King Fahd University of Petroleum & Minerals
CIVIL ENGINEERING DEPARTMENT

# CE 201 STATICS (Sections 1 & 2)

Second Semester 1432 / 2011 (102)

Name: Key
ID #: _____

**Quiz # 10**

Score ___ / 10

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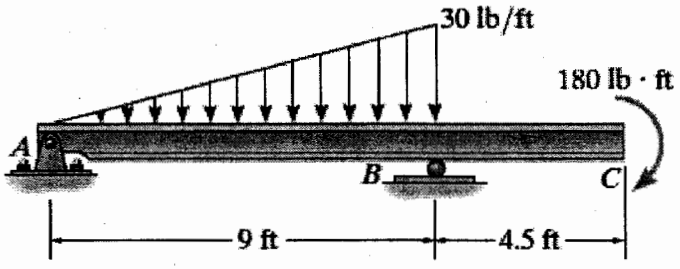
**Draw the shear and moment diagrams** for the beam using the equations.

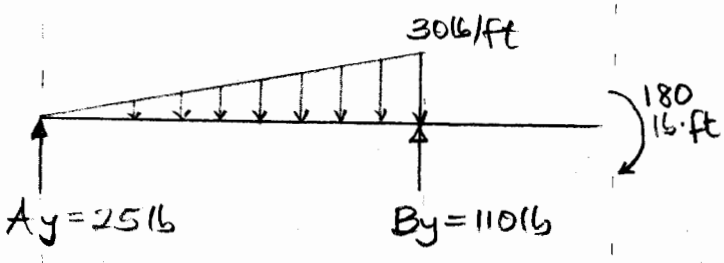



$\overset{+}{\circlearrowleft}\sum M_B = -9A_y + \frac{1}{2}(30)(9)(3) - 180 = 0$

$+\uparrow \sum F_y = A_y + B_y - \frac{1}{2}(30)(9) = 0$

$\Rightarrow A_y = 25\,lb,\ B_y = 110\,lb$

Given the beam as shown, its required to generate BM & SF equations & diagrams




Solution: We have 2 sections:

Section 1: AB [$0' \le x \le 9'$]

From the FBD shown,

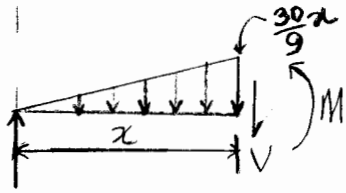



fig. 1

$+\uparrow \sum F_y = 0 \Rightarrow \boxed{V = V(x) = 25 - \frac{5}{3}x^2}$

$V = 0$ @ $x = \sqrt{\frac{25\times 3}{5}} = 3.87'$

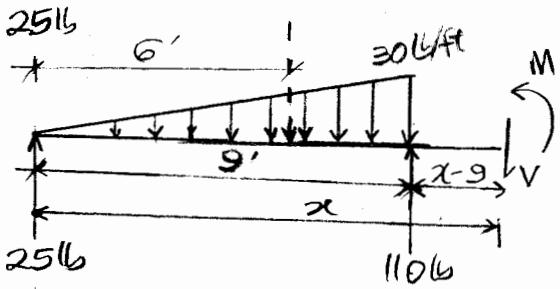



fig. 2

$\overset{+}{\circlearrowleft}\sum M = 0 \Rightarrow \boxed{M = M(x) = 25x - \frac{5x^3}{9}}$

$M_{max} = M(3.87) = 64.55\,lb\cdot ft$

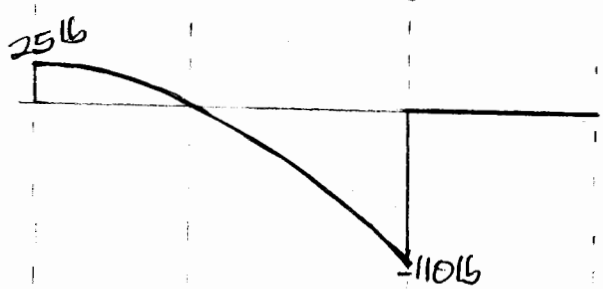



fig. 3

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Section 2: BC [$9' \le x \le 13.5'$]

From the FBD shown,

$+\uparrow \sum F_y = 0 \Rightarrow \boxed{V = V(x) = 0}$

$\overset{+}{\circlearrowleft}\sum M = 0 \Rightarrow \boxed{M = M(x) = -180}$

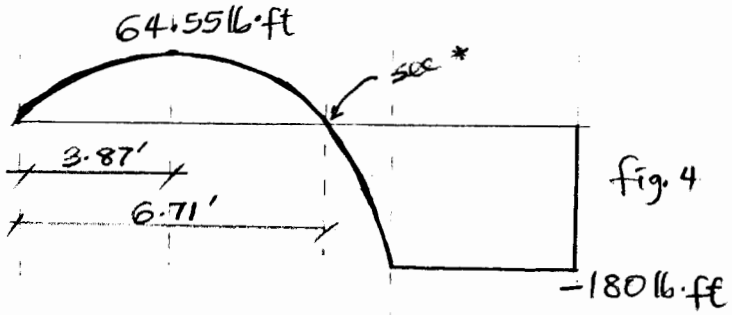


fig. 4

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* From section 1,

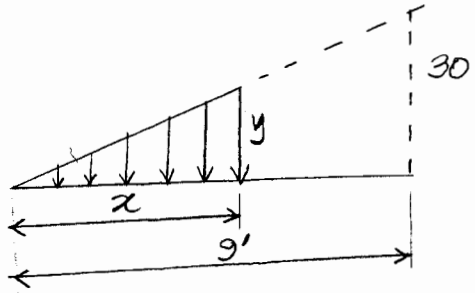
$M = 0$ @ $x = \sqrt{9\times 5} = 6.71'$

*Note: See the attached details for the calculations

# Details of the calculations

Support reactions: calculation shown in the solution

## Section 1: AB $[0' \le x \le 9']$




By Similar triangles,

$$\frac{y}{x} = \frac{30}{9} \Rightarrow y = \frac{30}{9}x$$

From the FBD shown (fig. 1)

$$+\uparrow \Sigma F_y = -\frac{1}{2}\cdot\frac{30}{9}x\cdot x - V = 0 \Rightarrow \boxed{V = 25 - \frac{5x^2}{3}}$$

When $V = 0$, $25 - \frac{5x^2}{3} = 0$ ; $x = \pm\sqrt{\frac{25\times3}{5}} = \pm\sqrt{15}$

We take +ve value since $x$ is defined in $0' \le x \le 9'$

Hence @ $V = 0$, $x = 3.87'$

Also from the FBD (fig 1),

$$\overset{+}{\circlearrowleft} \Sigma M = -25x + \frac{1}{2}\cdot\frac{30}{9}x\cdot x\cdot\frac{x}{3} + M = 0 \Rightarrow \boxed{M = 25x - \frac{5}{9}x^3}$$

M is max @ $V = 0 \Rightarrow M_{max} = M(3.87) = 25(3.87) - \frac{5}{9}(3.87)^3 = 64.55\ lb\cdot ft$

When $M = 0$, $25x - \frac{5}{9}x^3 = 0$ ; $5x\left(5 - \frac{1}{9}x^2\right) = 0$

This equation has 3 roots: $x = 0$, $x = \pm\sqrt{9\times5} = \pm 6.71$

Since $x$ is defined in $0' \le x \le 9'$, we choose $+6.71'$, apart from $x = 0$

Thus the BM curve crosses the 'x' axis at $x = 6.71'$ as shown in fig. 4

## Section 2: BC $[9' \le x \le 13.5']$

From fig. 2, $+\uparrow \Sigma F_y = 25 - \frac{1}{2}(30)(9) + 110 - V = 0$

$$\Rightarrow \boxed{V = 0}$$

Also from fig 2, $\overset{+}{\circlearrowleft} \Sigma M = -25x - 110(x-9) + \frac{1}{2}(30)(9)(x-6) + M = 0$

$$-25x - 110x + 990 + 135x - 810 + M = 0$$

$$\Rightarrow \boxed{M = -180}$$