Universitas Pembangunan Jaya

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Mata Kuliah : Statika
Kode : CVL – 104
SKS : 3 SKS

Representasi Gaya Dalam Pada Struktur balok sederhana

Pertemuan – 5 & 6

- TIU :
  - Mahasiswa dapat menghitung gaya-gaya dalam momen, lintang dan normal pada struktur statis tertentu
- TIK :
  - Mahasiswa dapat menganalisis gaya dalam momen, lintang dan netral pada struktur balok sederhana

- Sub Pokok Bahasan :
  - Gaya dalam momen
  - Gaya dalam Lintang
  - Gaya dalam Normal

What are the Internal Loads used for ?

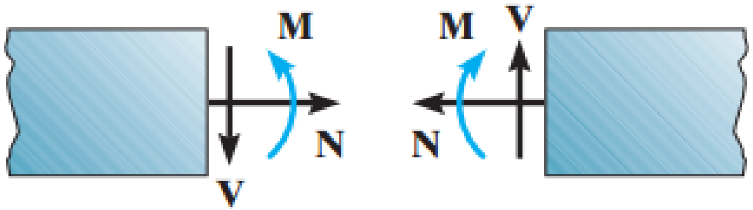
To determine the forces and moment that act within it.

Normal Stresses are determined by the bending moment

Shear stresses are determined by the maximum shear force and the maximum torsional moments

Internal loads can be determined by using Cross section Method

From left side



From right side

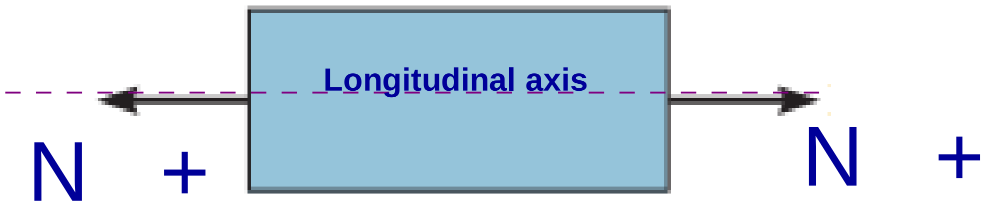
internal loadings

Internal Loading for Coplanar structure will consist :

- Normal/Axial Force (N)
- Shear Force (V / D)
- Bending Moment (M)

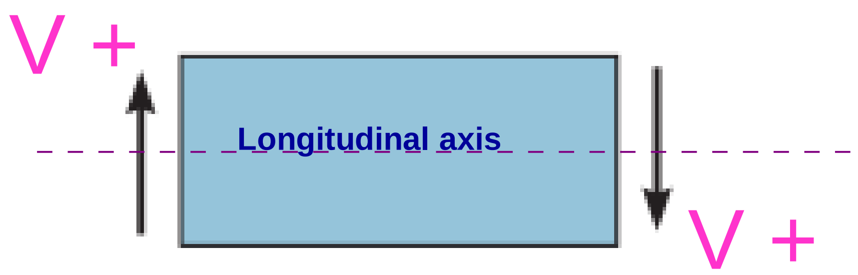
Normal /Axial Force

The algebraic sum of the components acting **parallel** to the axis of the beam of all the loads and reactions applied to the portion of the beam on either side of that cross section



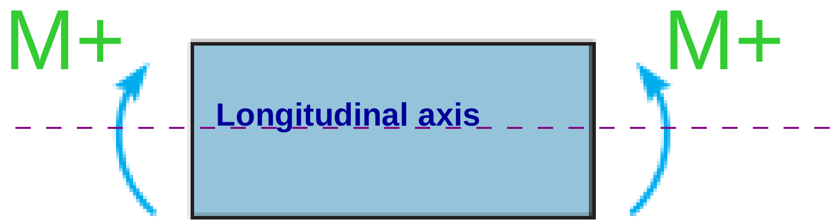
Shear Force?

The algebraic sum of the components acting **transverse** to the axis of the beam of all the loads and reactions applied to the portion of the beam on either side of that cross section



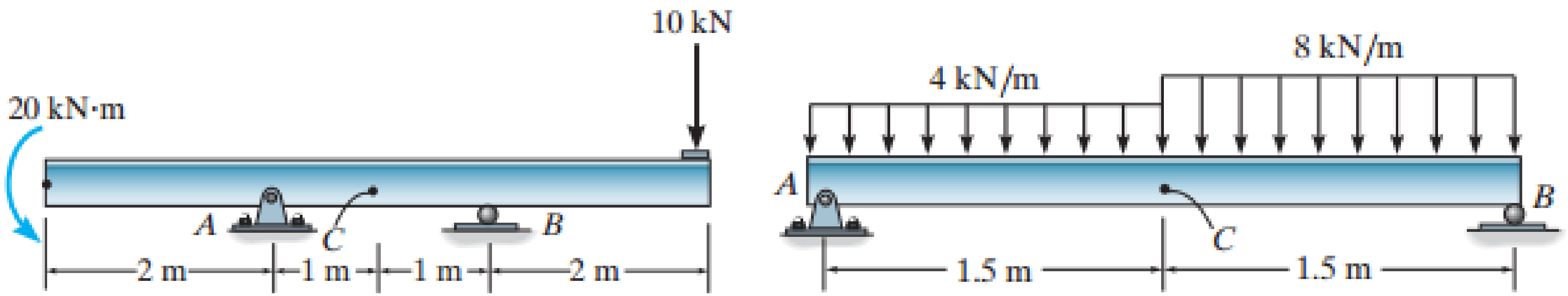
Bending Moment

The algebraic sum of the moments, taken about an axis (which is **normal** to the plane of loading), passing through the centroid of the cross section of all the loads and reactions applied to the portion of the beam on either side of that cross section.



- **Example 1**

Determine the internal normal force, shear force and bending moment acting at point C in the beam.



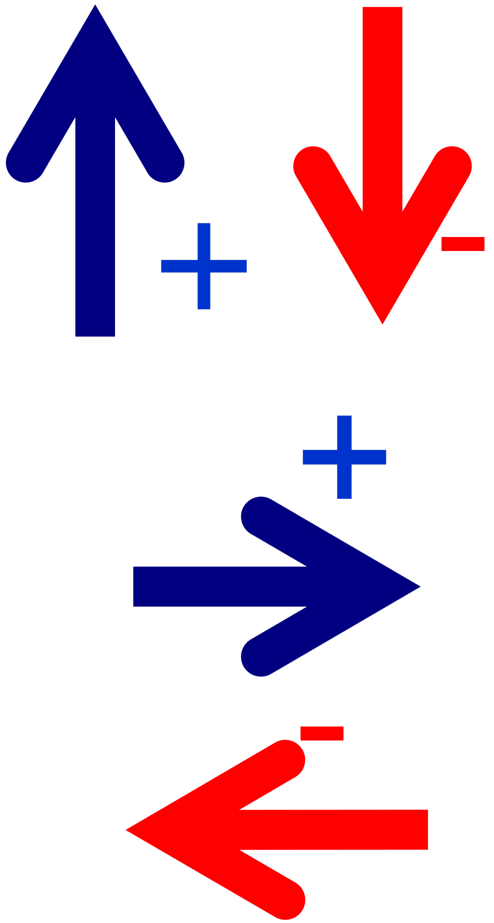
Shear and Moment Functions

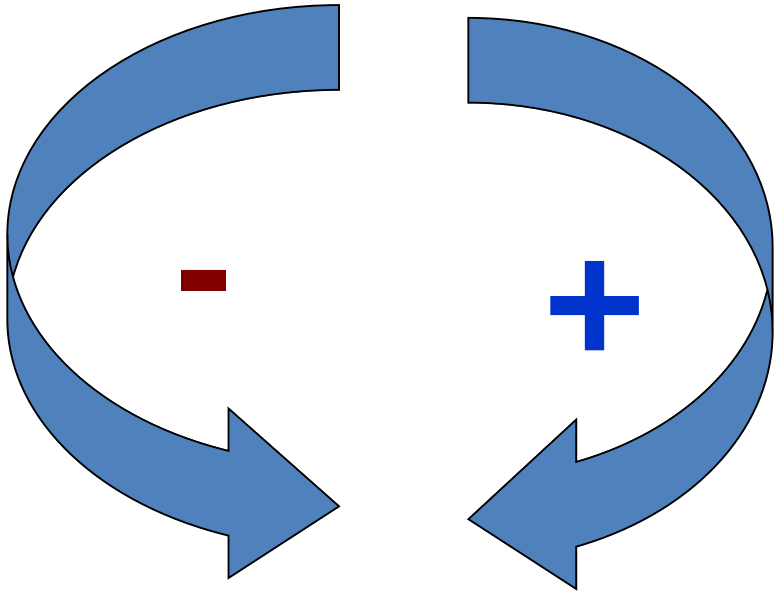
- The design of a beam requires a detailed knowledge of the *variations* of the internal shear force *V* and moment *M* acting at each point along the axis of the beam.
- The variations of *V* and *M* as a function of the position *x* of an arbitrary point along the beam's axis can be obtained by using the method of sections
- shear and moment functions must be determined for each region of the beam located *between* any two discontinuities of loading

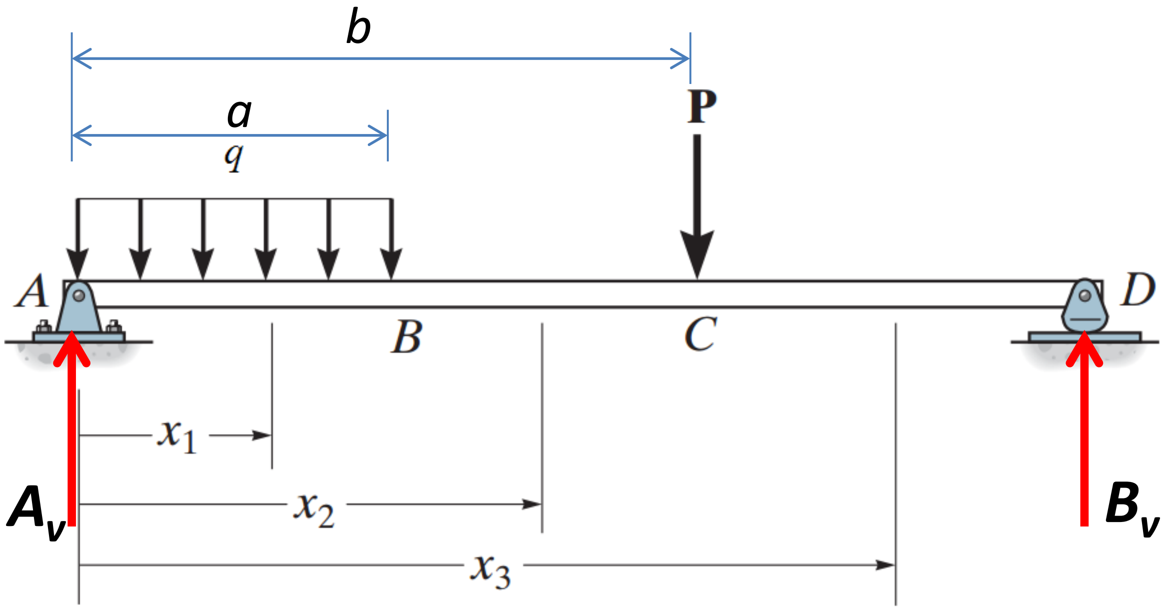
Procedure for Analysis

- Determine the support reactions on the beam
- Specify separate coordinates *x* and associated origins
- Section the beam perpendicular to its axis at each distance *x*, draw free-body diagram
- V_x and M_x obtained from equilibrium equation
- The results can be checked by noting that ***dM/dx* = V** and ***dV/dx* = *q***, where q is positive when it acts upward, away from the beam

- Sign Convention



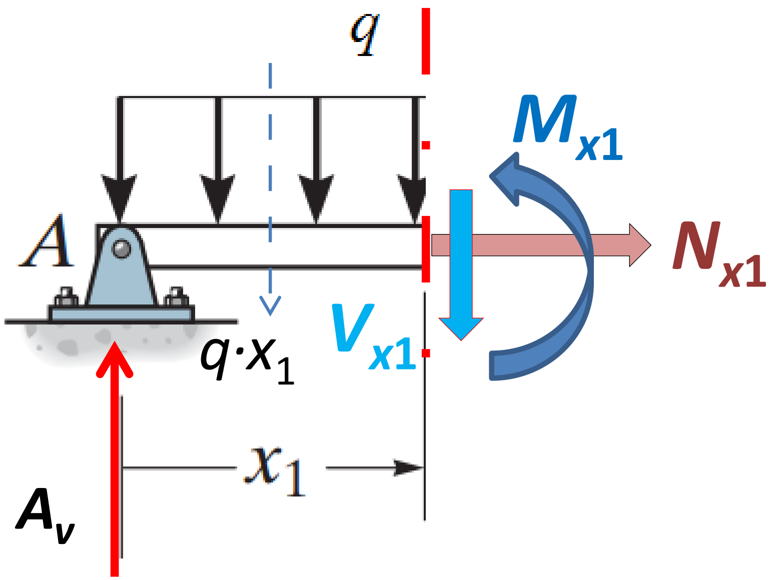




From equilibrium equation :

$\Sigma M_A = 0, \Sigma M_B = 0 , \Sigma F_y = 0$

Determine A_v and B_v



For region A-B :

$\Sigma F_y = 0$

$+A_v \,\square\, q \cdot x_1 - V_{x1} = 0$

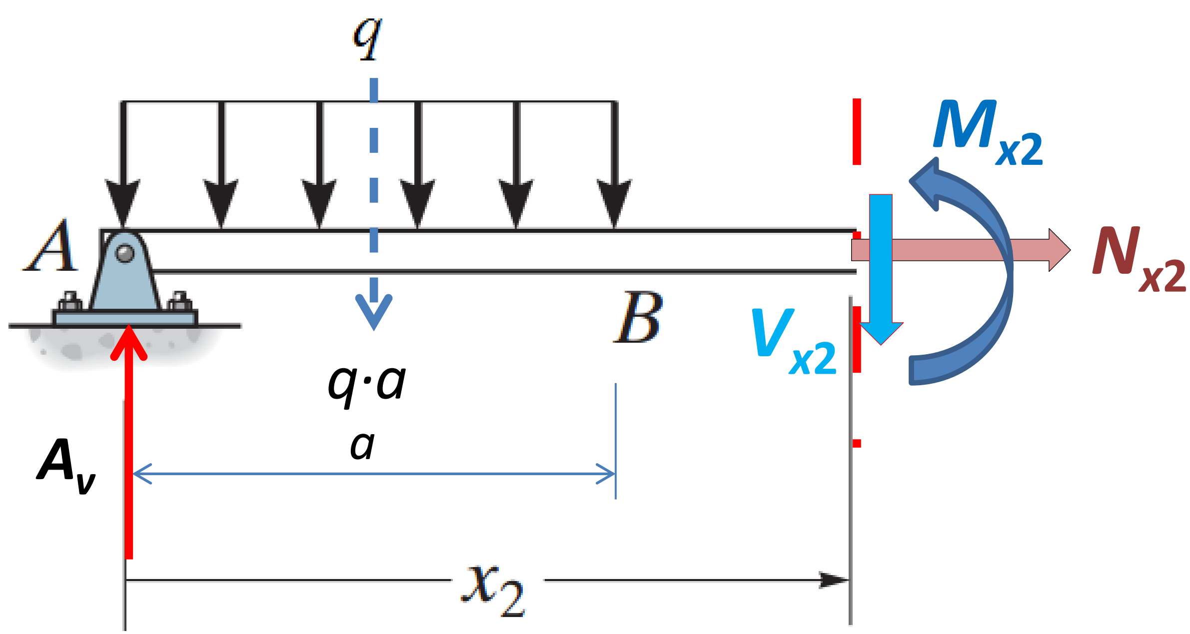
$V_{x1} = A_v \,\square\, q \cdot x_1$

$\Sigma M_{x1} = 0$

$+A_v \cdot x_1 - \frac{1}{2} q \cdot x_1^2 - M_{x1} = 0$

$M_{x1} = A_v \cdot x_1 - \frac{1}{2} q \cdot x_1^2$

Check for dM_{x1}/dx_1 !



<u>For region B-C :</u>

$\Sigma F_y = 0$

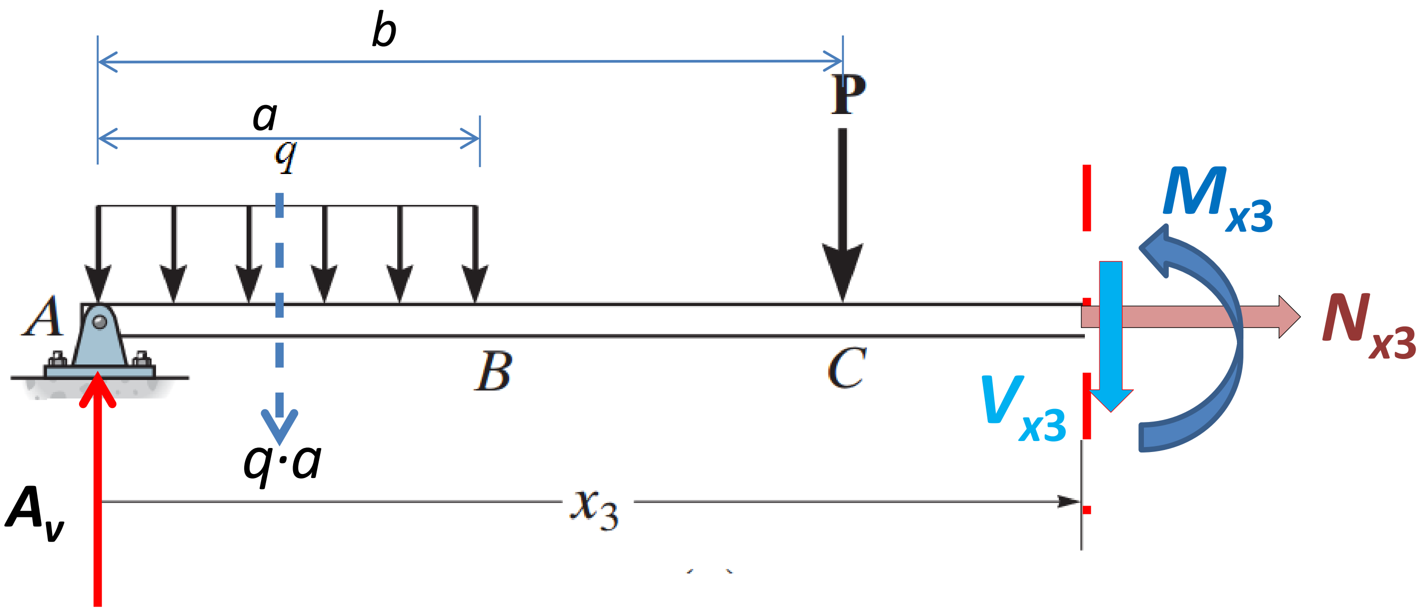
$+A_v - q\cdot a - V_{x2} = 0$

$V_{x2} = A_v - q\cdot a$

$\Sigma M_{x2} = 0$

$+A_v\cdot x_2 - q\cdot a(x_2 - a/2) - M_{x2} = 0$

$M_{x2} = A_v\cdot x_2 - q\cdot a(x_2 - a/2)$



For region C-D :

$\Sigma F_y = 0$

$+A_v - q \cdot a - P - V_{x3} = 0$

$V_{x3} = A_v - q \cdot a - P$

$\Sigma M_{x3} = 0$

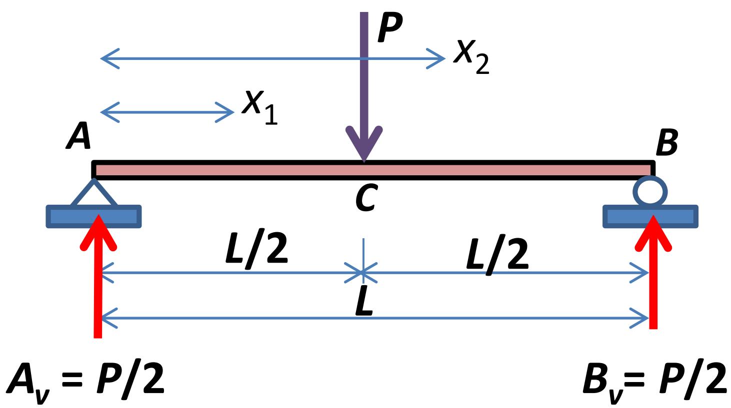
$+A_v \cdot x_3 - q \cdot a(x_3 - a/2) - P(x_3\text{-b}) - M_{x3} = 0$

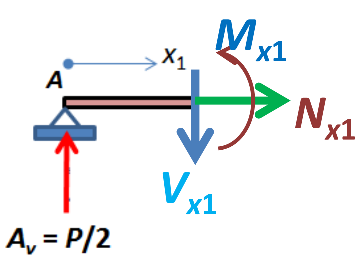
$M_{x3} = A_v \cdot x_3 - q \cdot a(x_3 - a/2) - P(x_3\text{-b})$

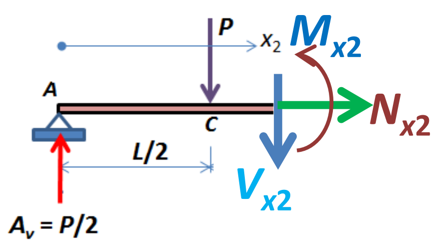
- If the variations of *V* and *M* as functions of *x* are plotted, the graphs are termed the ***shear force diagram (SFD)*** and ***bending moment diagram (BMD),*** respectively.

Example 2

- Derive the shear and moment function for the beams shown in the figure, then draw the SFD and BMD







For region A-C :

$\Sigma F_y = 0 \rightarrow \quad V_{x1} = A_v$

$\Sigma M_{x1} = 0 \rightarrow M_{x1} = A_v \cdot x_1$

For region C-B :

$\Sigma F_y = 0 \rightarrow \quad V_{x2} = A_v - P$

$\Sigma M_{x2} = 0 \rightarrow M_{x2} = A_v \cdot x_2 - P(x_2 - L/2)$

For region A-C :

$V_{x1} = A_v$

For $x_1 = 0$ $V_{x1} = +A_v = +P/2$

For $x_1 = L/2$ $V_{x1} = +A_v = +P/2$

$M_{x1} = A_v \cdot x_1$

For $x_1 = 0$ $M_{x1} = 0$

For $x_1 = L/2$ $M_{x1} = P/2(L/2) = +PL/4$

For region C-B :

$V_{x2} = A_v - P$

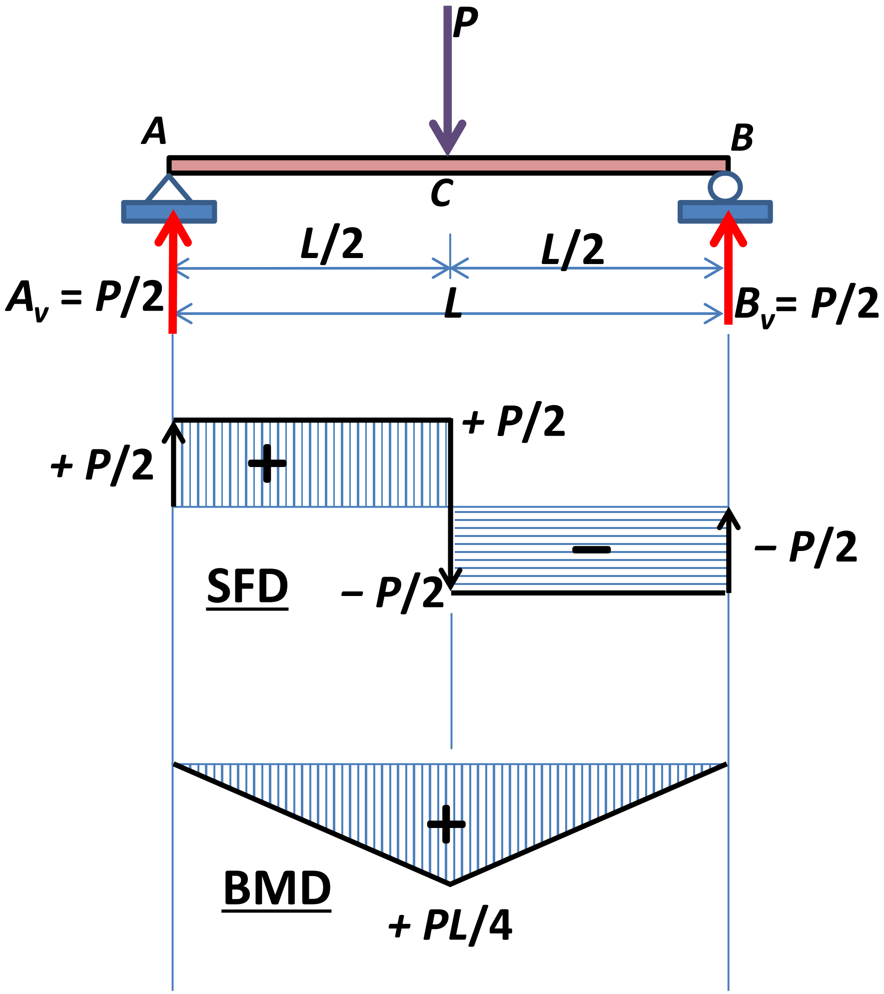
For $x_2 = L/2$ $V_{x2} = -P/2$

For $x_2 = L$ $V_{x2} = -P/2$

$M_{x2} = A_v \cdot x_2 - P(x_2 - L/2)$

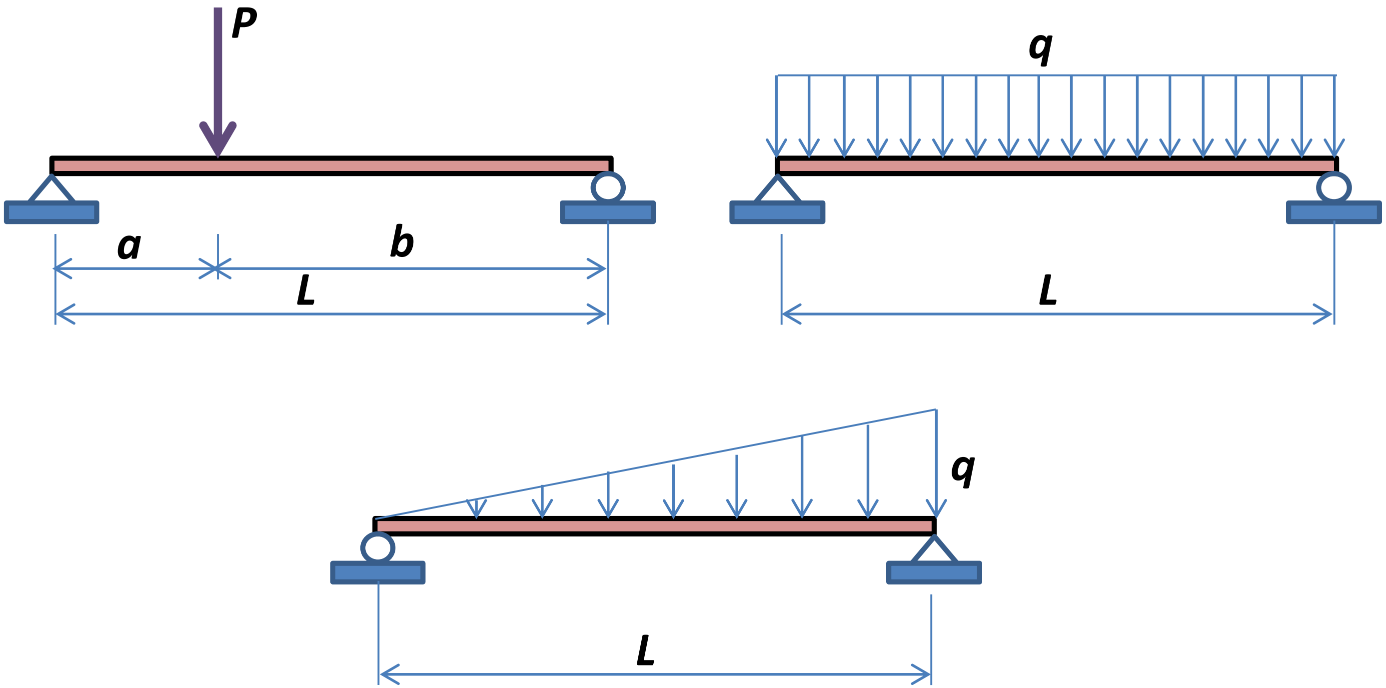
For $x_2 = L/2$ $M_{x2} = +PL/4$

For $x_2 = L$ $M_{x2} = 0$



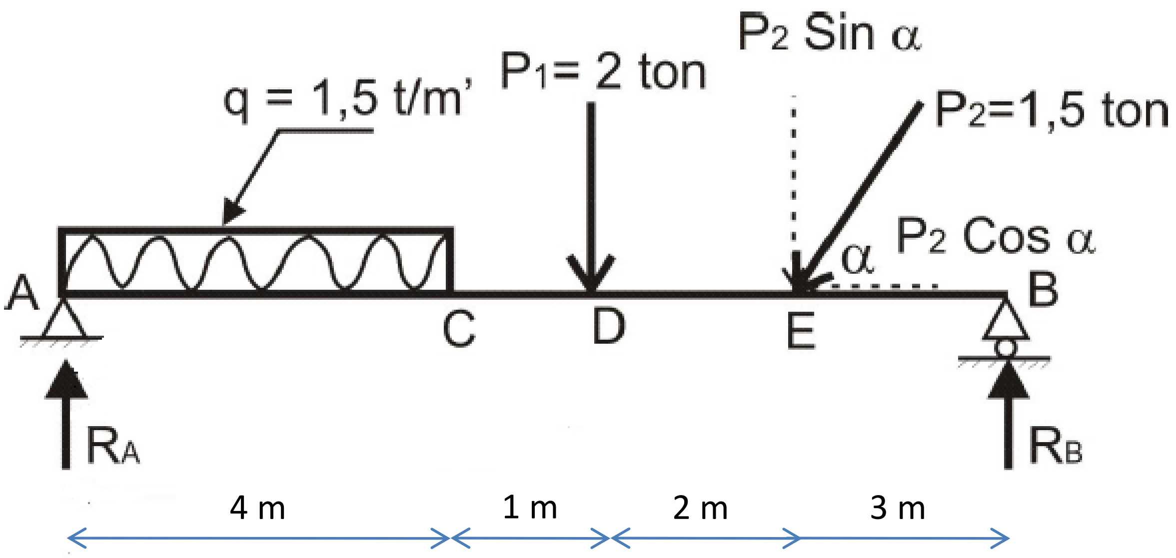
Example 3

- Derive the shear and moment function for the beams shown in the figure, then draw the SFD and BMD for each beam



Example 4

- Draw the shear, normal and moment diagram for the beam in figure. (tan α = ¾)



Example 5

- Draw the shear and moment diagrams for each member of the frame. Assume the frame is pin connected at *A*, and *C*