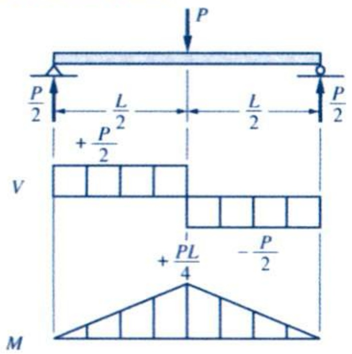
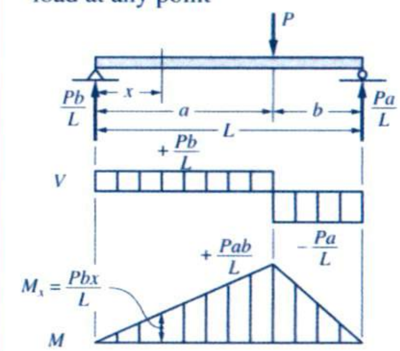
13-9
Shear and Moment Formulas

TABLE 13–1 Shear and Moment Formulas for Some Simple Loadings

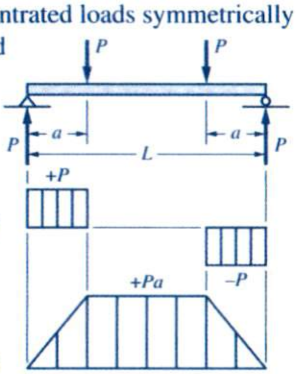
1. Simple beam with a concentrated load at the center



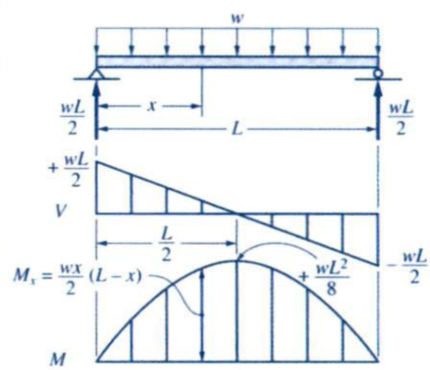
2. Simple beam with a concentrated load at any point



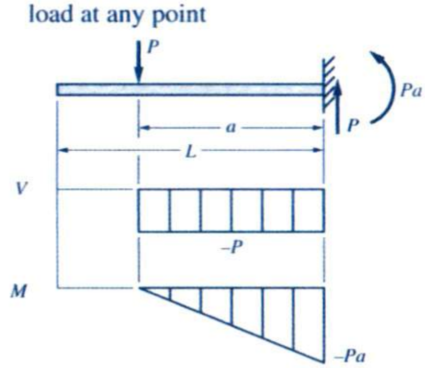
3. Simple beam with two equal concentrated loads symmetrically placed



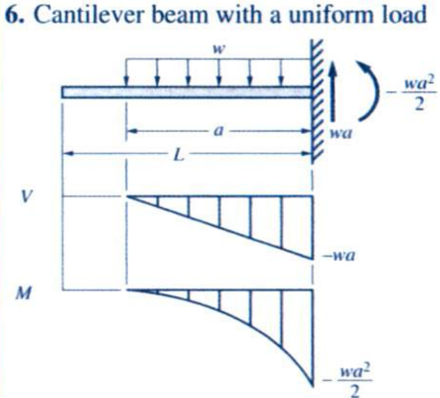
4. Simple beam with a uniform load



5. Cantilever beam with a concentrated load at any point

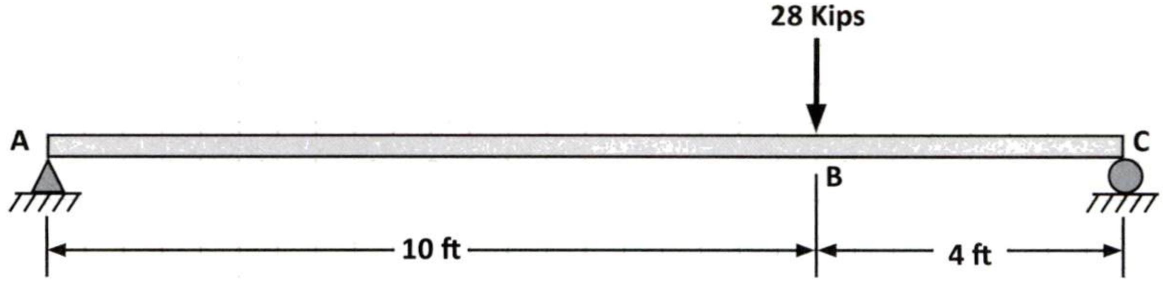


6. Cantilever beam with a uniform load

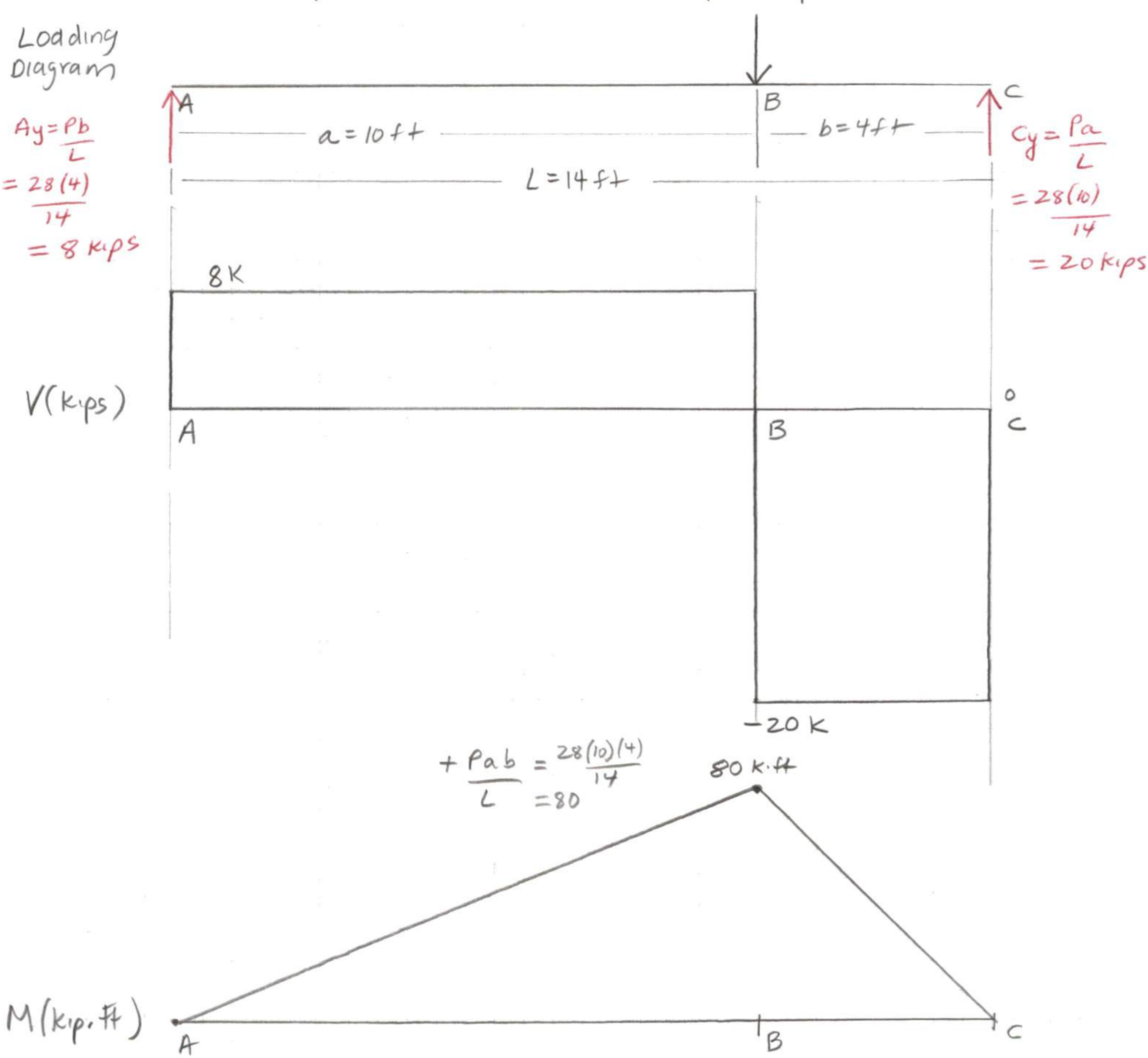


Example

Draw the shear force and bending moment diagrams for the beam subjected to the loading shown. Find the maximum shear force and the maximum bending moment.



Solution. Table 13-1, case 2.



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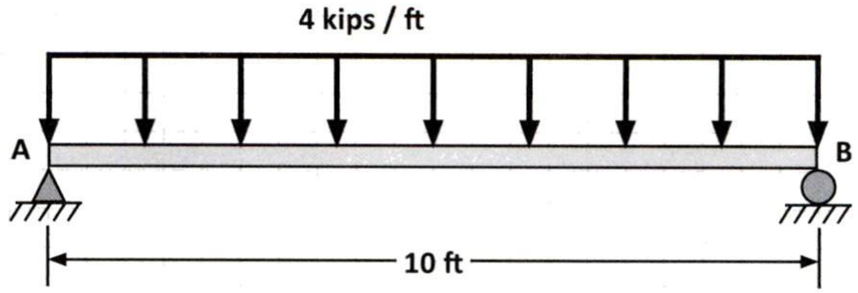


Solution.

Table 13-1, case 4

Loading Diagram

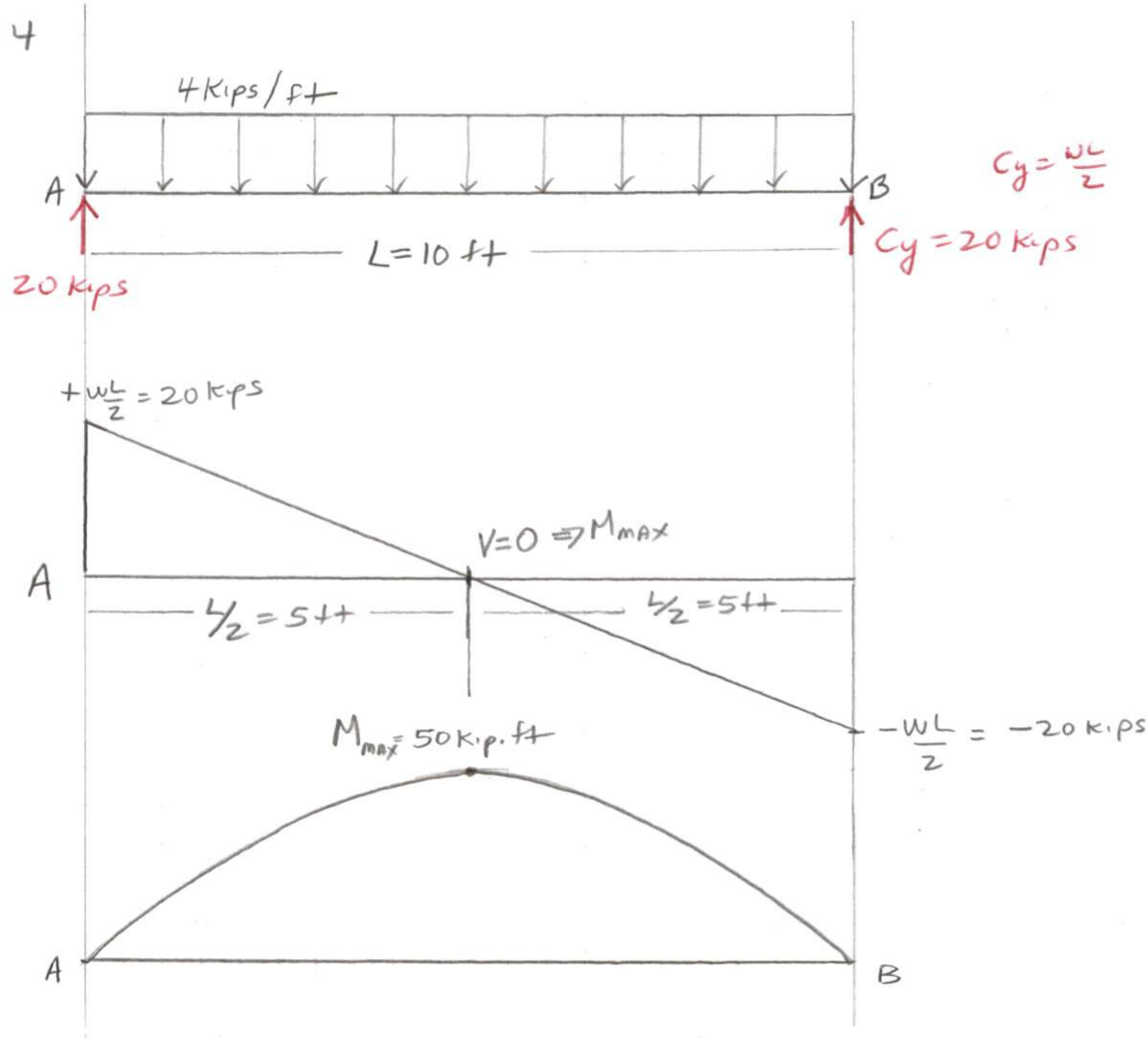
$A_y = \frac{wL}{2}$

$= \frac{4 \frac{kips}{ft}(10ft)}{2}$

$A_y = 20$ kips

V (kips)

M (kip.ft)



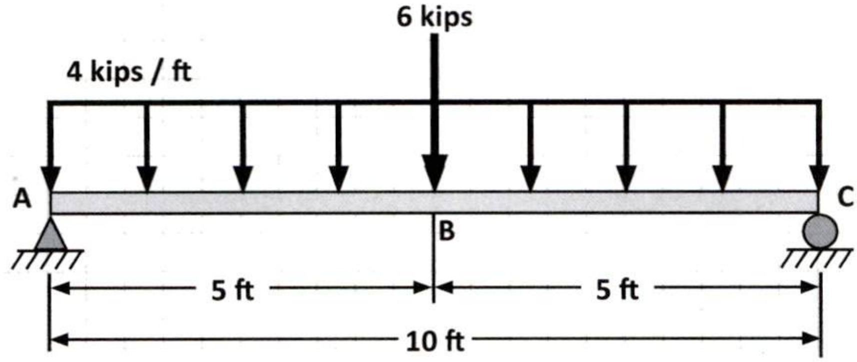
From Table 13-1, case 4

$$M_{MAX} = +\frac{wL^2}{8} = \frac{4\frac{kips}{ft}(10ft)^2}{8} = 50 \text{ kip.ft}$$

The Method of Superposition

- If the maximum shear or the maximum moment is required for a beam subjected to a loading consisting of several forces, the method of superposition can be used.
- Using this method, the effect of each load is computed separately and the combined effect is added algebraically.

Example



Solution.

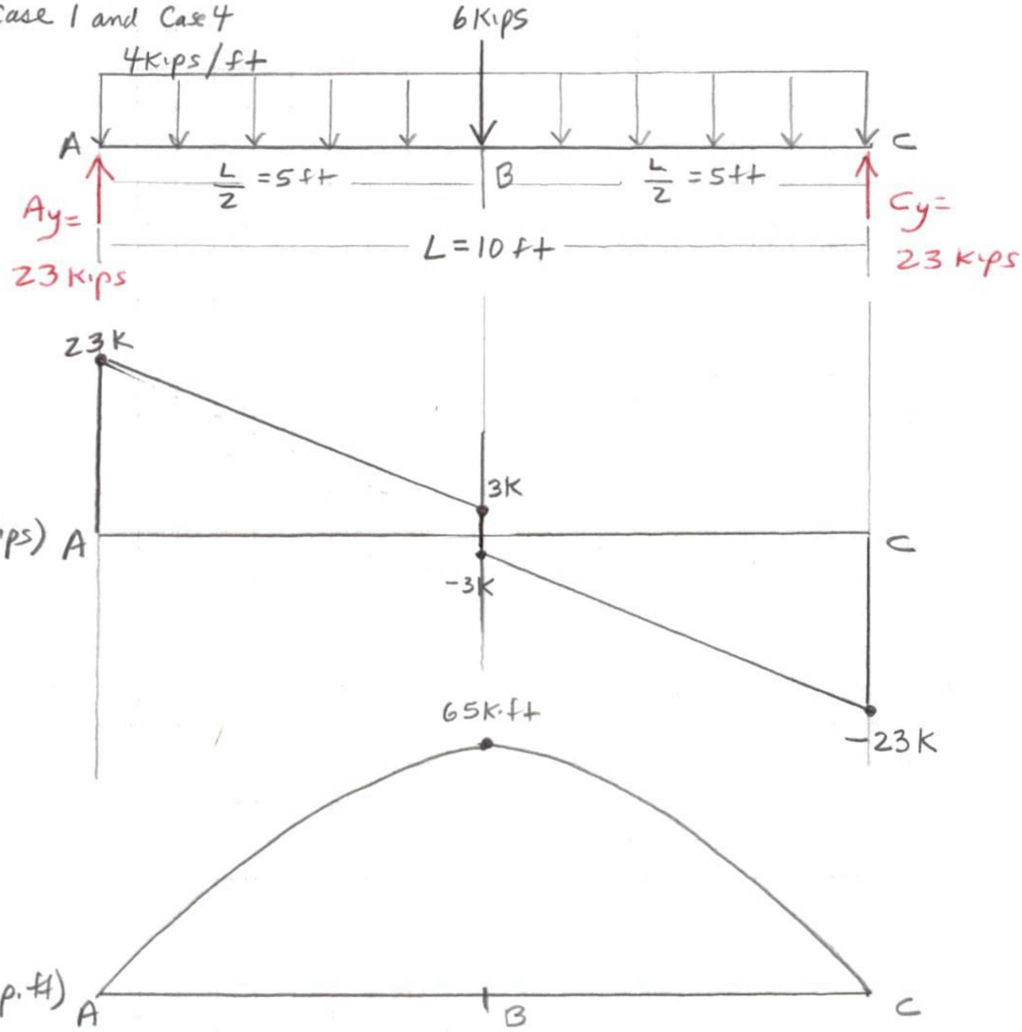
Table 13-1, Case 1 and Case 4

Loading Diagram

$A_y = \frac{P}{2} + \frac{wL}{2}$

$= \frac{6}{2} + \frac{4(10)}{2}$

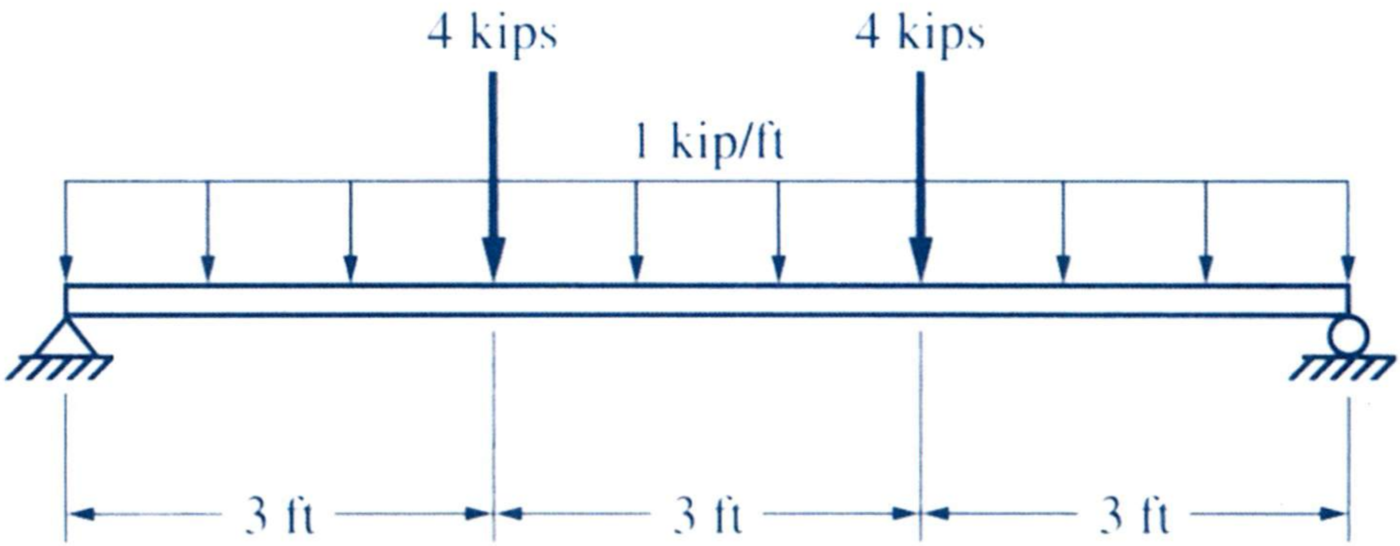
$= 23$ kips



$M_{MAX} = \frac{PL}{4} + \frac{wL^2}{8} = \frac{6(10)}{4} + \frac{4(10)^2}{8} = 15 + 50 = 65$ kip·ft

Example 13-10

Find the maximum shear force and the maximum bending moment in the simple beam due to the loading shown.



Solution.

Table 13-1, case 3 and Case 4

By Superposition,

$$V_{MAX} = P + \frac{wL}{2} = 4\text{ kips} + \frac{1\text{ kip/ft}\,(9\text{ ft})}{2} = 8.5\text{ kips}$$

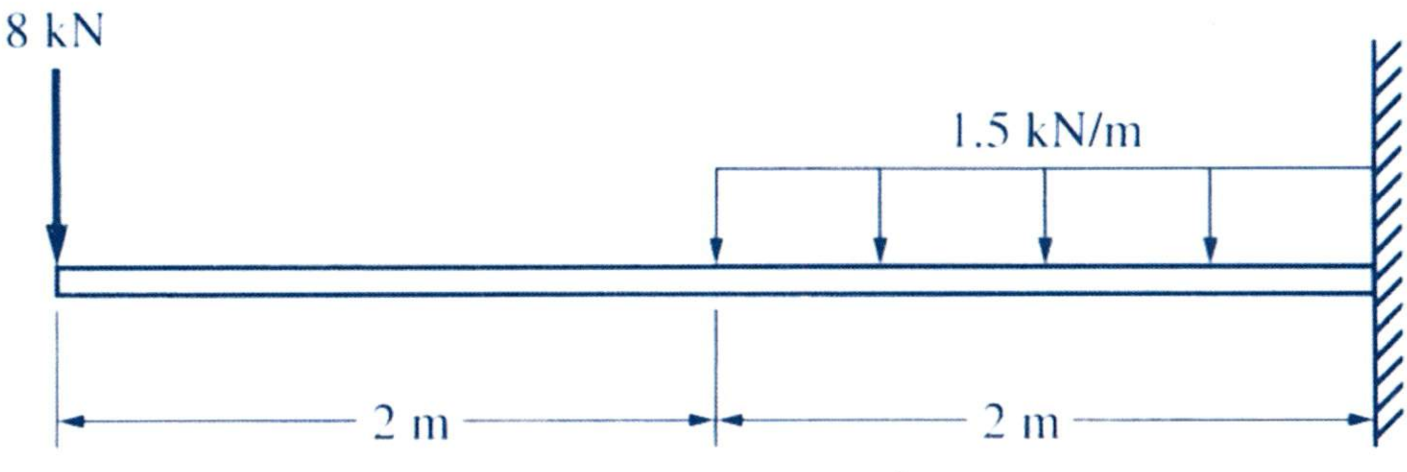
$$M_{MAX} = Pa + \frac{wL^2}{8} = 4\text{ kips}\,(3\text{ ft}) + \frac{1\text{ kip/ft}\,(9\text{ ft})^2}{8}$$

$$= 12\text{ kip ft} + 10.125$$

$$M_{MAX} = 22.125\text{ kip.ft}$$

Example 13-11

Find the maximum shear force and the maximum bending moment in the simple beam due to the loading shown.



Solution.

Table 13-1, case 5 and Case 6

$$|V_{MAX}| = P + wa = 8\text{ kN} + 1.5\frac{\text{kN}}{\text{m}}(2\text{m}) = \underline{\underline{11\text{ kN}}}$$

"Pa" (a=L)

$$|M_{MAX}| = PL + \frac{wa^2}{2} = 8\text{kN}(4\text{m}) + \frac{1.5\frac{\text{kN}}{\text{m}}(2\text{m})^2}{2}$$

$$= \underline{\underline{35\text{ kN}\cdot\text{m}}}$$