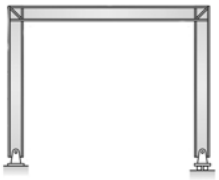
Shear and Moment Diagrams for Frames

- A ***frame*** is a structure composed of several members that are either fixed– or pin–connected at their ends.
- It is often necessary to draw shear and moment diagrams to design frames.



Shear and Moment Diagrams for Frames

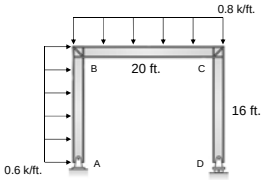
Procedure for analysis - the following is a procedure for constructing the shear and moment diagrams for a frame

1. Determine the support reactions for the frame, if possible.
2. Determine the support reactions ***A***, ***V***, and ***M*** at the end of each member using the method of sections.
3. Construct both shear and moment diagrams just as before.

   We will use the following sign convention: *always draw the moment diagram on the compression side of the member.*

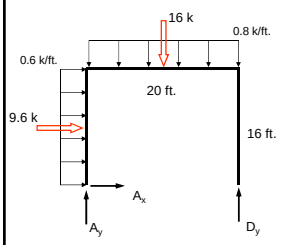
Shear and Moment Diagrams for Frames

Example: Draw the shear and moment diagrams for the following frame:



Shear and Moment Diagrams for Frames

First, find as many external reactions as possible.



$$\circlearrowleft^{+}\sum M_A = 0$$

$$= -9.6\,\text{k}(8\,\text{ft.}) - 16\,\text{k}(10\,\text{ft.}) + D_y(20\,\text{ft.})$$

D_y = 11.84 k

$$+\uparrow \sum F_y = 0 = A_y + D_y - 16\,\text{k}$$

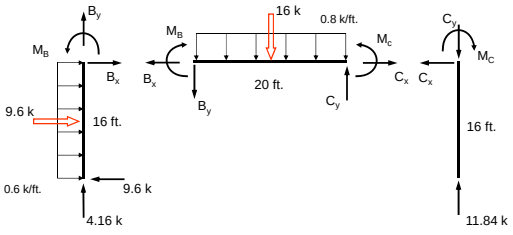
A_y = 4.16 k

$$\overset{+}{\rightarrow}\sum F_x = 0 = A_x + 9.6\,\text{k}$$

A_x = -9.6 k

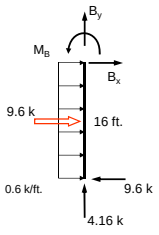
Shear and Moment Diagrams for Frames

Second, cut the frame into its component members and find the internal reactions



Shear and Moment Diagrams for Frames

Next, solve the equations of equilibrium for each member. Let's start with member AB.



$$\circlearrowleft^{+}\sum M_B = 0 = M_B + 9.6\,\text{k}(8\,\text{ft.}) - 9.6\,\text{k}(16\,\text{ft.})$$

M_B = 76.8 k ft.

$$+\uparrow \sum F_y = 0 = 4.16\,\text{k} + B_y$$

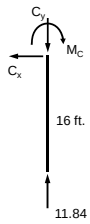
B_y = -4.16 k

$$\overset{+}{\rightarrow}\sum F_x = 0 = B_x - 9.6\,\text{k} + 9.6\,\text{k}$$

B_x = 0

Shear and Moment Diagrams for Frames

Next, solve the equations of equilibrium for member CD.



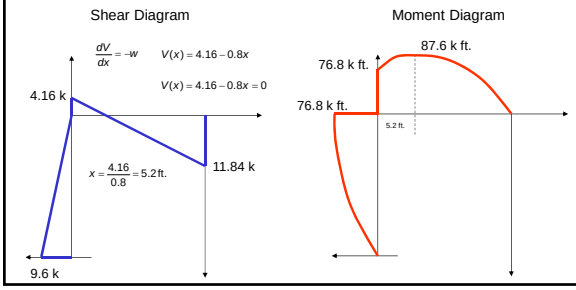
$$\sum M_C = 0 = -M_C \qquad \boxed{M_C = 0}$$

$$\sum F_y = 0 = 11.84\,\text{k} - C_y \qquad \boxed{C_y = 11.84\ \text{k}}$$

$$\sum F_x = 0 = -C_x \qquad \boxed{C_x = 0}$$

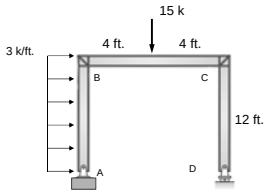
Shear and Moment Diagrams for Frames

Now, let's draw the shear and moment diagram (remember to draw the diagram on the compression side of the member).



Shear and Moment Diagrams for Frames

Example: Draw the shear and moment diagrams for the following frame:



Shear and Moment Diagrams for Frames

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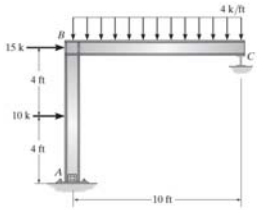

Shear and Moment Diagrams for Frames

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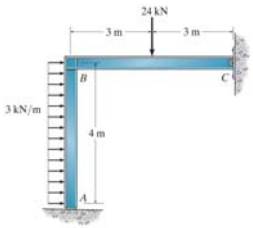

Shear and Moment Diagrams for Frames

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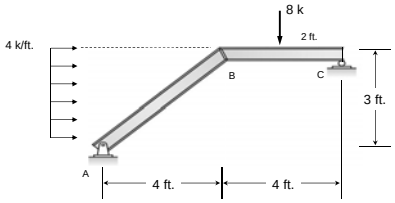
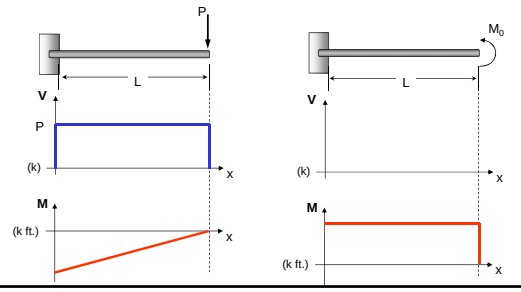


Shear and Moment Diagrams by Superposition

- We have learned how to construct a moment diagram from either writing the moment as a function of *x* or from the slope relationship with the shear diagram.
- If the beam or frame is linearly elastic, we can use the principles of superposition to construct moment diagrams from a series of parts rather than from a single complex shape.

Shear and Moment Diagrams by Superposition

Most loadings on beams and frames in structural analysis can be formed as a combination of the following loadings:



Shear and Moment Diagrams by Superposition

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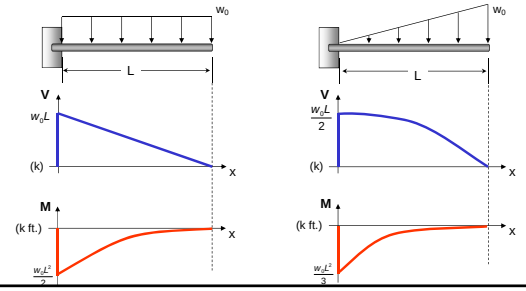
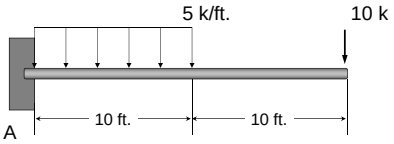


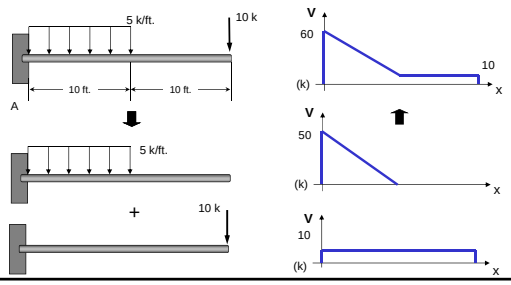
Shear and Moment Diagrams by Superposition

Example: Draw the shear and moment diagrams for the following beam using superposition.



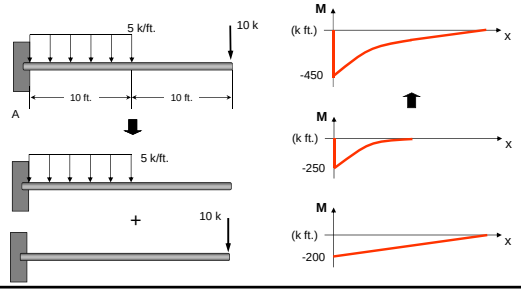
Shear and Moment Diagrams by Superposition

The shear diagrams using superposition



Shear and Moment Diagrams by Superposition

The moment diagrams using superposition



Shear and Moment Diagrams by Superposition

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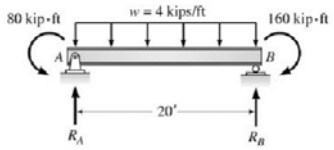

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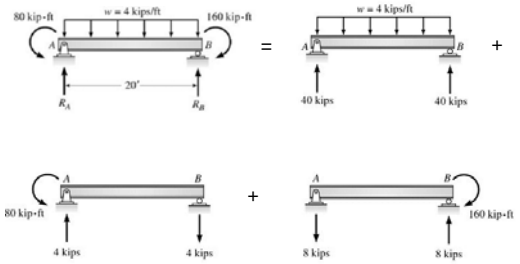

Shear and Moment Diagrams by Superposition

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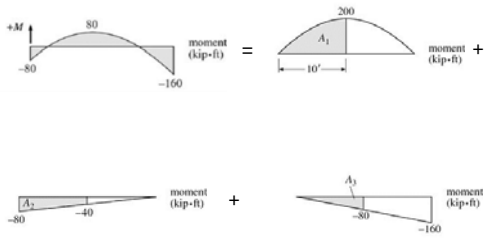

Shear and Moment Diagrams by Superposition

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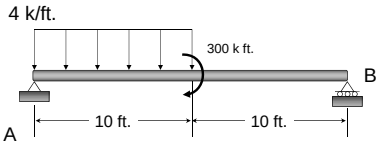

End of Internal Loads – Part 4

Any questions?