Printout

Monday, March 11, 2019 10:06 AM

Announcements

- Quiz 4 review session tonight 6-8PM in DCL L520
- Quiz 4 retry: Tuesday – Thursday (3/12-14)
- TAM 210/211 students – check your grades on Compass

- Upcoming deadlines:
- Tuesday (3/12)
  - PL HW
- Friday (3/15)
  - Written Assignment

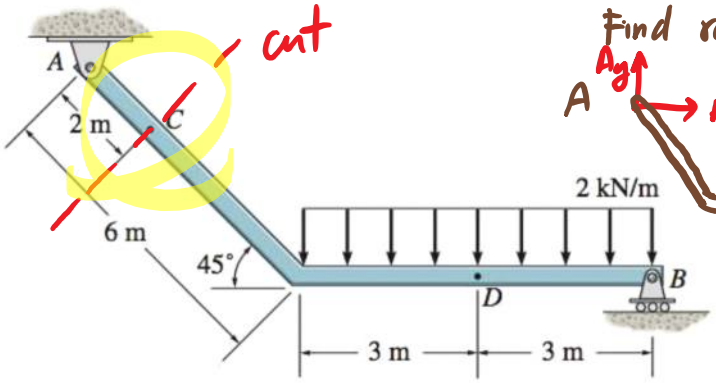
1

Objective

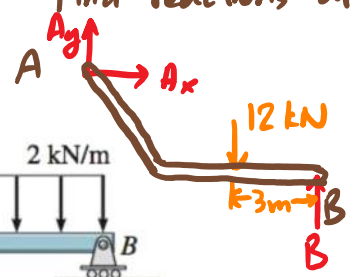
- Internal Loadings
  - Shear force diagram
  - Bending moment diagram

2

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



Find reactions at A & B:



$\Sigma F_x = \boxed{A_x = 0}$

$\Sigma M_A = B(6+6\cos 45°)m - 12\,kN(3+6\cos 45)m = 0$

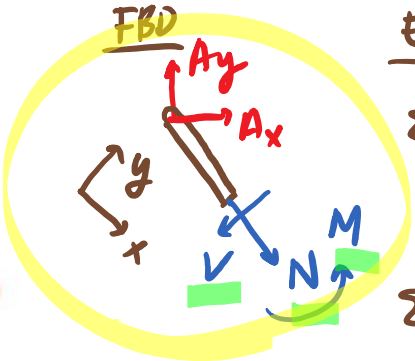
$B = \dfrac{12(3+6\cos 45°)}{6+6\cos 45} \approx 8.49\ kN$

$\Sigma F_y = A_y - 12kN + 8.49\,kN = 0$

$\boxed{A_y \approx 3.51\ kN}$

Use left section to find V, N, M.

FBD



EoE

$\Sigma F_x = N - A_y\cos 45° = 0$

$N = A_y\cos 45°$

$\Sigma F_y = -V + A_y\sin 45° = 0$

$V = A_y\sin 45°$

$\Sigma M_A = 0 = -V(2m) + M$

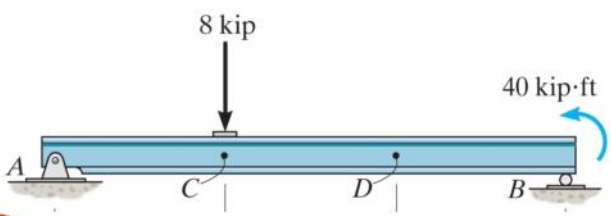
$M = 2V = 2A_y\sin 45°.$

3

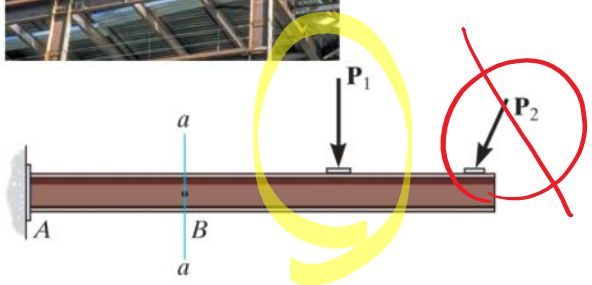
Shear and Moment Diagram

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

Simply supported beam



Cantilever beam



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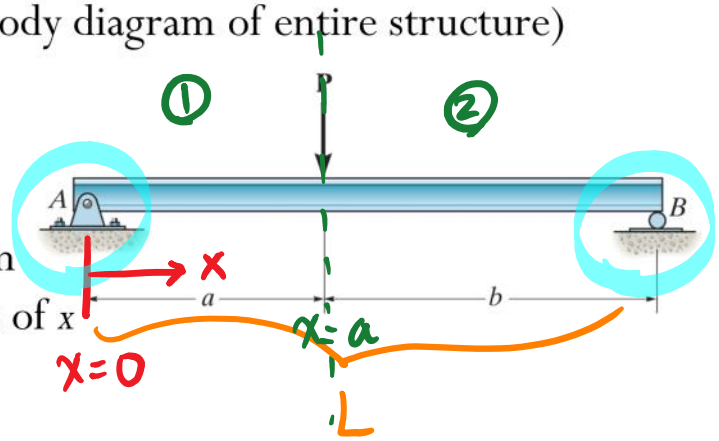
Shear and Moment Diagram

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

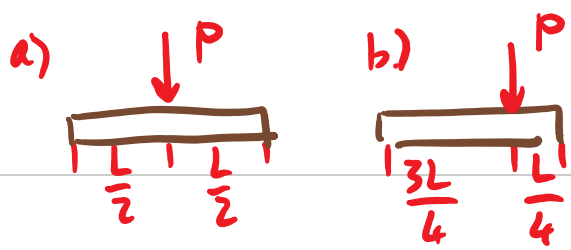
make cuts in the middle of each region from part 2.



Example

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

5



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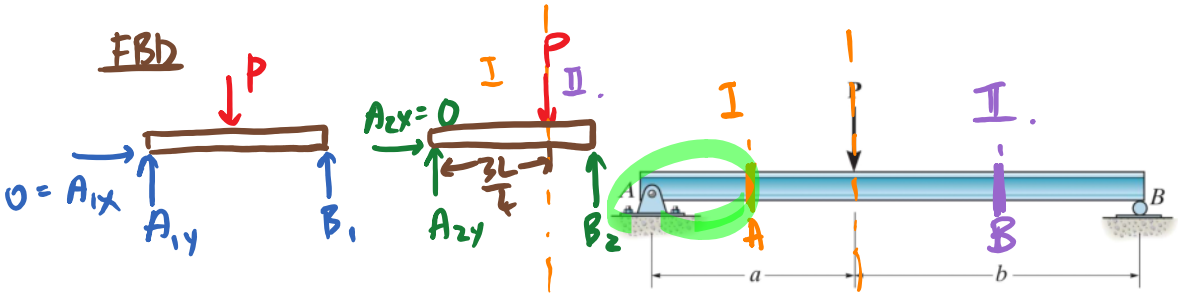
<u>Example</u>

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



a.)

$\Sigma F_y = A_{1y} + B_1 - P = 0$

$\Sigma M_A = -\frac{PL}{2} + B_1 L = 0$

$A_{1y} = B_1 = \frac{P}{2}$

b.)

$\Sigma F_y = A_{2y} + B_2 - P = 0$

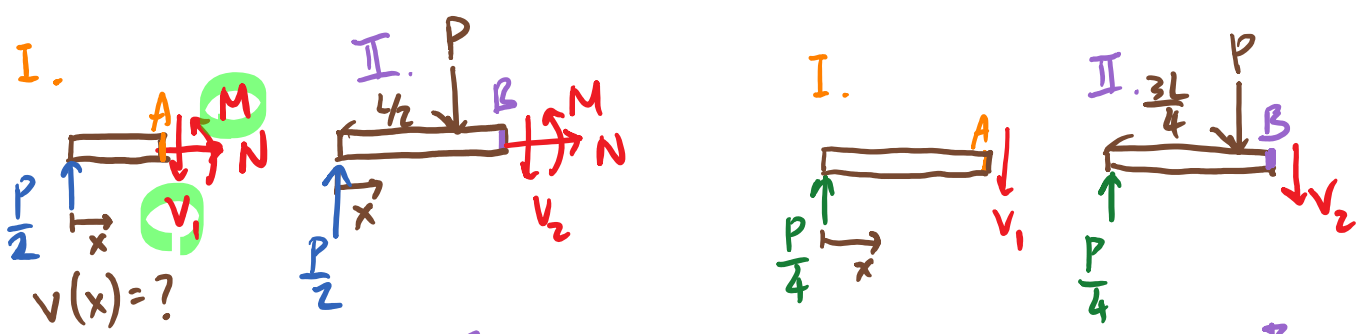
$\Sigma M_A = -P\left(\frac{3L}{4}\right) + B_2 L = 0$

$B_2 = \frac{3}{4}P, \quad A_{2y} = \frac{1}{4}P$

Find support reactions at A & B.

7

Find internal shear forces in regions I and II by cutting somewhere in the middle of those regions.



$V(x) = ?$

$\Sigma F_y = \frac{P}{2} - V = 0$

$V_I = \frac{P}{2}$

$\Sigma F_y = \frac{P}{2} - P - V = 0$

$V_{II} = -\frac{P}{2}$

$\Sigma F_y = \frac{P}{4} - V = 0$

$V_I = \frac{P}{4}$

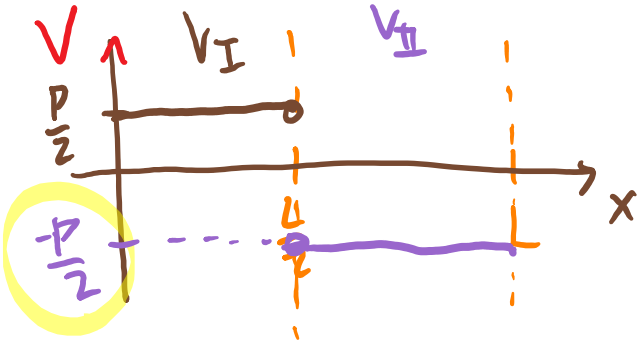
$\Sigma F_y = \frac{P}{4} - P - V_2 = 0$

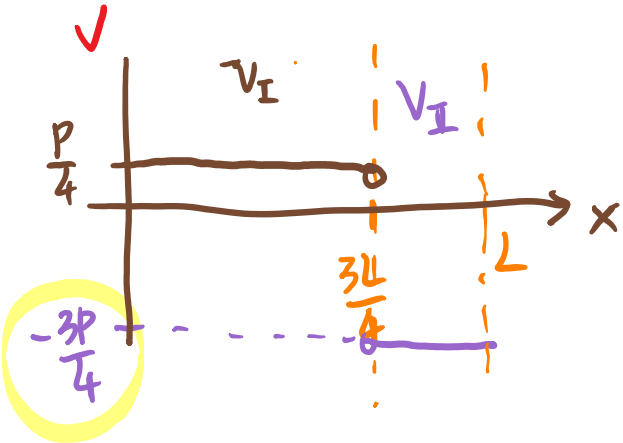
$V_{II} = \frac{-3P}{4}$

$V_I : 0 \le x < \frac{L}{2}$

$V_{II} : \frac{L}{2} < x \le L$

$V_I : 0 \le x < \frac{L}{2}$ $\quad V_{II} : \frac{L}{2} < x \le L$

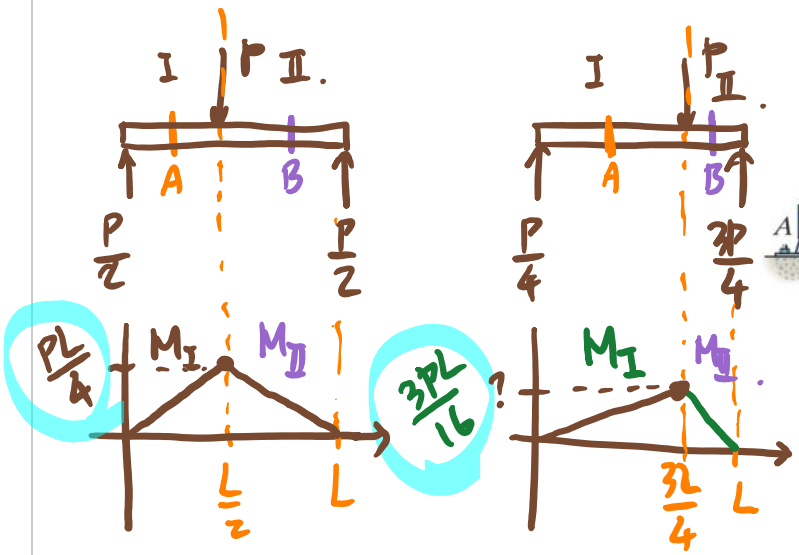


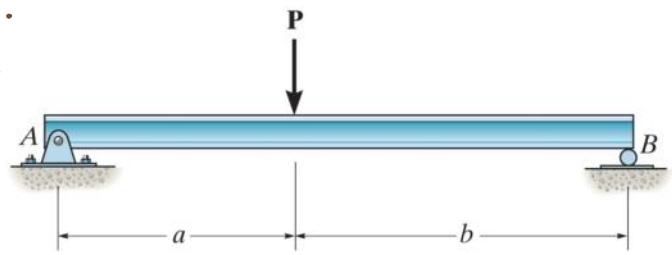


iClicker

<u>Example</u>

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





$$\frac{PL}{4} > \frac{3PL}{16}$$

FBD

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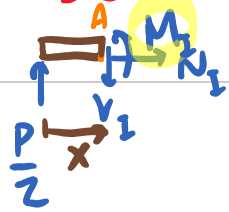
for $0 < x < \frac{L}{2}$



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

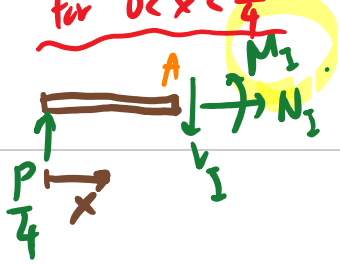
$$M_I = Vx = \left(\frac{P}{2}\right)x$$

$$M_I(x=0) = 0$$

$$M_I\left(x=\frac{L}{2}\right) = \frac{P}{2}\left(\frac{L}{2}\right) = \frac{PL}{4}$$

for $\frac{L}{2} < x < L$

for $0 < x < \frac{3L}{4}$



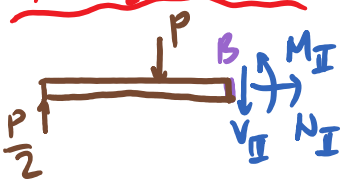
$$\Sigma M_A = -V_I x + M_I = 0$$

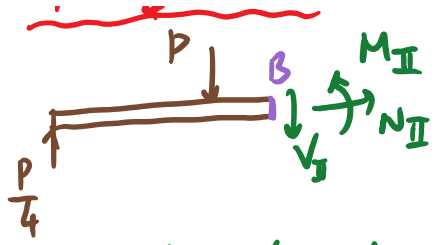
$$M_I = V_I x = \frac{P}{4}x$$

$$M_I\left(x=\frac{3L}{4}\right) = \frac{P}{4}\left(\frac{3L}{4}\right) = \frac{3PL}{16}$$

for $\frac{3L}{4} < x < L$

for $\frac{L}{2} < x < L$





$$\Sigma M_A = -P\left(\frac{L}{2}\right) - V_{II}x + M_{II} = 0$$

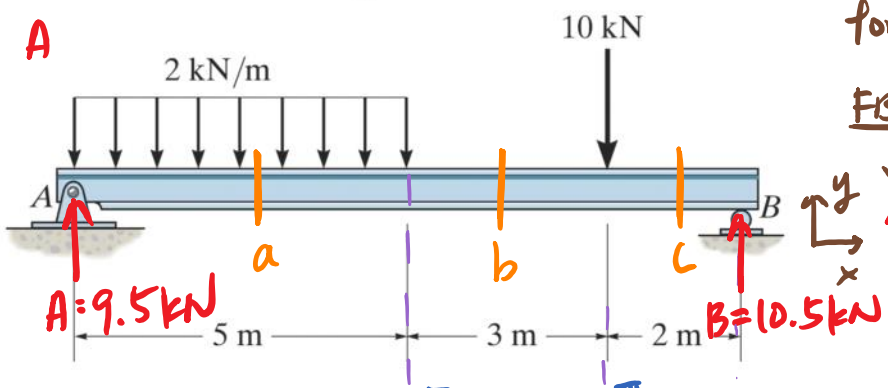
$$M_{II} = \frac{PL}{2} + V_{II}x = \frac{PL}{2} + \left(-\frac{P}{2}\right)x$$

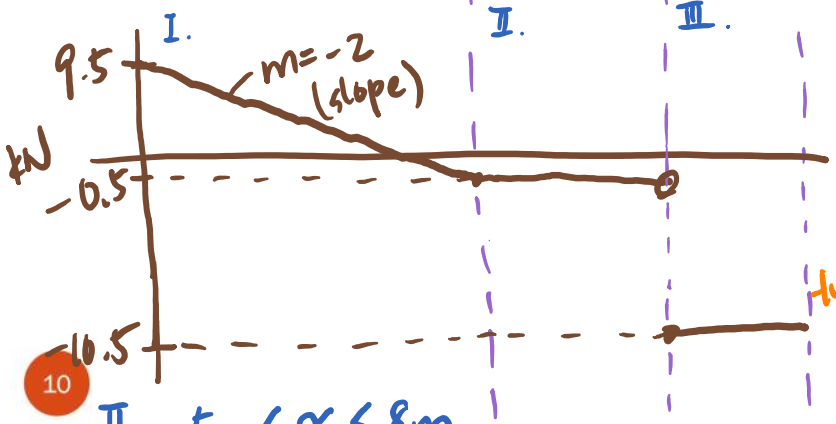
$$\Sigma M_A = -P\left(\frac{3L}{4}\right) - V_{II}x + M_{II} = 0$$

$$M_{II} = \frac{3PL}{4} + \left(\frac{-3P}{4}\right)x$$

Example

Draw the shear diagrams for the beam.

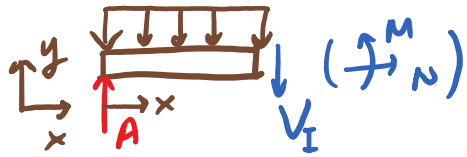




I. $0 < x < 5m$

- cut at a for internal forces in region I.

FBD



$\Sigma F_y = A - (2\,kN/m)x - V_I = 0$

$V_I = 9.5 - 2x$

find V at the two ends of the region

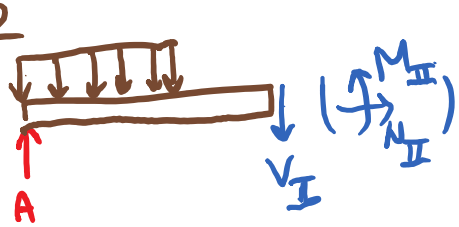
$V_I(x=0) = 9.5\,kN$

$V_I(x=5m) = 9.5 - 2(5) = -0.5\,kN$

II. $5m < x < 8m$

- cut at b.

FBD



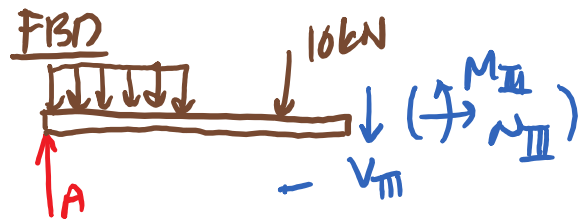
$\Sigma F_y = A - (2kN/m)(5m) - V_{II} = 0$

$V_{II} = 9.5\,kN - 10\,kN = -0.5\,kN$

III. $8m < x < 10m$

- cut at c

FBD



$\Sigma F_y = 9.5\,kN - (2kN/m)(5m) - 10kN - V_{III} = 0$

$V_{III} = -10.5\,kN$