Class: 2nd Class
Subject: Mechanics of Materials
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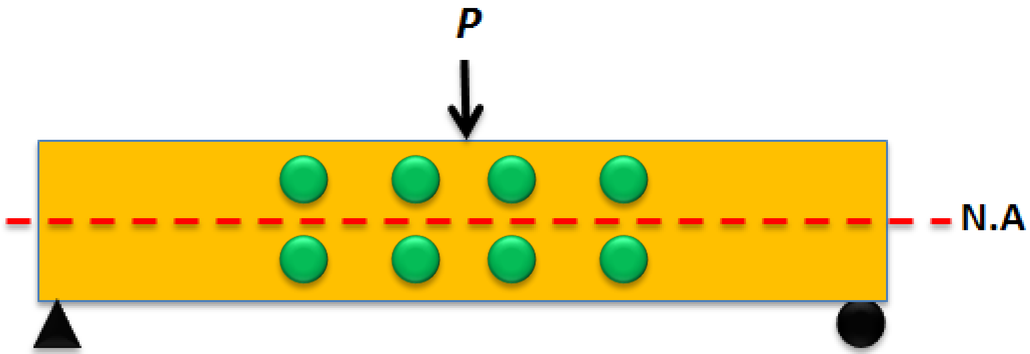
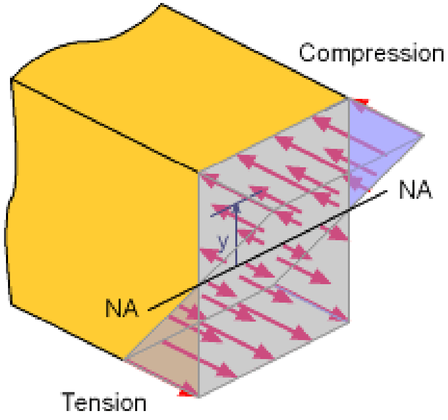
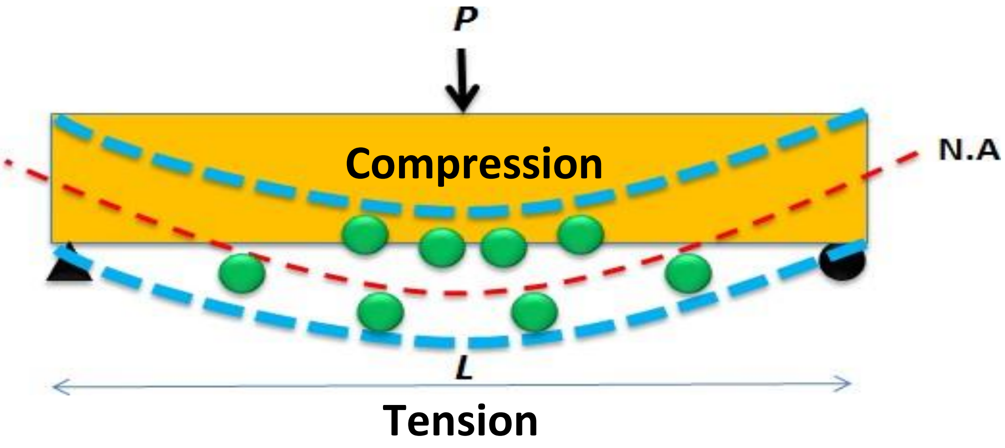
Lec7/Bending stress in the beam

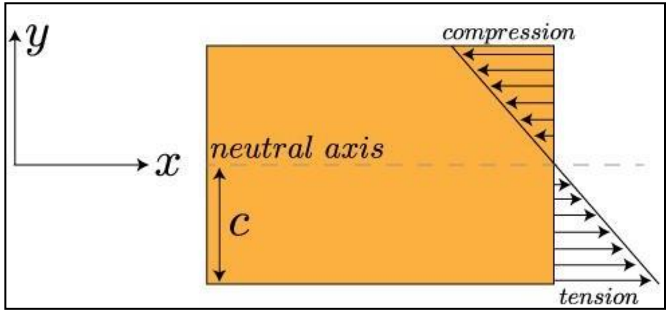
Bending stress

It is described geometrically as stress consisting of two stresses, namely tension and compression.



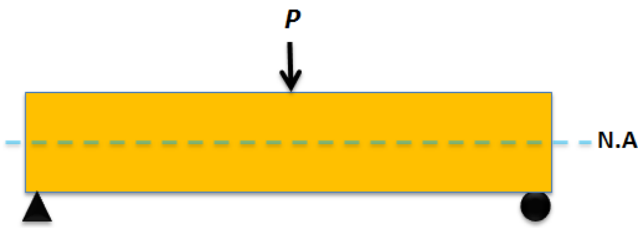


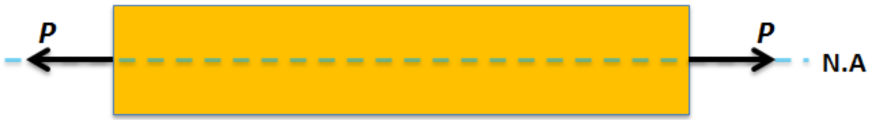




Bending stress

The tensile or compressive stress resulting from the application of a non-axial force on a structural member.





Bending stress

Or

Non-axial stress

Normal stress

Or

Axial stress

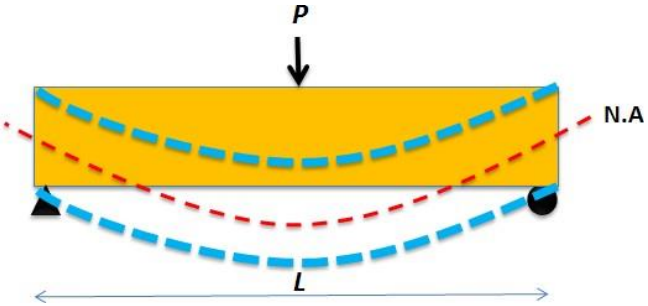

One –point


INSTRON
4486
One –point


Two –point load

Bending stress

$$\sigma_{max} = \frac{M\ C}{I_x}$$

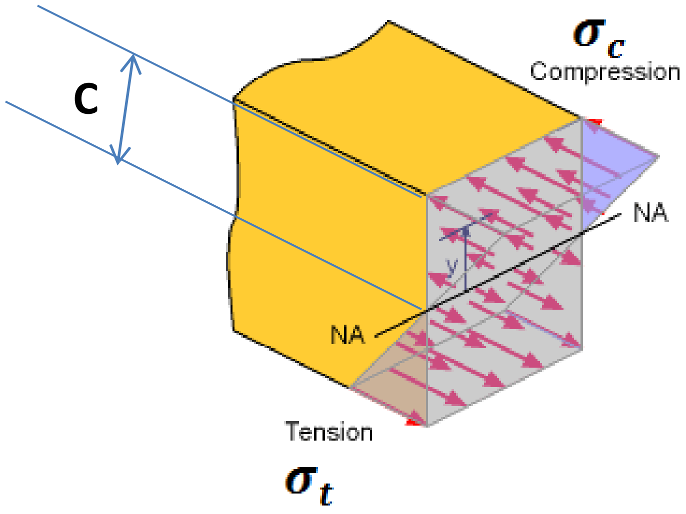


σ_{max} = max. bending stress in (pa)

M = moment of neutral axis in (N.m)

C = distance from N.A to outer fiber in (m)

I_x = moment of interia in (mm^4)

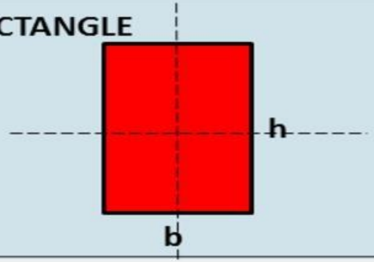
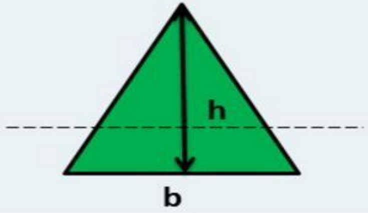
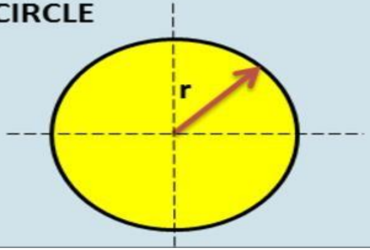


Moment of inertia (I_x)

$$I_x = I_C + Ad^2$$

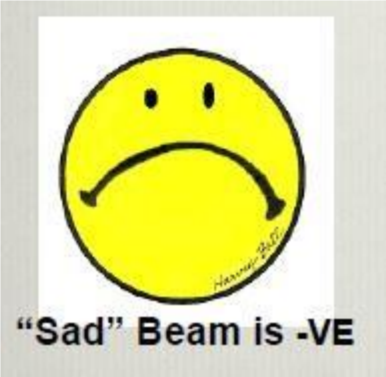
A = Area of the cross-section(mm^2)

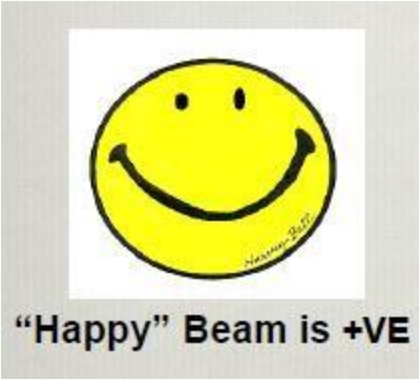
d = the distance from the center of the shape area(m).

SHAPE	MOMENT OF INERTIA
RECTANGLE 	$I_c = \frac{bh^3}{12}$
TRIANGLE 	$I_c = \frac{bh^3}{36}$
CIRCLE 	$\frac{\pi r^4}{4}$ OR $\frac{\pi D^4}{64}$

Pure bending:

Pure bending (Theory of simple bending) is a condition of stress where a bending moment is applied to a beam without the simultaneous presence of axial, shear, or torsional forces.





Q/ Find the max. bending stresses ?

$$\sigma_{max} = \frac{M\,C}{I_x}$$

$$M_{max} = 150\ kN.m$$

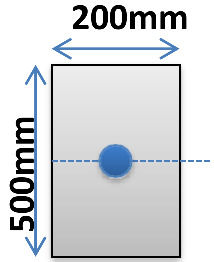
$$I_X = \frac{bh^3}{12} + Ad^2$$

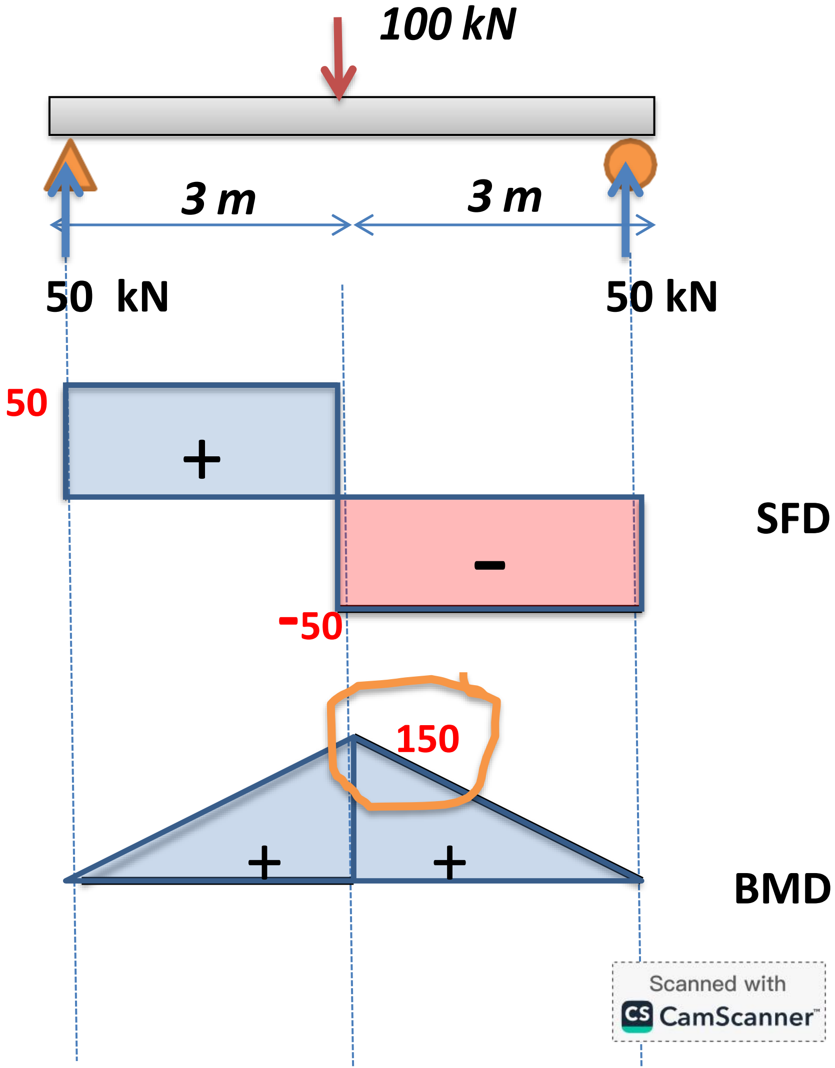
$$I_X = \frac{200(500)^3}{12} + (500)(200)(250-250)^2$$

$$I_X = 2.0833x10^9 mm^4$$

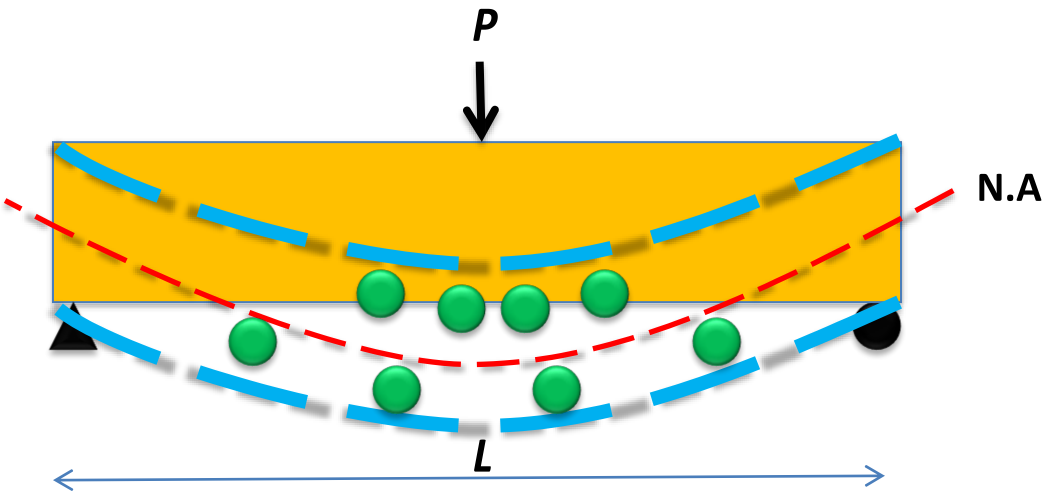
$$\sigma_c = \frac{(150x10^3x10^3)(250)}{2.0833x10^9}\left(\frac{N.mm\ \ mm}{mm^4}\right)$$

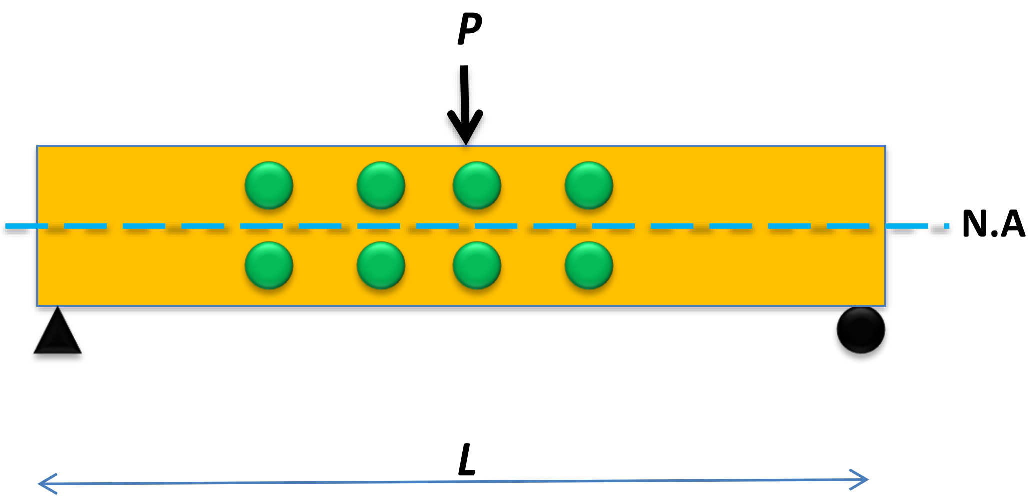
$$\sigma_c = 18\ Mpa$$



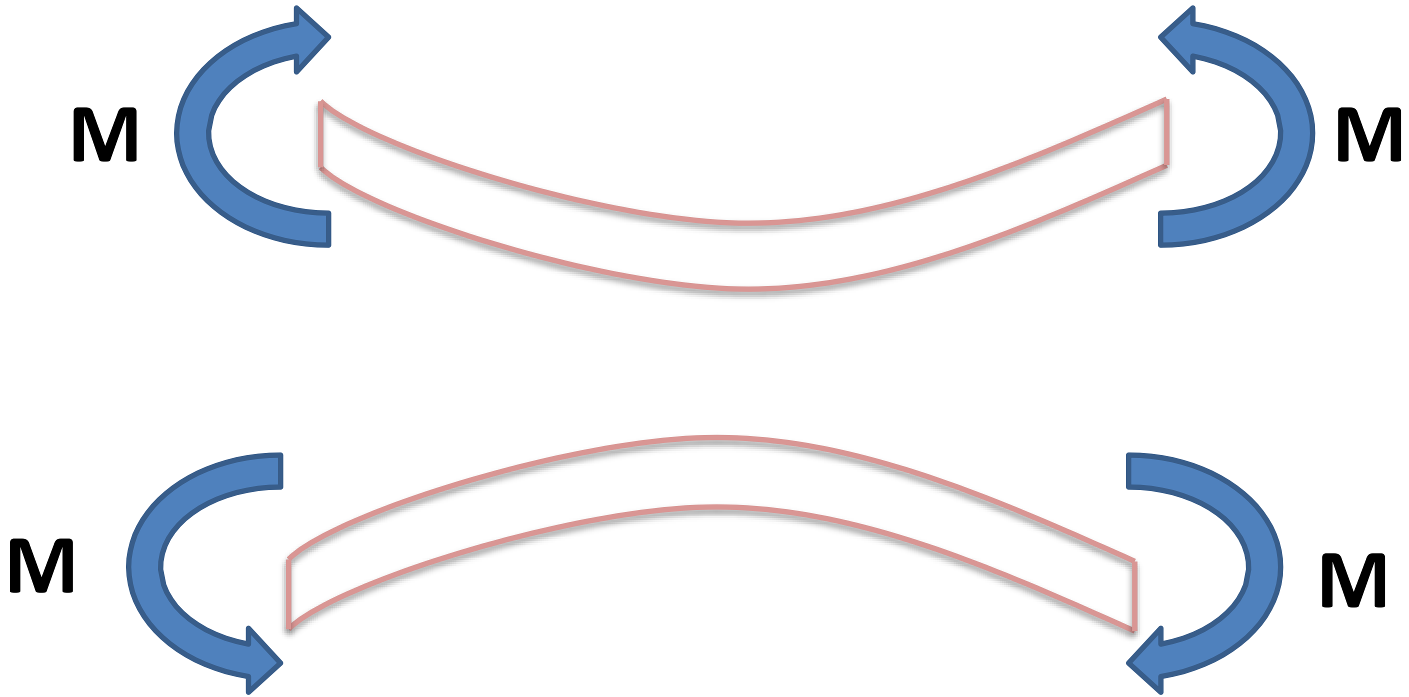


$$\sigma_t = \frac{(150x10^3x10^3)(250)}{2.0833x10^9} = 18Mpa$$

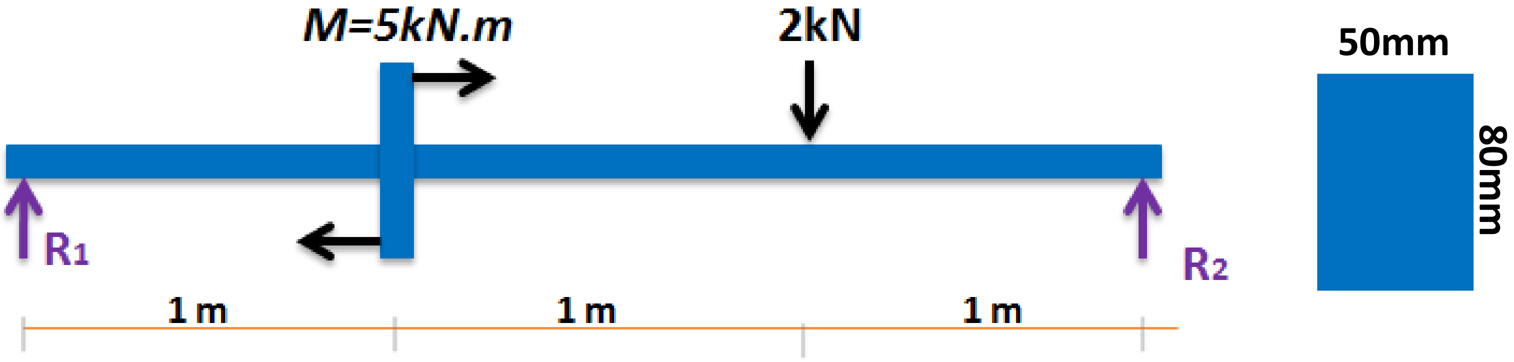

P
N.A
L

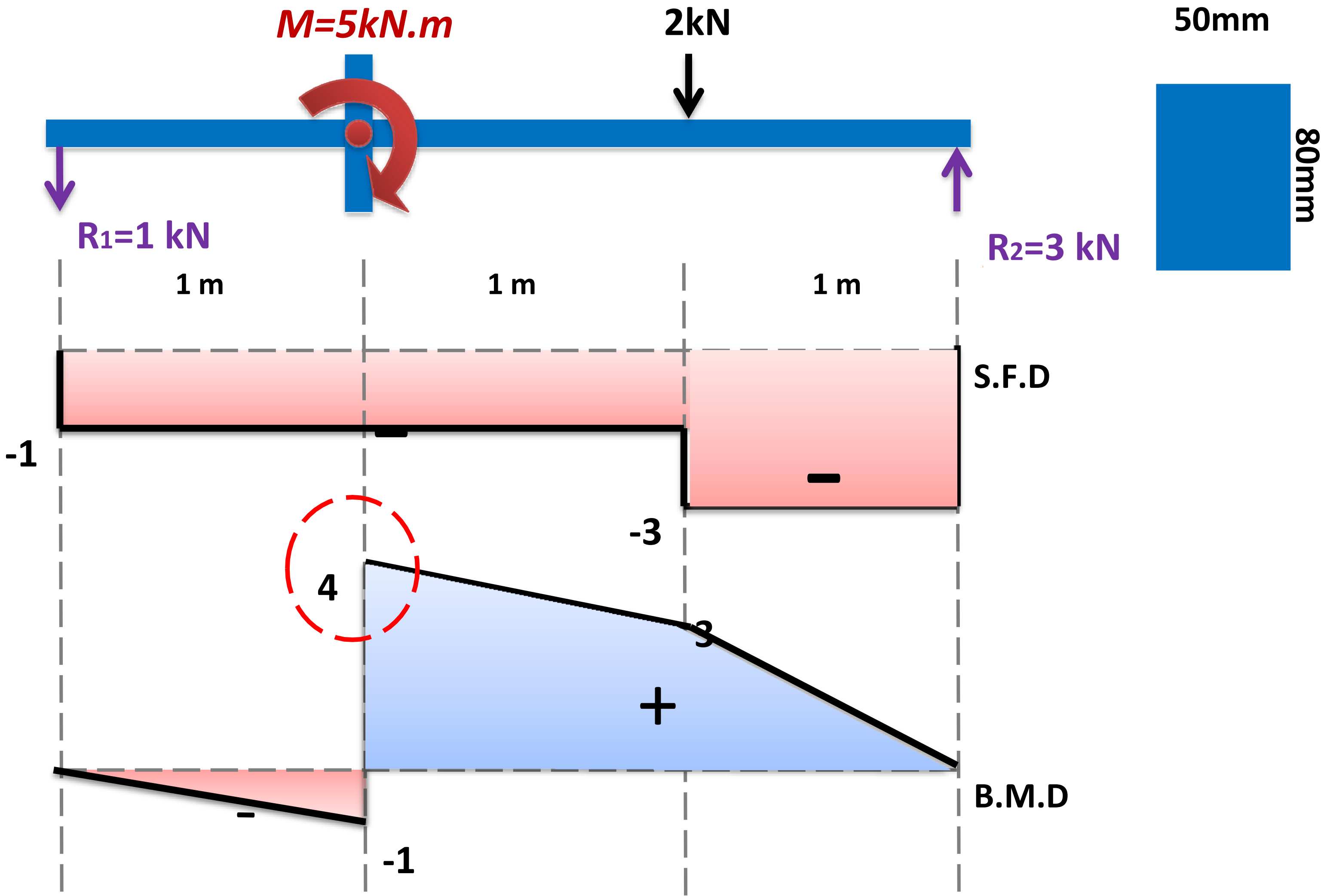

P
N.A
L


P
P
N.A


M
M
M
M

Q/ A rectangular steel beam, 50mm wide by 80mm deep, is loaded as shown in Figure below. Determine the magnitude and location of the maximum flexural stress (bending stress),





M=5kN.m
2kN
50mm
80mm
R1=1 kN
R2=3 kN
1 m
1 m
1 m
S.F.D
-1
-3
4
3
-1
B.M.D

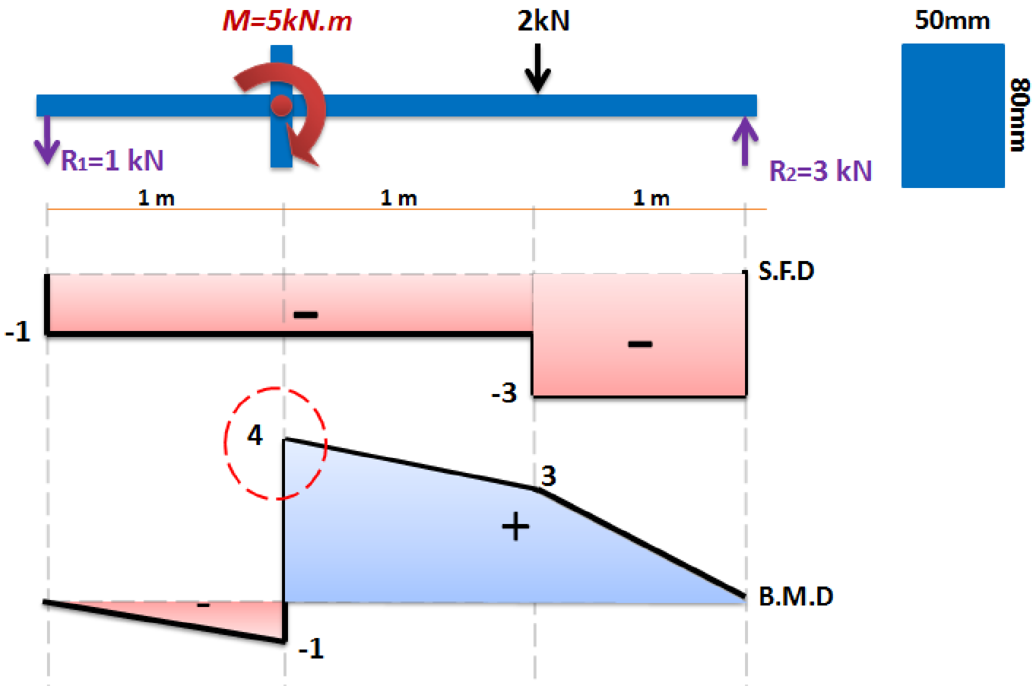
$$M_{Max} = 4\ kN.m$$

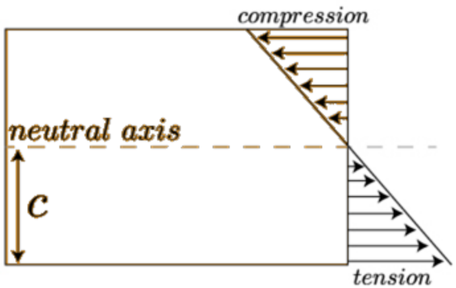
$$\sigma = \frac{MC}{I} = \frac{M\left(\frac{h}{2}\right)}{\frac{bh^3}{12}}$$

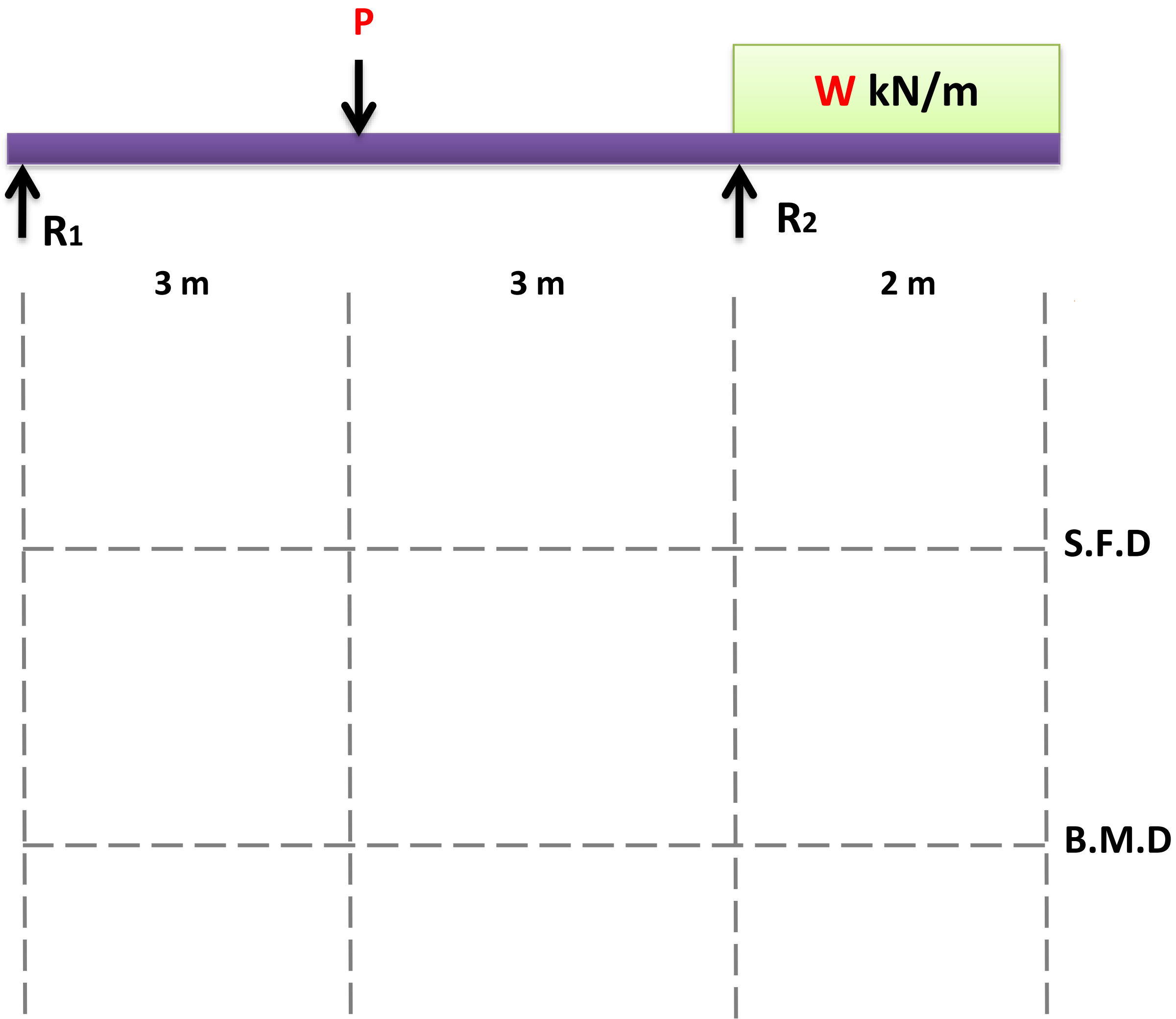
$$\sigma = \frac{6\ M}{bh^2}$$

$$\sigma = \frac{6(4000)x10^3}{(50)(80)^2}\left(\frac{N.mm}{mm.\ mm^2}\right)$$

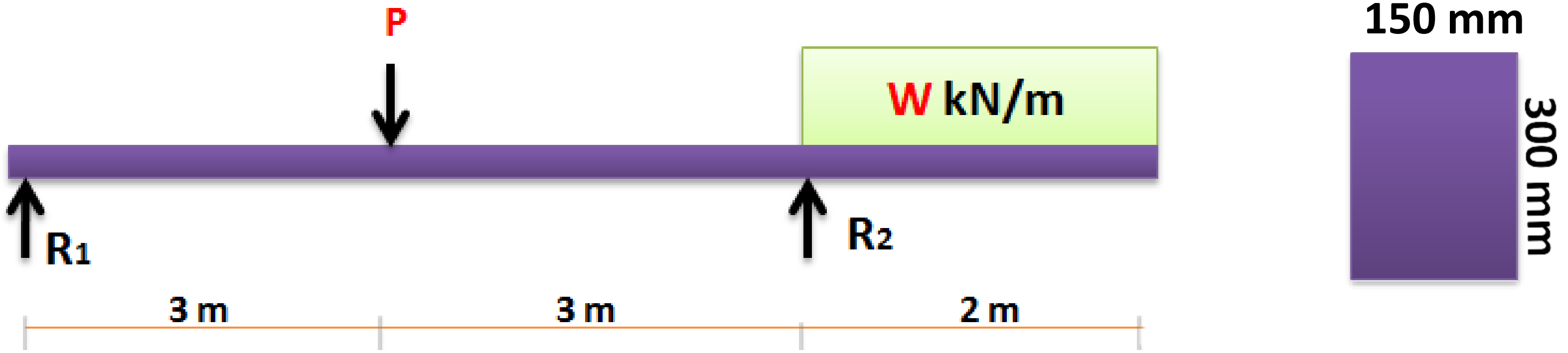
$$\sigma = 75\ Mpa$$

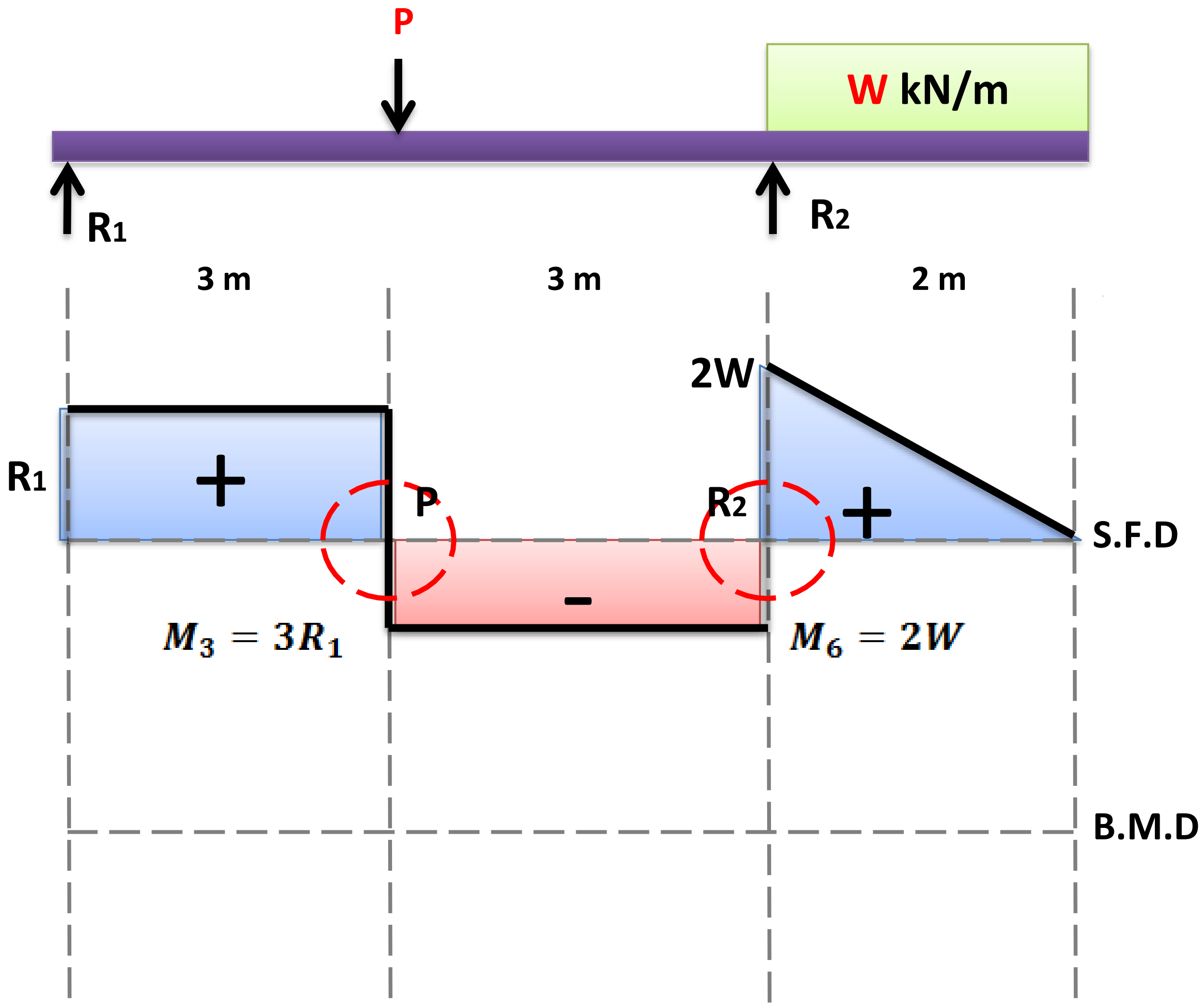





P
W kN/m
R1
R2
3 m
3 m
2 m
S.F.D
B.M.D

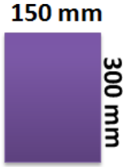
Q/ A wooden beam 150 mm wide by 300 mm deep is loaded shown in Figure as below. If the maximum flexural stress is 8 Mpa the maximum values of **W** and **P** that can be applied simultaneously.

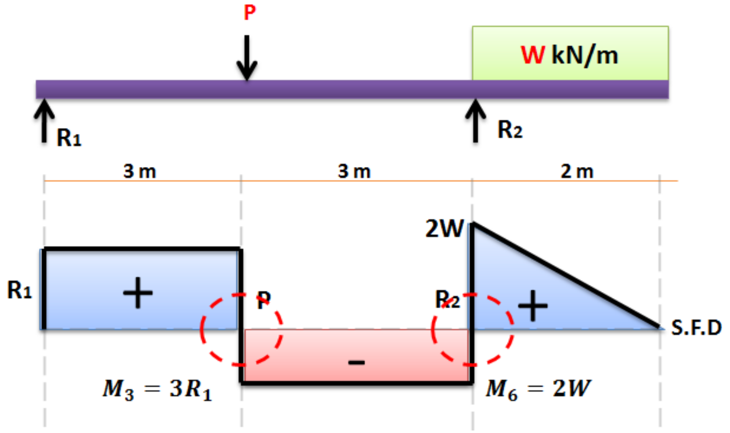




P
W kN/m
R1
R2
3 m
3 m
2 m
2W
R1
+
P
R2
+
-
S.F.D
$M_3 = 3R_1$
$M_6 = 2W$
B.M.D

$$\sigma = \frac{MC}{I} = \frac{M\left(\frac{h}{2}\right)}{\frac{bh^3}{12}} \qquad \sigma = \frac{6\ M}{bh^2}$$





$$M = \frac{\sigma b h^2}{6}$$

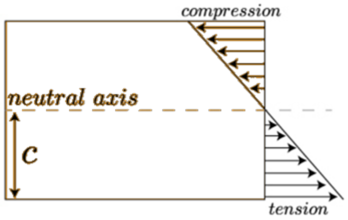
<u>$at\ x = 6m\ ; \quad (M_6 = 2W)$</u>

$$2W = \frac{(8x10^6)(150x10^{-3})(300x10^{-3})}{6}$$

$$\sigma \leq 8Mpa$$

$$W = 9000\ N/m$$

$$\sum M_{R_2} = 0$$



<u>$at\ x = 3m\ ; \quad (M_3 = 3R_1)$</u>

$$6R_1 - 3P + 2W(1) = 0$$

$$M = 3R_1$$

$$P = \frac{6(6000) + 2(9000)}{3} = 18kN$$

$$2W = 3R_1$$

$$R_1 = \frac{2(9000)}{3} = 6000N$$

Q/ Compute the maximum tensile and compressive stresses for simply supported beam, if the maximum bending moment (M_{max}=16.2kN.m),