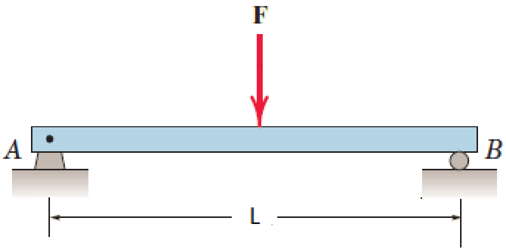
3.5 Types of External Loads

a) Concentrated Load (F) الحمل المركز



b) Distribution Load: الحمل المنتشر

Distribution Load can be represented as single load acting on the center point of the distribution area.

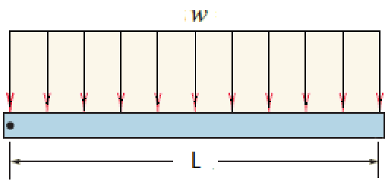
يمكن تمثيل الحمل المنتشر على أنه حمل مفرد يؤثر في نقطة مركز مساحة الحمل المنتشر

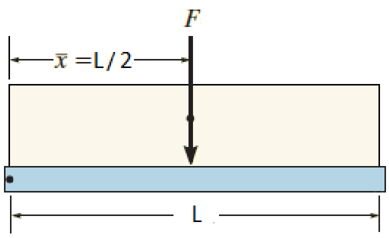
Single load: area of distribution load. الحمل المفرد: مساحة الحمل المنتشر

Point of action: center point of the area. نقطة التأثير: نقطة مركز المساحة

i. Liner Distribution Load:

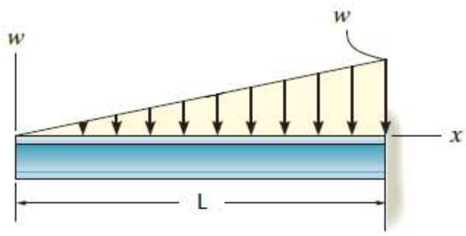
1- Rectangular load:

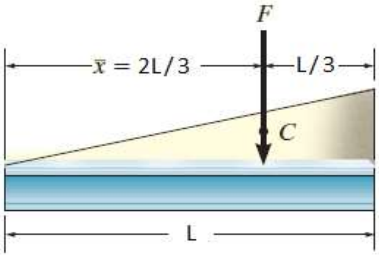




$F = wL$

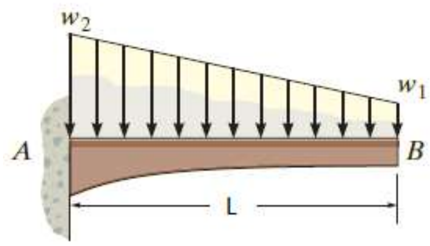
2- Triangular load:

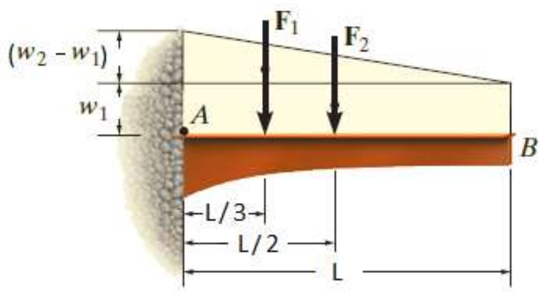




$$F = \frac{1}{2} wL$$

3- Trapezoidal load:





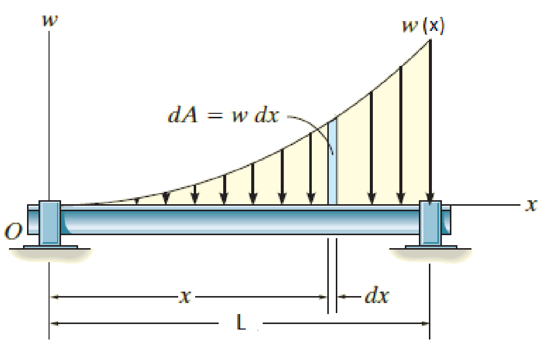
$$F_1 = \frac{1}{2}(w_2 - w_1)L$$

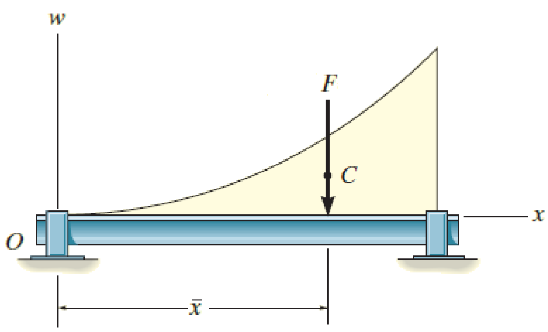
$$F_2 = w_1 L$$

ii. Nonlinear Distribution Load

The resultant force (F) is equivalent to the area under the distribution loading curve and acts through centroid of this area.

محصلة القوة الناتجة (F) تكافئ مساحة المنطقة الواقعة تحت منحنى الحمل المنتشر وتؤثر في نقطة مركز المساحة.

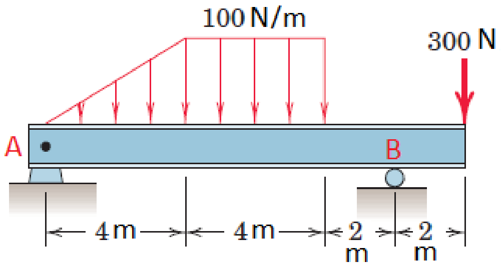




$$F = \int_0^L w(x) \cdot dx$$

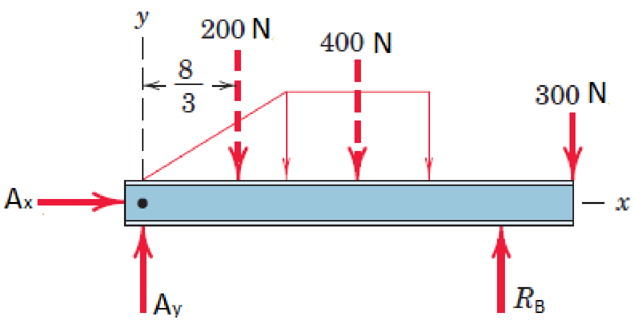
$$\bar{x} = \frac{\int_0^L w(x) \cdot x \cdot dx}{\int_0^L w(x) \cdot dx}$$

Example No. 1: For the beam shown in figure, determine the reaction at A and B.



Solution:

Draw F.B.D. for beam AB



$$F_1 = 100 \times 4 = 400\ N$$

$$F_2 = \frac{1}{2} \times 100 \times 4 = 200\ N$$

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

$$200 \times \left(\frac{2}{3} \times 4\right) + 400 \times 6 + 300 \times 12 - R_B \times 10 = 0$$

$R_B = 653.333\ N \quad \uparrow$ *answer*

$$\rightarrow^{+} \sum F_x = 0$$

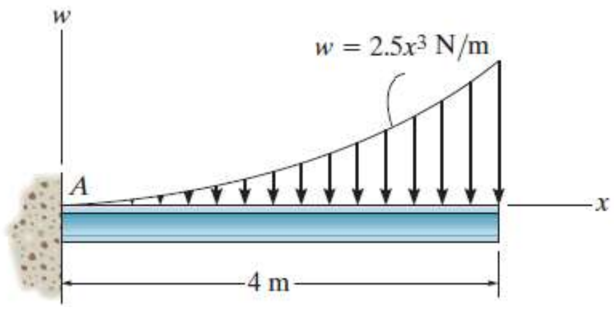
$A_x = 0$ *answer*

$$\uparrow^{+} \sum F_y = 0$$

$$A_y + 653.333 - 300 - 400 - 200 = 0$$

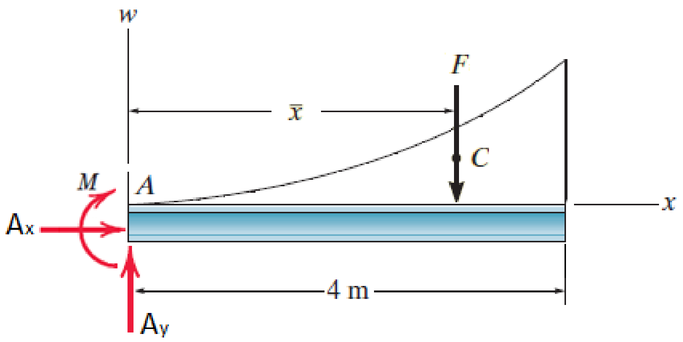
$A_y = 246.667\ N \quad \uparrow$ *answer*

Example No. 2: For the beam shown in figure, determine the reaction at Fixed A.



Solution:

Draw F.B.D. for beam AB



$$F = \int_0^L w(x) \cdot dx = \int_0^4 2.5\, x^3 \cdot dx = 2.5\, \frac{x^4}{4}\Big]_0^4 = 160\ N$$

$$\bar{x} = \frac{\int_0^L w(x) \cdot x \cdot dx}{\int_0^L w(x) \cdot dx} = \frac{\int_0^4 2.5\, x^4 \cdot dx}{160} = \frac{2.5\, \frac{x^5}{5}\Big]_0^4}{160} = \frac{512}{160} = 3.2\ m$$

$$\rightarrow^{+} \sum F_x = 0 \qquad \rightarrow \qquad A_x = 0 \quad \textit{answer}$$

$$\uparrow^{+} \sum F_y = 0$$

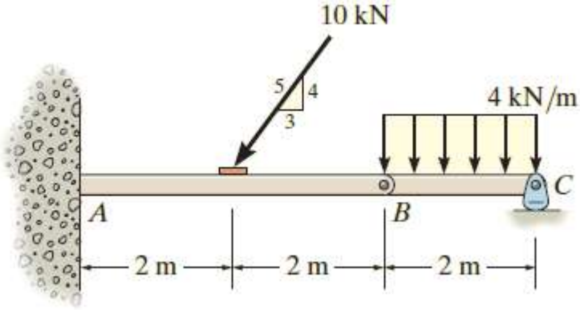
$$A_y - 160 = 0 \qquad \rightarrow \qquad A_y = 160\ N\ \uparrow \quad \textit{answer}$$

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

$$M_A + 160 \times 3.2 = 0$$

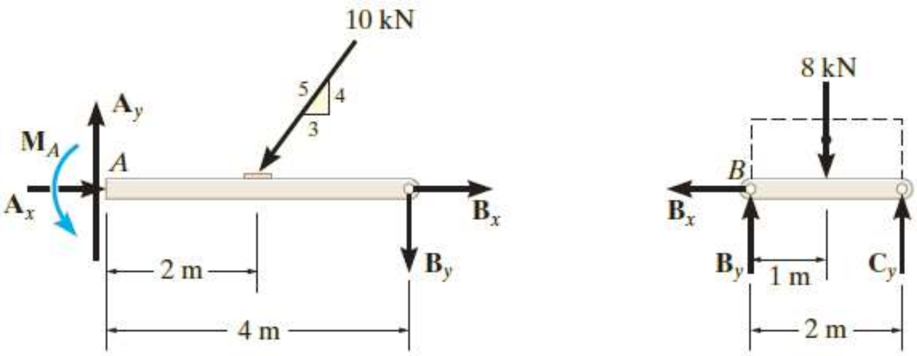
$$M_A = -512\ N.m = 512\ N.m \circlearrowleft \quad \textit{answer}$$

Example No. 3: The compound beam shown in Figure is pin connected at *B*. Determine the components of reaction at fixed A and roller C.

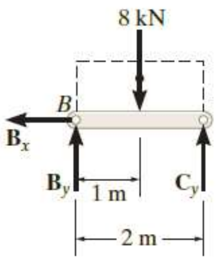


Solution:

Draw F.B.D. for all beam:



At member BC as F.B.D:



$$\circlearrowright^{+} \sum M_C = 0$$

$$B_y \times 2 - 8 \times 1 = 0$$

$$B_y = 4\ kN\ \uparrow$$

$$\rightarrow^{+} \sum F_x = 0$$

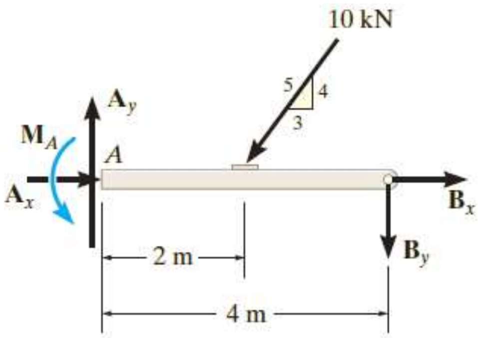
$$B_x = 0$$

$$\uparrow^{+} \sum F_y = 0$$

$$4 - 8 + C_y = 0$$

$$C_y = 4\ kN\ \uparrow \qquad answer$$

At member AB as F.B.D:



$\xrightarrow{+} \sum F_x = 0$

$A_x - 10 \times \frac{3}{5} + 0 = 0 \qquad \Longrightarrow$

$A_x = 6\ kN\ \rightarrow$ *answer*

$\uparrow^{+} \sum F_y = 0$

$A_y - 10 \times \frac{4}{5} - 4 = 0$

$A_y = 12\ kN\ \uparrow$ *answer*

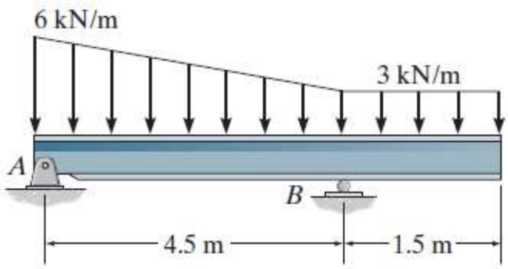
$\circlearrowright^{+} \sum M_B = 0$

$12 \times 4 - M_A - 10 \times \frac{4}{5} \times 2 = 0$

$M_A = 32\ kN.m \circlearrowleft$ *answer*

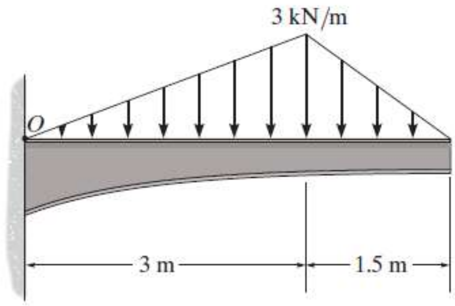
Problem:

1. Determine the reaction force at A and B for the beam shown in Figure.



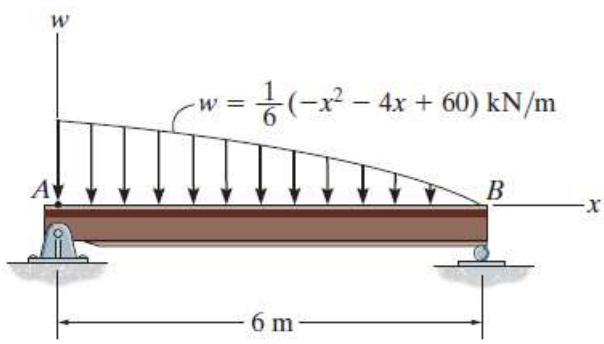
Answer: $R_B = 14.25\ kN\ \uparrow, \quad A_x = 0\ , \quad A_y = 10.5\ kN\ \uparrow$

2. For the beam shown in Figure, determine the reaction at Fixed O.



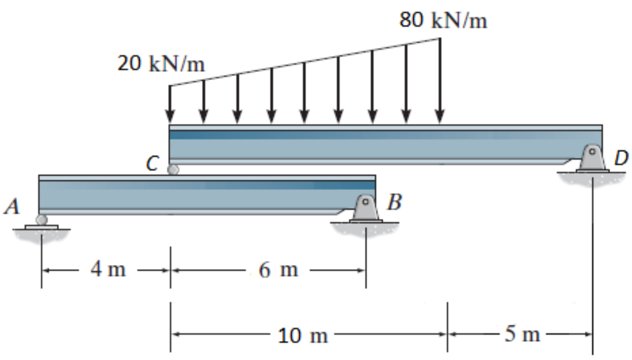
Answer: $O_x = 0 \rightarrow, \quad O_y = 6.75\ kN \uparrow, \quad M_O = 16.875\ \ kN.m$ ↻

3. Determine the reaction force at A and B for the beam shown in Figure.



Answer: $R_B = 13\ kN \uparrow, \quad A_x = 0, \quad A_y = 23\ kN \uparrow$

4. For the frame shown in Figure, determine the reaction at A, B, C and D.



Answer: $A_y = 280\ kN \uparrow, \quad B_x = 0, \quad B_y = 186.667\ kN \uparrow, \quad C_y = 300\ kN$

$D_x = 0, \quad D_y = 200\ kN \uparrow$