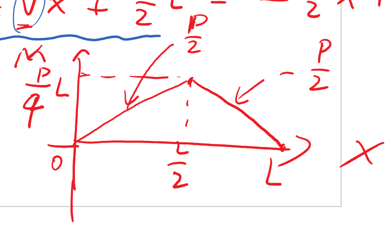


$A_y - P - V = 0$. $\boxed{V = -\frac{P}{2}}$

$$M - P\cdot\frac{L}{2} - Vx = 0$$

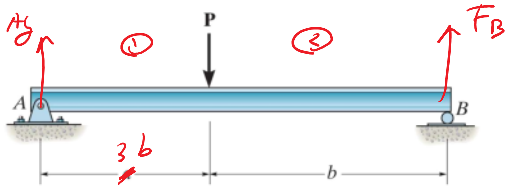
$$M = Vx + \frac{P}{2}L = -\frac{P}{2}x + \frac{L}{2}P$$





Example

Draw the V diagrams for: $a = 3b$. Let L (= $a + b$) be the total length of the beam.



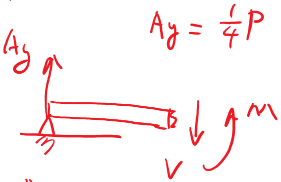
$A_y + F_B = P$

$P \cdot 3b = F_B \cdot 4b$

$F_B = \frac{3}{4}P$

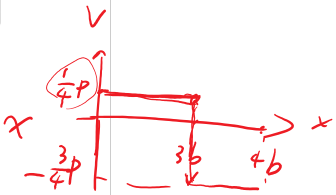
$A_y = \frac{1}{4}P$

Region ①:

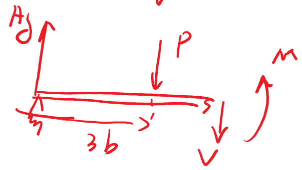


$A_y - V = 0$ $V = \frac{1}{4}P$

$M - Vx = 0$ $M = \frac{1}{4}P \cdot x$



Region ②:



$A_y - V - P = 0$

$M - Vx - P \cdot 3b = 0$

$V = A_y - P = -\frac{3}{4}P$

$M = Vx + 3Pb = -\frac{3}{4}P \cdot x + 3Pb$