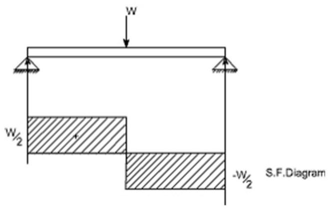


.For B.M diagram:
If we just take the moments to the left of the cross-section,

$B.M_{x\text{-}x} = \frac{W}{2}x$ for x lies between 0 and l/2

$B.M_{at\,x=\frac{l}{2}} = \frac{W}{2}\,\frac{l}{2}$ i.e B.M at x = 0

$= \frac{Wl}{4}$

$B.M_{Y\text{-}Y} = \frac{W}{2}x - W\left(x - \frac{l}{2}\right)$

Again

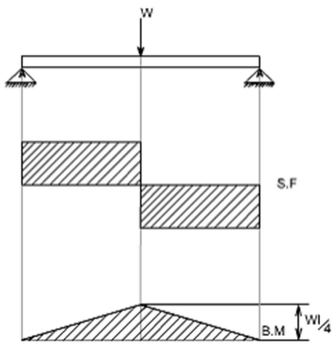
$= \frac{W}{2}x - Wx + \frac{Wl}{2}$

$= -\frac{W}{2}x + \frac{Wl}{2}$

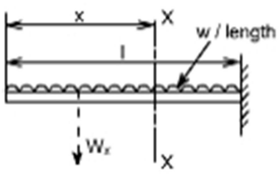
$BM_{at\,x=l} = -\frac{Wl}{2} + \frac{Wl}{2}$

$= 0$

Which when plotted will give a straight relation i.e.



A cantilever beam subjected to U.d.L, draw S.F and B.M diagram.



Here the cantilever beam is subjected to a uniformly distributed load whose intensity is given w / length.
Consider any cross-section XX which is at a distance of x from the free end. If we just take the resultant of all the forces on the left of the X-section, then

$S.F_{xx} = -Wx$ for all values of 'x'. ---------- **(1)**

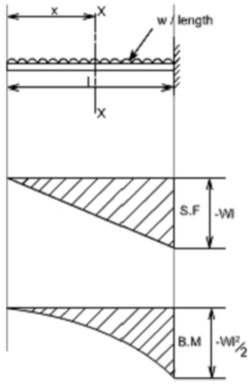
$S.F_{xx} = 0$

$S.F_{xx\ at\ x=l} = -Wl$

So if we just plot the equation No. (1), then it will give a straight line relation. Bending Moment at X-X is obtained by treating the load to the left of X-X as a concentrated load of the same value acting through the centre of gravity.

Therefore, the bending moment at any cross-section X-X is

$$B.M_{X\text{-}X} = -W x \frac{x}{2}$$
$$= -W\frac{x^2}{2}$$

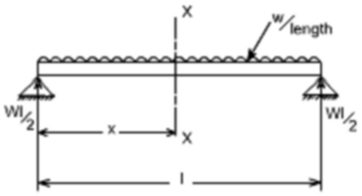


The above equation is a quadratic in x, when B.M is plotted against x this will produces a parabolic variation.

The extreme values of this would be at x = 0 and x = l

$$B.M_{at\ x = l} = -\frac{Wl^2}{2}$$
$$= \frac{Wl}{2} - Wx$$

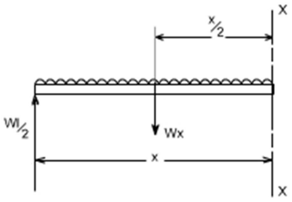
Simply supported beam subjected to a uniformly distributed load U.D.L



S.F at any X-section X-X is

$$= \frac{Wl}{2} - Wx$$
$$= W\left(\frac{l}{2} - x\right)$$

The bending moment at the section x is found by treating the distributed load as acting at its centre of gravity, which at a distance of x/2 from the section



$$B.M_{X\text{-}X} = \frac{Wl}{2}x - Wx.\frac{x}{2}$$

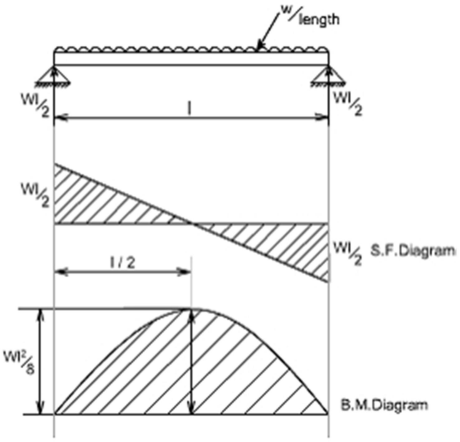
so the

$$= W.\frac{x}{2}(l - 2) \quad ....(2)$$

$B.M_{at\ x=0} = 0$

$B.M_{at\ x=l} = 0$

$$B.M\Big|_{at\ x=l} = -\frac{Wl^2}{8}$$



An I - section girder, 200mm wide by 300 mm depth flange and web of thickness is 20 mm is used as simply supported beam for a span of 7 m. The girder carries a distributed
load of 5 KN /m and a concentrated load of 20 KN at mid-span.
Determine the
(i). The second moment of area of the cross-section of the girder
(ii). The maximum stress set up.

Solution:

The second moment of area of the cross-section can be determined as follows :

For sections with symmetry about the neutral axis, use can be made of standard I value for a rectangle about an axis through centroid i.e. (b.d3)/12. The section can thus be divided into convenient rectangles for each of which the neutral axis passes through the centroid. Example in the case enclosing the girder by a rectangle

$$I_{girder} = I_{rectangle} - I_{shaded\ portion}$$

$$= \left[\frac{200 \times 300^3}{12}\right]10^{-12} - 2\left[\frac{90 \times 260^3}{12}\right]10^{-12}$$

$$= (4.5 - 2.64)10^{-4}$$

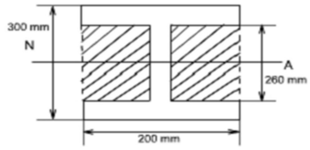
$$= 1.86 \times 10^{-4}\ m^4$$

The maximum stress may be found from the simple bending theory by equation

$$\frac{\sigma}{y} = \frac{M}{I} = \frac{E}{R}$$

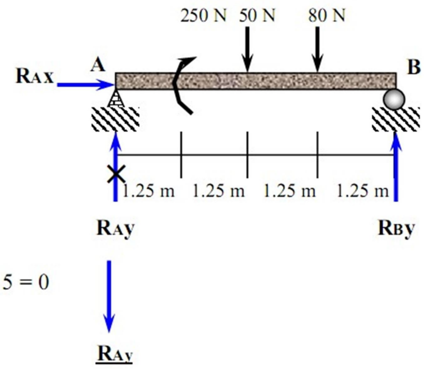
i.e.

$$\sigma_{max^m} = \frac{M_{max^m}}{I}\ y_{max^m}$$



Calculations of Beam Reactions

Ex3:



$\longrightarrow \sum F_x = 0$ --- (1)

$R_{AX} = 0$

$\circlearrowleft + \sum M@A = 0$ --- (2)

$250 + 80 \times 2.5 + 80 \times 3.75 - R_B \times 5 = 0$

$\therefore R_{By} = +135\ N \uparrow$

$\uparrow \sum F_y = 0$ --- (3)

$R_{Ay} = -5\ N \uparrow \Rightarrow R_{Ay} = 5\ N \downarrow$