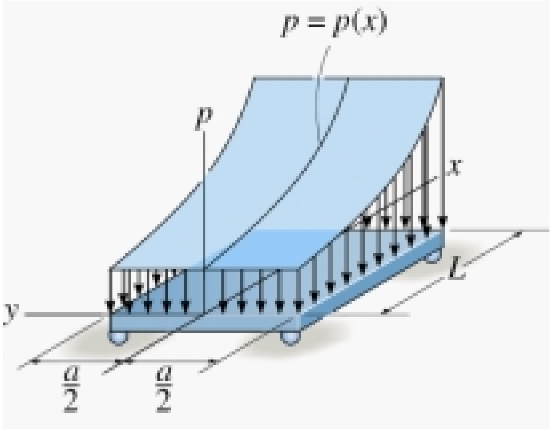
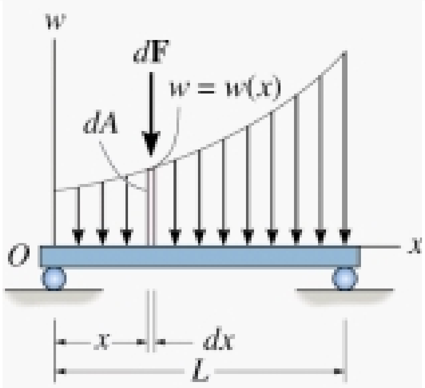
Forces and Moments: Part 8

Distributed loading:

Wind, fluids, and the weight of a material supported over a body's surface are examples of distributed loadings. Pressure p (force/unit area) is the intensity of these loadings.



The loading function is written as $p=p(x)$ Pa or N/m^2. Because it is a function of $\bar{x}$ and it is uniform along the y-axis. If we multiply $p=p(x)$ by width a, we get $w= p(x)$. a which is called the load intensity.
[with the dimension of $(N/m^2)(m)=N/m$]
So $w= w(x)$ N/m.



The system of forces of intensity $w=w(x)$ can be simplified into a single resultant force F_R and its location x can be specified.
Magnitude of the resultant force:

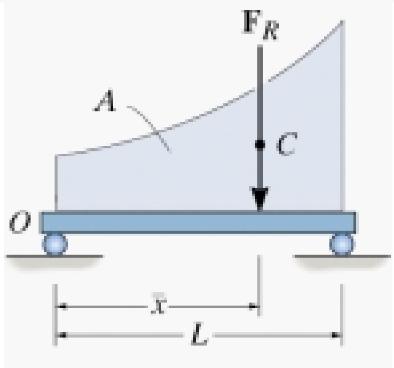
$$F_R = \sum F$$

Since there is an infinite number of parallel forces dF acting along the plate $\Rightarrow$ integration must be used

$$dF = w(x)dx = dA$$

$$+\downarrow F_R = \sum F$$

$$\Rightarrow F_R = \int_L w(x)dx = \int_A dA = A$$



$\Rightarrow$ The magnitude of the resultant force is equal to the total area A under the loading diagram $w = w(x)$ (Fig.b)

$$\circlearrowleft + M_{R_O} = \sum M_O$$

$$\Rightarrow \bar{x}F_R = \int_L xw(x)dx$$

$$\Rightarrow \bar{x} = \frac{\int_L xw(x)dx}{\int_L w(x)dx} = \frac{\int_A xdA}{\int_A dA}$$

This equation represents the x coordinate for the centroid
$\Rightarrow F_R$ has a line of action which passes through the centroid C of the area defined by the distributed loading diagram $w(x)$

So in general, the magnitude of F_R is defined by calculating the volume under the distributed loading curve $p=p(x)$ and the location of resultant force is determined by finding the centroid of this volume.