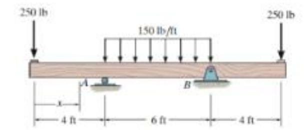
Homework 10

Tuesday, November 10, 2020 5:07 PM

"I pledge my honor I have abided by the Stevens Honor system."

- Alex Gaskins

11-2. Draw the shear and moment diagrams for the beam, and determine the shear and moment in the beam as functions of x for $0 \le x < 4$ ft, 4 ft $< x <$ 10 ft, and 10 ft $< x <$ 14 ft.



$\Sigma M_B = 0$

$-A_y(6) + 250(10) + (6(150)(\frac{6}{2})) - 250(4) = 0$

$6A_y = 4200$

$A_y = 700$ lbs.

$\Sigma F_y = 0$

$A_y + B_y - (6(150)) - 250 - 250 = 0$

$A_y + B_y = 1400$

$(700) + B_y = 1400$

$B_y = 700$ lbs.

$0 \le x < 4$ ft

$V(x) = -250$ lbs. (shear force)

$M(x) = -150$ lb·ft (Bending moment)

4 ft $< x <$ 10 ft

$V(x) = -250 + A_y - (150)(x-4)$

$V(x) = -250 + 700 - (150)(x-4)$

$V(x) = 400 - 150x + 600$

$V(x) = [1050 - 150x]$ lbs.

$M(x) = -250x + A_y(x-4) - (150)(x-4)(\frac{x-4}{2})$

$M(x) = -250x + 700x - 2800 - 75(x^2 - 8x + 16)$

$M(x) = [-75x^2 + 1050x - 4000]$ lb·ft

10 ft $< x \le$ 14 ft

$V(x) = -250 + A_y - 150(6) + B_y$

$V(x) = -250 + 700 - (150(6)) + 700$

$V(x) = 250$ lbs.

$M(x) = -250x + A_y(x-4) - (150(6))(x-7) + B_y(x-10)$

$M(x) = -250x + (700)(x-4) - (150(6))(x-7) + (700)(x-10)$

$M(x) = [250x - 3500]$ lb·ft

Shear force test points:

$V_{x=0} = -250$ lbs.

$V_{x=4^-} = -250$ lbs.

$V_{x=4^+} = [1050 - 150(4)] = 450$ lbs.

$V_{x=10^-} = [1050 - 150(10)] = -450$ lbs.

$V_{x=10^+} = 250$ lbs.

$V_{x=14} = 250$ lbs.

Bending moment test points:

$M_{x=0} = -250x = 0$

$M_{x=4^-} = -250x = -1000$ lb·ft

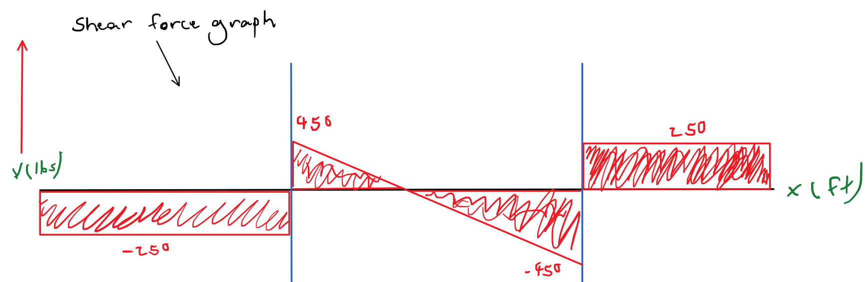
$M_{x=4^+} = [-75x^2 + 1050x - 4000] = -1000$ lb·ft

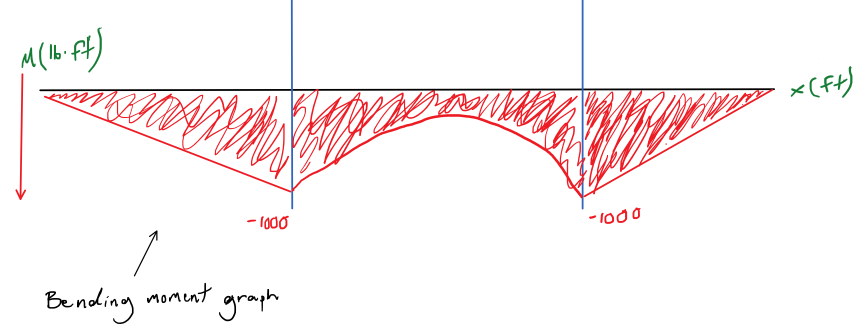
$M_{x=7} = [-75x^2 + 1050x - 4000] = -325$ lb·ft

$M_{x=10^-} = [-75x^2 + 1050x - 4000] = -1000$ lb·ft

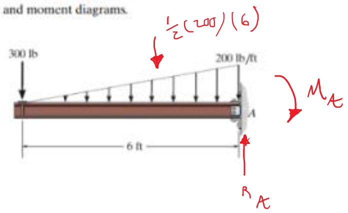
$M_{x=10^+} = [250x - 3500] = -1000$ lb·ft

$M_{x=14} = [250x - 3500] = 0$





11-5. Express the internal shear and moment in the cantilevered beam as a function of x and then draw the shear and moment diagrams.



$\Sigma F_y = 0$

$R_A - 300 - \frac{1}{2}(200)(6) = 0$

$R_A = 900$ lbs.

$M_A - R_A(6) + \frac{1}{2}(200)(6)(4) = 0$

$M_A - 900(6) + \frac{1}{2}(200)(6)(4) = 0$

$M_A = 3000$ lb·ft

$W = 200(\frac{x}{6})$

$W = 33.33x$

Shear force test points:

$\Sigma F_y = 0$

$-300 - \frac{1}{2}(33.33x)(x) - V = 0$

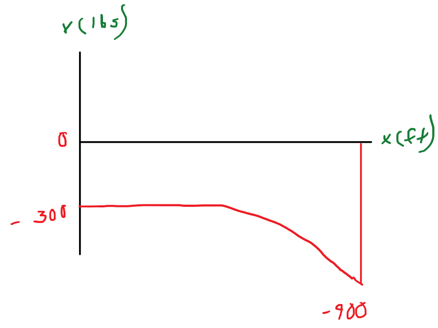
$V = (-300 - 16.67x^2)$ lb

$x = 0$

$V = -300$ lbs.

$x = 6$

$V = -900$ lbs.



Bending moment test points:

$\Sigma M_x = 0$

$M + \frac{1}{2}(33.33x)(x)(\frac{x}{3}) + 300x = 0$

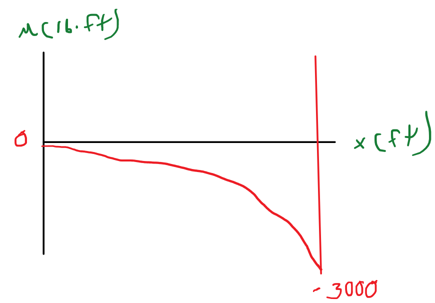
$M = (-300x - 5.556x^3)$ lb·ft

$x = 0$

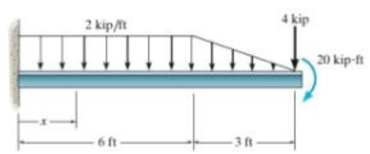
$M = 0$

$x = 6$

$M = 3000$ lb·ft



***11-8.** Draw the shear and moment diagrams for the beam, and determine the shear and moment throughout the beam as functions of x for $0 \le x \le 6$ ft and 6 ft $\le x \le 9$ ft.



$\Sigma F_y = 0$

$R_A - (2(9)) - 4 + (\frac{6}{2}) = 0$

$R_A = 19$ kip.

$\Sigma M_A = 0$

$M_A - (18(4.5)) - 4(9 - 20) + 3(8) = 0$

$M_A = 113$ kip·ft

$\Sigma F_y = 0$

$R_A - 2x - V_x = 0$

$V_x = 19 - 2x$

$\Sigma M_x = 0$

$M_A - R_A(x) + 2x(\frac{x}{2}) + M_x = 0$

$M_x = 19x - x^2 - 113$

$\Sigma F_y = 0$

$R_A - 2x + \frac{1}{2}(x-6)y - V_x = 0$

$V_x = 19 - 2x + \frac{(x-6)^2}{3}$

6 ft $\le x \le 9$ ft

$\Sigma M_x = 0$

$M_A - R_A(x) + 2x(\frac{x}{2}) - [\frac{1}{2}(x-6)xy]\frac{1}{3}(x+6) + M_x = 0$

$M_x = \frac{(x-6)^3}{9} - x^2 + 19x - 113$

Shear force:

A = 19 kip

B = 4 kip

C = 7 kip

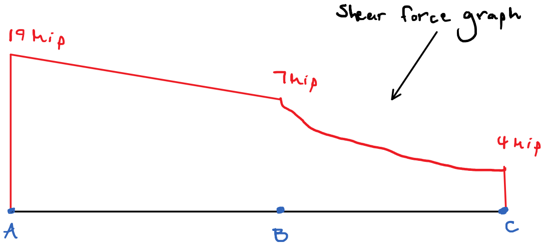
Bending moment:

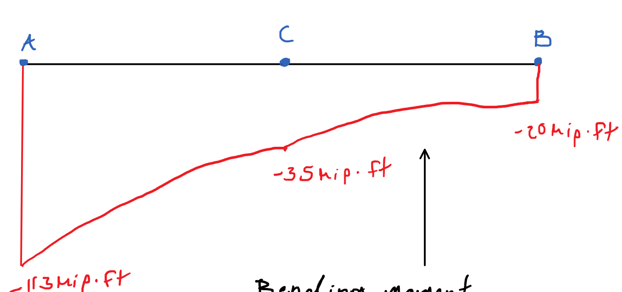
A = -113 kip·ft

B = -20 kip·ft

C = -35 kip·ft

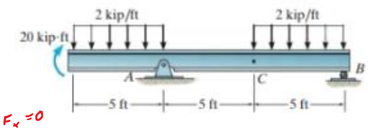
Shear force graph





Bending moment graph

11–21. Draw the shear and moment diagrams for the beam.



$\Sigma F_x = 0$

$A_x = 0$

$\Sigma M_B = 0$

$A_y(10) + 20 - (2(5))\left(10 + \frac{5}{2}\right) - 10\left(\frac{5}{2}\right)$

$A_y = 13$ kip.

$\Sigma F_y = 0$

$A_y + B_y - 2(5) - 2(5) = 0$

$A_y + B_y = 20$

$13 + B_y = 20$

$B_y = 7$ kip.

$\Sigma F_y = 0$

$-(2x) - V = 0$

$V = -2x$

$x = 0$

$V = 0$

$x = 5$

$V = -10$ kip.

Bending moment:

$\Sigma M_x = 0$

$-20 + 2x\left(\frac{x}{2}\right) + M_x = 0$

$M_x = 20 - x^2$

$x = 0$

$M_x = 0$

$x = 5$

$M_x = -5$ kip·ft

$M = 0$

$20 - x^2 = 0$

$x = \sqrt{20}$

$x = 4.472$ ft.

$\Sigma F_y = 0$

$-10 + A_y - V = 0$

$V = A_y - 10$

$V = 13 - 10$

$V = 3$ kips.

$x = 5$ $\quad$ $x = 10$

$V = 3$ kips. $\quad$ $V = 3$ kips.

$\Sigma M_x = 0$

$-20 + 10\left(x - \frac{5}{2}\right) - A_y(x-5) + M = 0$

$M = 20 - 10\left(x - \frac{5}{2}\right) + 13(x-5)$

$x = 5$ $\quad$ $x = 10$

$M = -5$ kip·ft $\quad$ $M = 10$ kip·ft

$M = 0$

$20 - 10\left(x - \frac{5}{2}\right) + 13(x-5) = 0$

$x = 6.667$ ft.

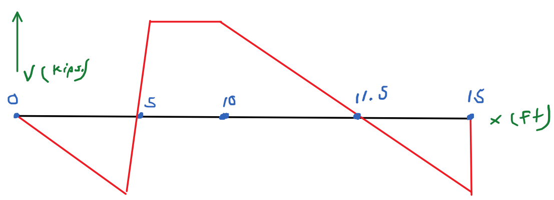
$\Sigma F_y = 0$

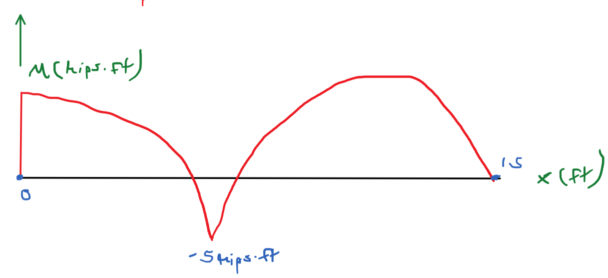
$-10 + A_y - 2(x-10) - V = 0$

$V = 3 - 2(x-10)$

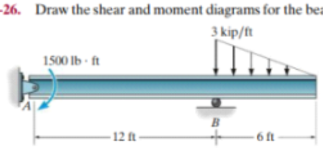
$x = 10$ $\quad$ $x = 15$ $\quad$ $V = 0$

$V = 3$ kips $\quad$ $V = -7$ kips. $\quad$ $x = 11.5$ ft.





11–26. Draw the shear and moment diagrams for the beam.



$\Sigma M_A = 0$

$-1.5 - (9(15)) + B_y(12) = 0$

$B_y = 10.625$ kip.

$\Sigma F_y = 0$

$A_y + B_y - 9 = 0$

$A_y + B_y = 9$

$A = -1.625$ kip.

$\frac{w'}{18-x} = \frac{3}{6}$

$w' = \frac{3}{6}(18-x)$

$w = 3 - w'$

$w = 3 - \frac{3}{6}(18-x)$

Shear $0 \le x < 12$ ft

$\Sigma F_y = 0$

$V = A_y$

$V = -1.625$ kip.

Bending Moment $0 \le x < 12$ ft

$\Sigma M = 0$

$M = A_y(x) + 1.5$

$M = [-1.625x + 1.5]$ kip·ft

Shear 12 ft $< x \le 18$ ft

$\Sigma F_y = 0$

$V = A_y + B_y - \frac{1}{2}\left(3 - \frac{3(18-x)}{6}\right)(x-12)$

$V = -1.625 + 10.625 - \frac{1}{2}\left(3 - \frac{3(18-x)}{6}\right)(x-12)$

$x = 12^+$ $\quad$ $x = 18$

$V = 9$ kips $\quad$ $V = 0$

Bending Moment 12 ft $< x \le 18$ ft

$M = -1.625 + 10.625(x-12) - \frac{1}{2}\left(3 - \frac{3(18-x)}{6}\right)(x-12)\left(\frac{2(x-12)}{3}\right)$

$x = 12$ $\quad$ $x = 18$

$M = -18$ kip·ft $\quad$ $M = 0$