Alfurat Al-Awsat Technical University
Technical College / Al-Najaf
Department : Building & Construction Technology Engineering
Subject: Theory of Structures
Class: Third year
Lecturer : Professor Dr. Hakim Alkurayshi

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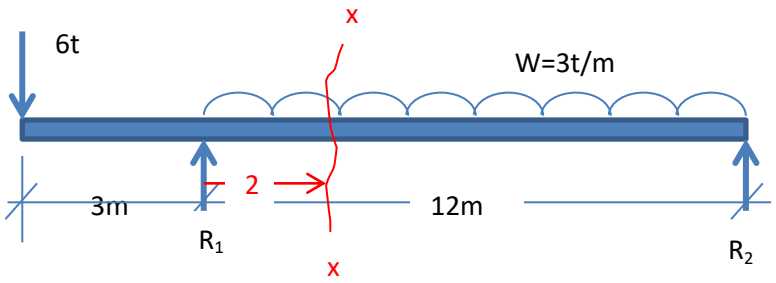
Statically determinate beams

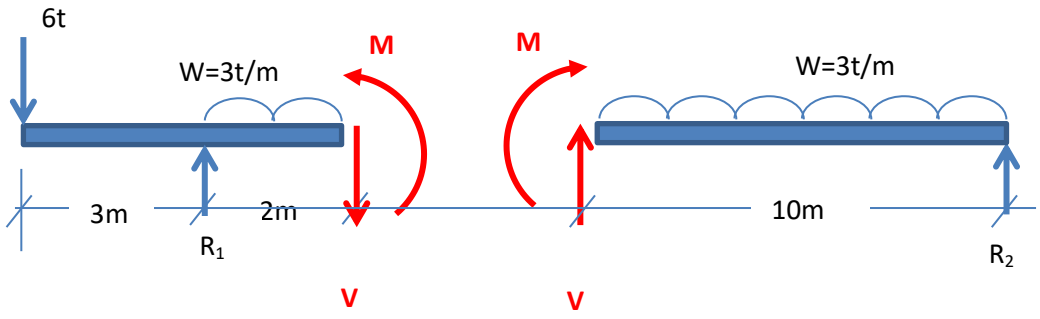
Shear force and bending moments in beams

Lecture (5+6) Concept of S.F. and B.M.

Consider this beam :



Suppose that the beam is cut at section x-x as shown .Separate it into two segments . For equilibrium a S.F.=V and a moment =M must act on each side of the section (or each segment). Take one segment as a free body (for example the left -side). To find V,



$V+6+3X2-R_1=0$ ……$V= R_1-12$ (Vertical equilibrium)

To find M, use ΣM=0 at the section

$M= R_1x2-6x5-3x2\ x2/2$

If the right-side segment is taken , then :

$V = -R_2 +3x10$

$M= R_2x10-3x10x10/2$

Here :

V=S.F. (Cutting at the section)

M=B.M.(Bending at the section)

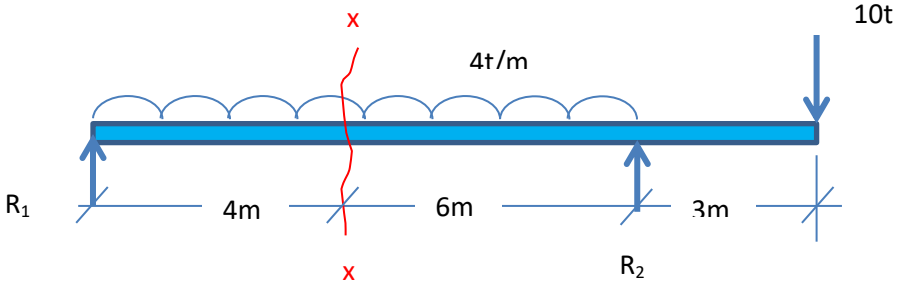
From the equations :

S.F.=sum of all lateral forces on one side of the section.

B.M. =sum of all moments of all forces on one side of the section. The moments are taken about the cut section.

Example :

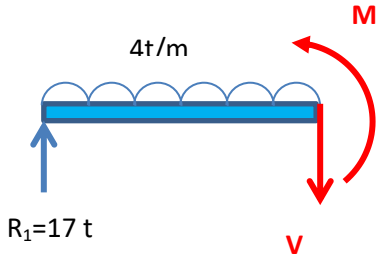
Find V and M at x-x section of the beam shown ,



Solution:

First find the external reactions,

$R_1=[4x10x10/2-10x3]/10 =17t$ Up

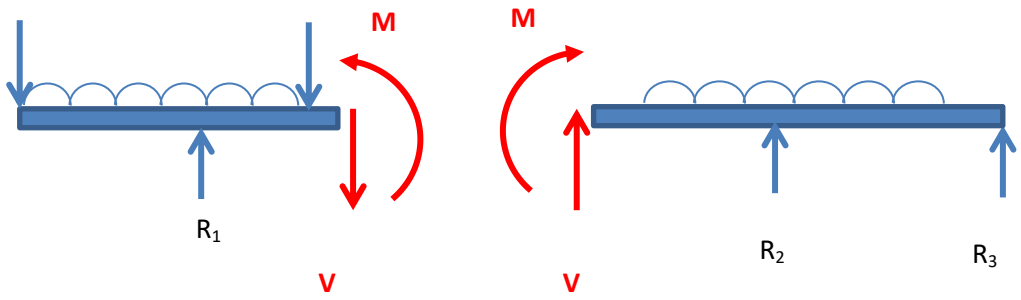


R_2 is not needed if left –side segment is used

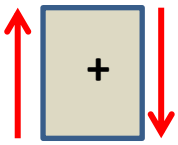
V=17-4x4 =1 t

M=17x4-4x4x4/2 =36 t.m (Sagging)

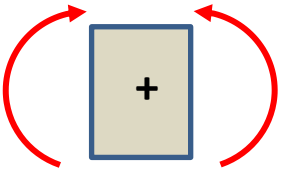
<u>Sign conventions:</u>



For S.F. :Shear force is positive (+ve) if its direction is down on left side segment or up on right side segment. Or Shear force is positive (+ve) if ΣFy on left side is up or ΣFy is down on right side .



For B.M. : The B.M. at a section will cause curvature .There is compression on the inside and tension on the outside of the curvature. Usually +B.M. is drawn on the compression faces.

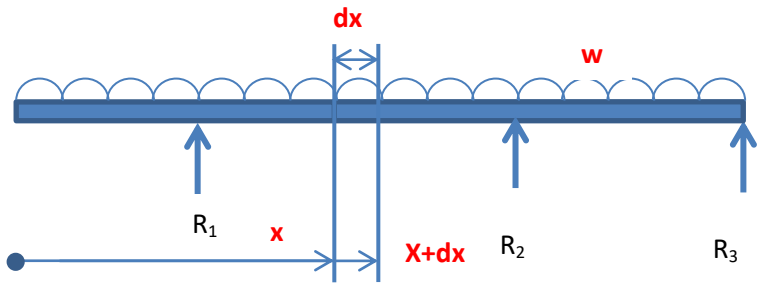


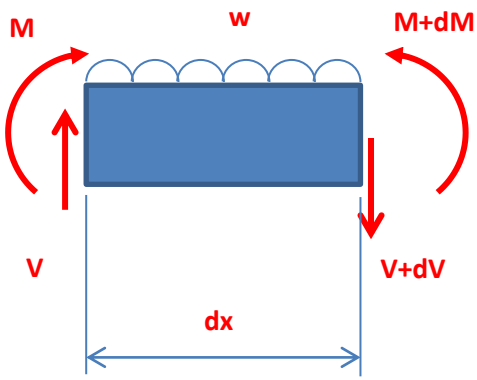
Relation between SHEAR FORCE, BEDING MOMENT AND LOADING (w)

Take a small piece (or segment) of length dx . Here V &M act on one side (at section x),then V+dV and M+dM will act at section (x+dx).

By vertical equilibrium , **V+dV-V +w dx=0**

Then, **dV/dx =-w**





Take moments at right end,

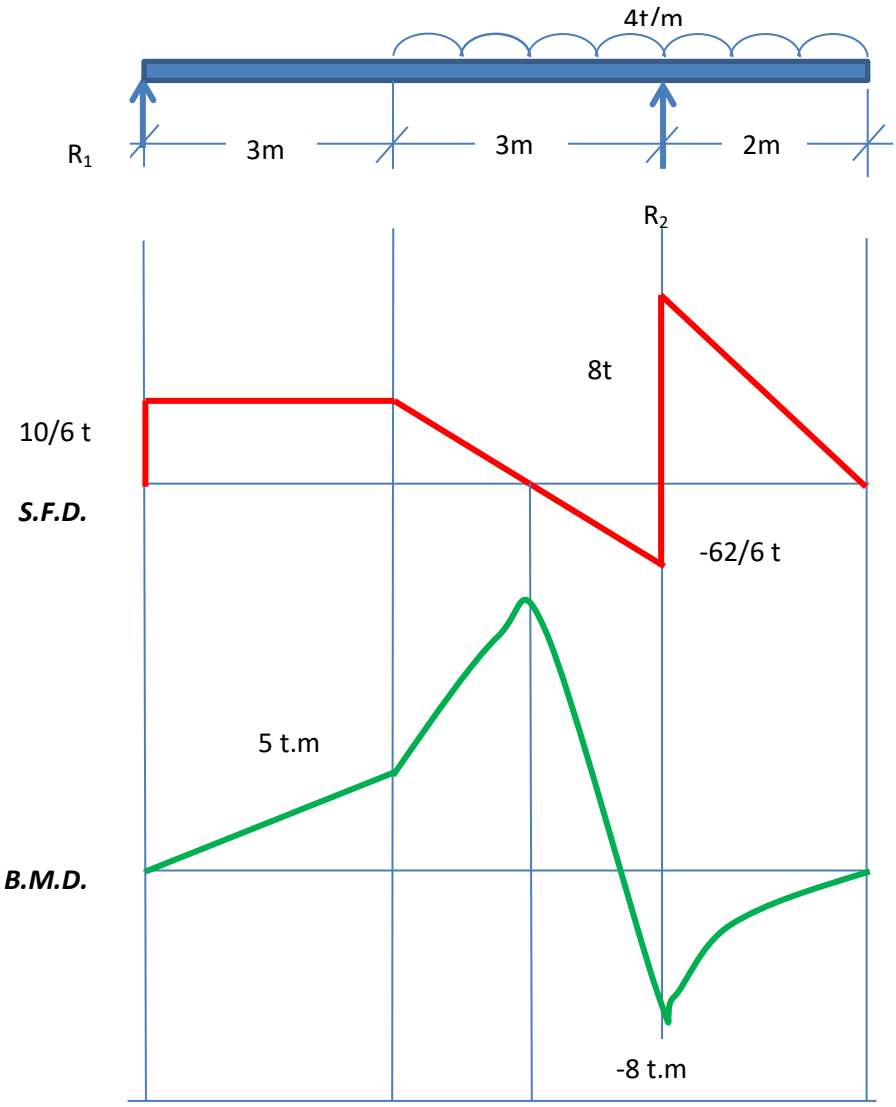
M+V .dx –(M+dM) –w .dx. dx/2 =0

$$\frac{dM}{dx} = V - \frac{w.dx}{2} \ldots\ldots\ldots (Neglecting \frac{w.dx}{2})$$

Then , $\boldsymbol{\frac{dM}{dx} = V}$

And $\boldsymbol{\frac{d^2M}{dx^2} = \frac{dV}{dx} = -w}$

Example: Draw S.F.D & B.M. for this beam.



Solution:

R_1=[4x5x0.5/6] =10/6 t Up

R_2=[4x5x5.5/6] =110/6 t Up

Check: R_1+ R_2 =? 4x5=20 t

10/6 +110/6 =120/6 =20 t …….O.K.