4 MOMENT DISTRIBUTION METHOD

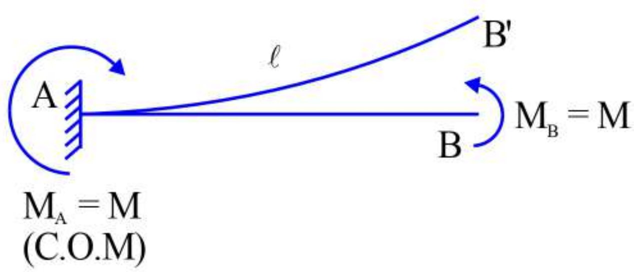
4.1. Introduction

1. Assumptions in moment distribution Method

- The effect of Axial forces and axial deformations are Neglected in moment distribution method.
- Clockwise and moments are taken as +ve and Anticlockwise end moment are taken a –ve {This sign convention is used while distributing the ends moments only}. In this case we will not see weather the end moment are sagging the beam or Hogging the Beam.
- Sagging BM is taken as +ve and Hogging BM is taken as –ve. The sign convention is used while drawing BM dig. only.

2. For cantilever Beam, C.O.M = – M {–ve because applied moment & C.O.M are opposite to each other}

(Applied Moment)



3. Carry Over Factor

It is the Ratio of carry over Moment and Applied moment

Case (1) : When for end is fixed $C.O.F = \frac{C.O.M}{\text{Applied moment}} = \frac{M/a}{M} = \boxed{\frac{1}{2}}^{**}$

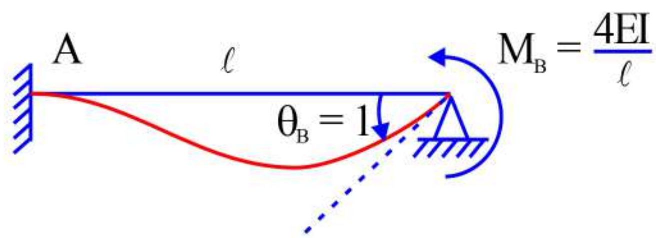
Case (2) : When for end is hinged = $C.O.F. = \frac{0}{M} = \boxed{0}^{**}$

Case (3) : For cantilever beam = $C.O.F. = \frac{-M}{M} = \boxed{-1}^{**}$

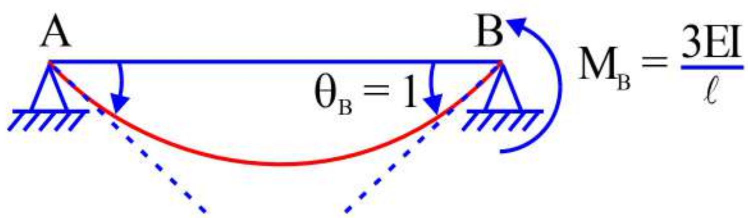
4. Stiffness Factor

It is the moment required to produce unit rotation

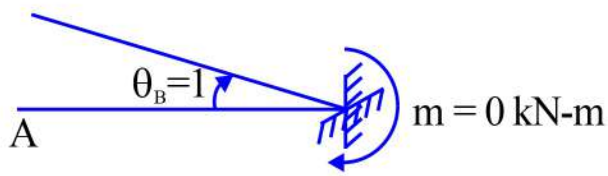
Case (1) : When for end is fixed stiffness factor = s = $\frac{4EI}{\ell}$



Case (2) : When for end is hinged, s = $\frac{3EI}{\ell}$



Case (3) : When for end is free, stiffness factor = s = 0



5. Relative Stiffness (K)

It is the ratio of moment of inertia and length of the member.

Case (1) : When for end is fixed, relative stiffness $K = \frac{I}{\ell}$

Case (2) : When for end is hinged, relative stiffness $K = \frac{3}{4}\frac{I}{\ell}$

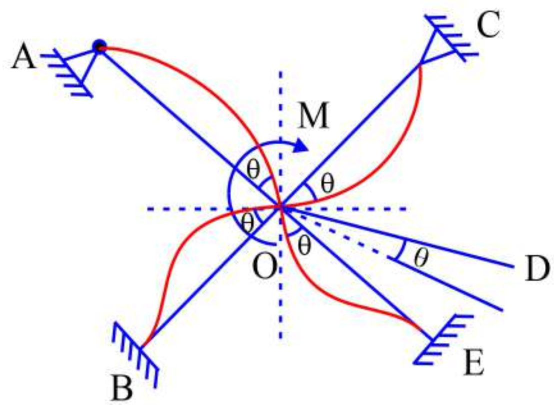
$$\frac{4EI}{\ell} \to \frac{I}{\ell}$$

$$\frac{3EI}{\ell} \to \frac{3}{4}\frac{I}{\ell}$$

Case (3) It for end is free $\boxed{K = 0}$ {Because s = 0}

6. Distribution Factor

It is the ratio in which the applied moment M is shared by the members meeting at any rigid joint.



'0' is a Rigid joint {After application of loads, angle between member remain same}

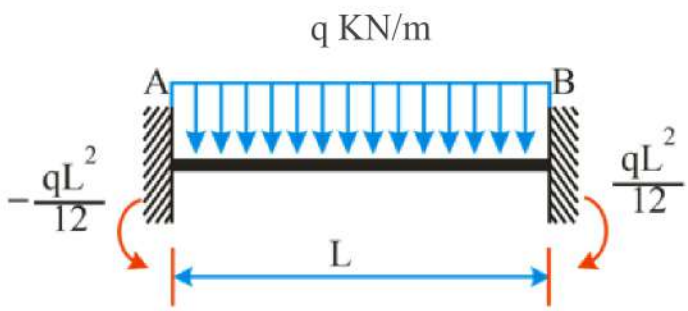
$$D.F = \frac{K}{\Sigma K}$$

7. Note:

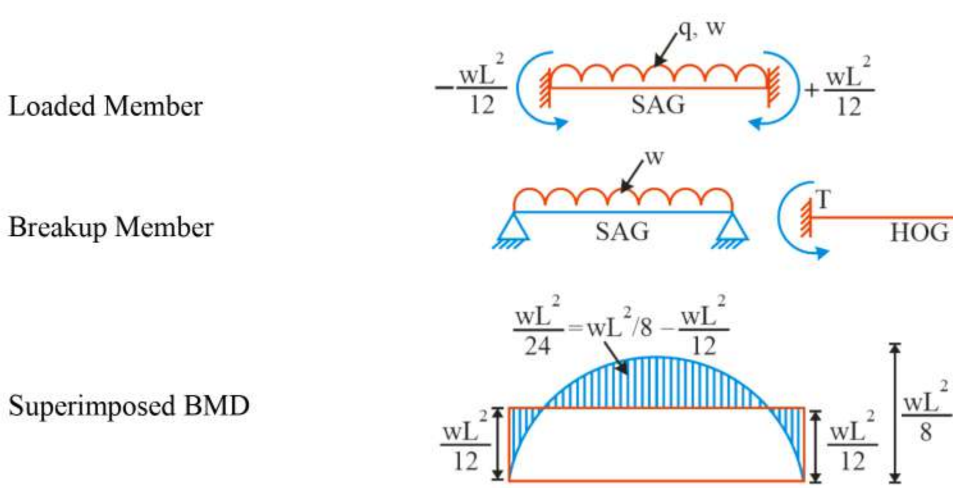
(1) The sum of the distribution factor of all members meeting oat a Rigid Joint = 1

(2) The concept of Distribution factor is Applicable to member metting at a Rigid Joint only.

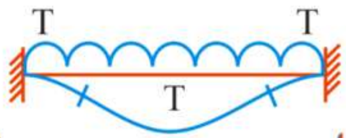
4.2. MDM – Standard Case



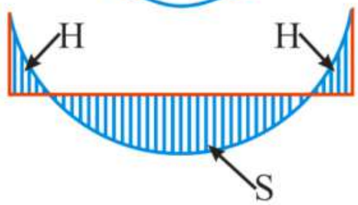
Bending Moment Diagram and Deflected Shape



Deflected Shape

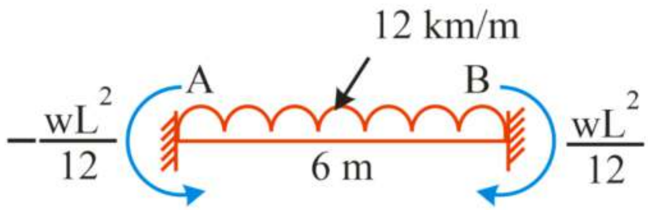


Actual BMD on Tension Side



Bending Moment Diagram and Deflected Shape

Example:



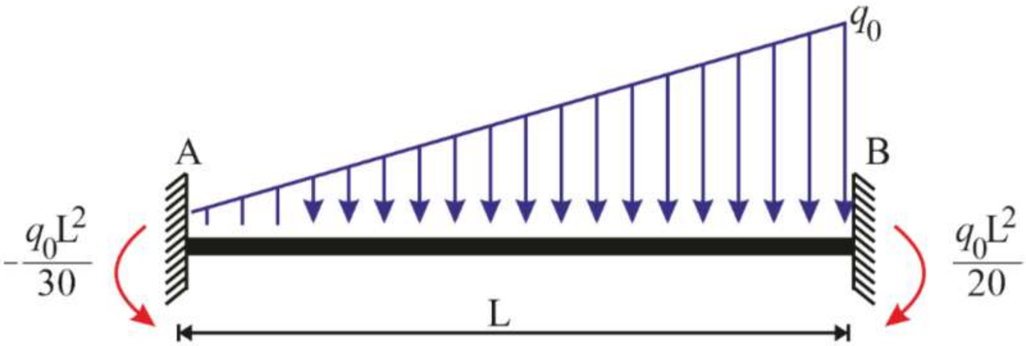
$$M_{AB} = \frac{-12 \times 6^2}{12} \Rightarrow -36\ \text{kNm}$$

$M_{BA} = +\ 36$ kNm

4.3. MDM – Standard Cases 4

Example:

$M_{BA} > M_{AB}$

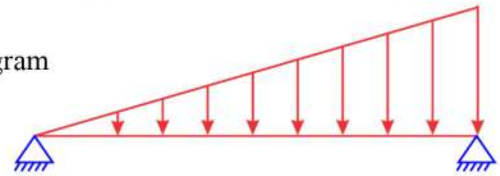


$$M_{AB} = \frac{-q \cdot L^2}{30}$$

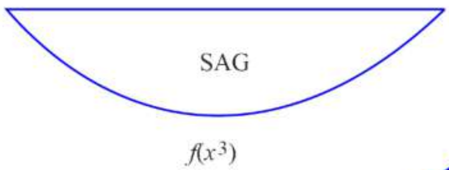
$$M_{BA} = \frac{+qL^2}{20}$$

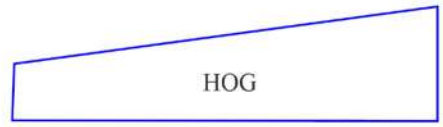
Bending Moment Diagram and Deflected Shape

Loading diagram

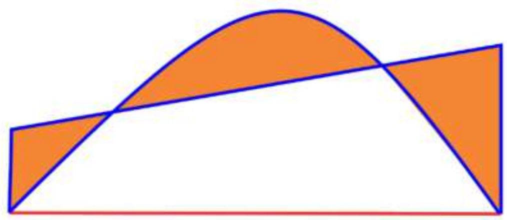


BMD



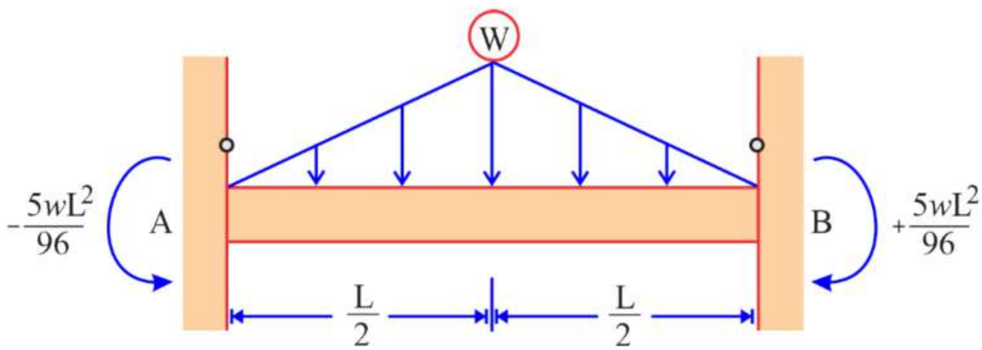


Superimposed BMD



Example:

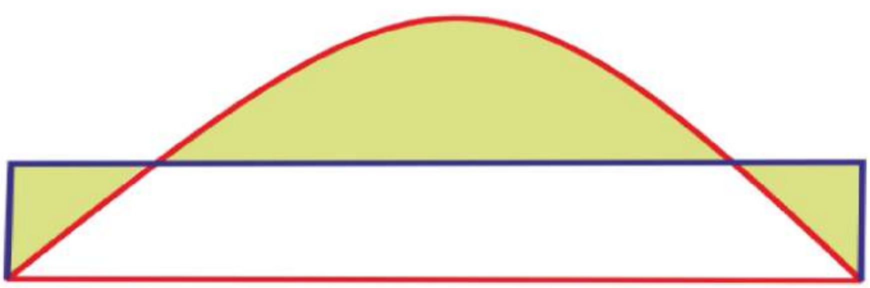
Standard Case



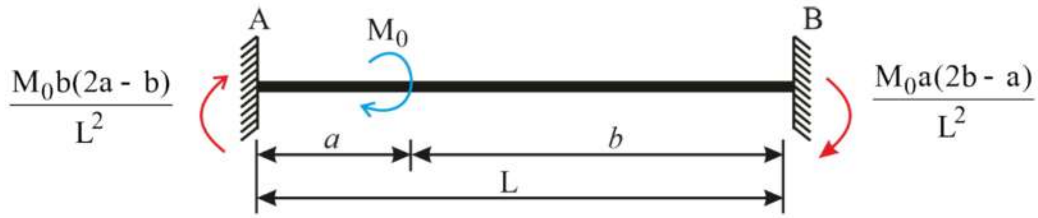
$$M_{AB} = -\frac{5}{96} wL^2$$

$$M_{BA} = +\frac{5wL^2}{96}$$

Bending Moment Diagram



4.4. MDM – Standard Cases 5

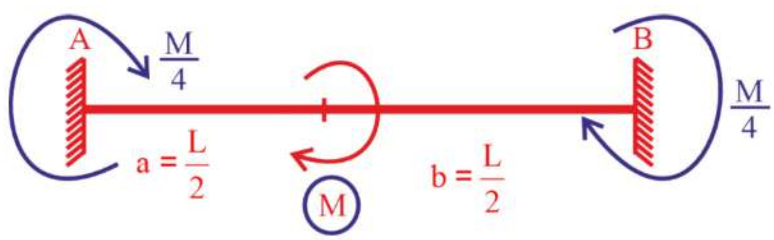


$$M_{AB} = \frac{M_0 b(2a - b)}{L^2}$$

$$M_{BA} = \frac{M_0 a(2b - a)}{L^2}$$

Example:

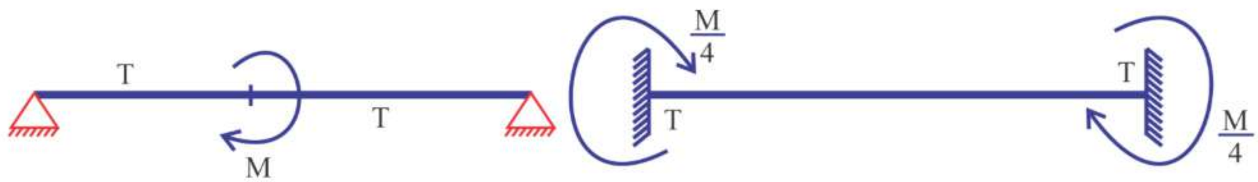
when $a = b = L/2$



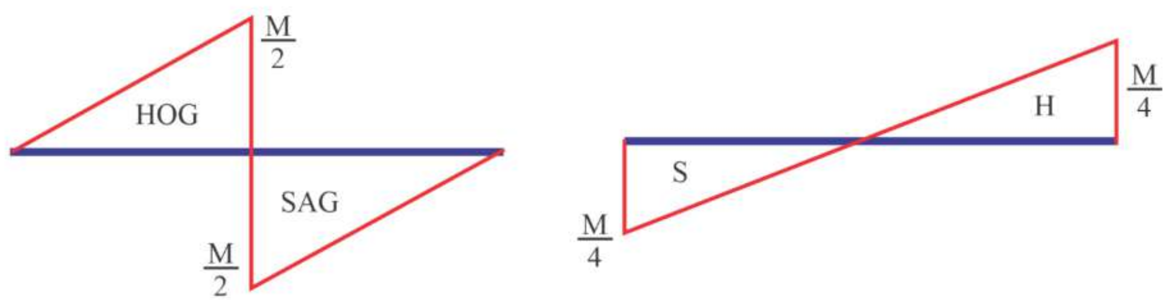
$$M_{AB} = \frac{M.b(2a - b)}{L} = \frac{M.\frac{L}{2}\left[L - \frac{L}{2}\right]}{L} = \frac{M}{4}$$

Bending Moment Diagram and Deflected Shape

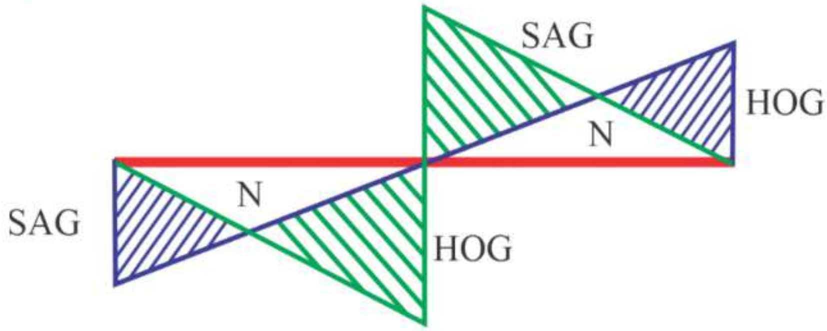
Loading diagram



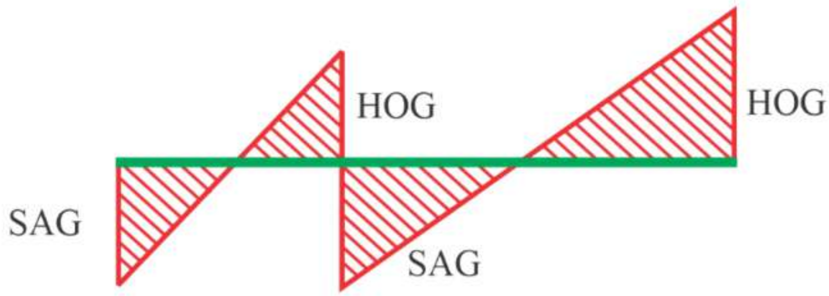
BMD



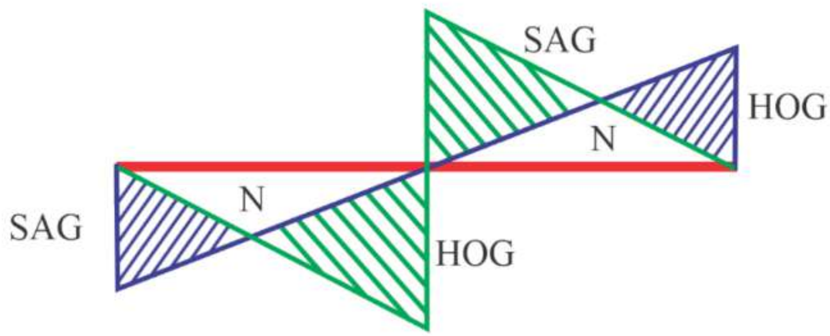
Resultant BMD after Superposition



Resultant BMD

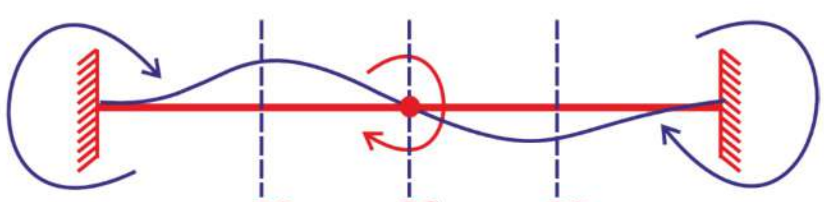


BMD on Tension Side



BMD by Super Position

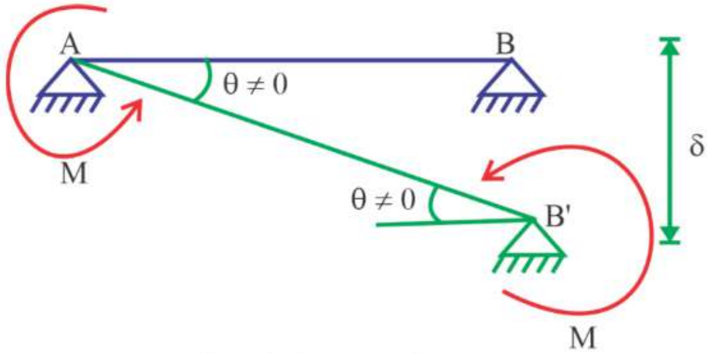
3 Point of Control Flexure and 4 Curvature



4.5. MDM – Standard Cases 6

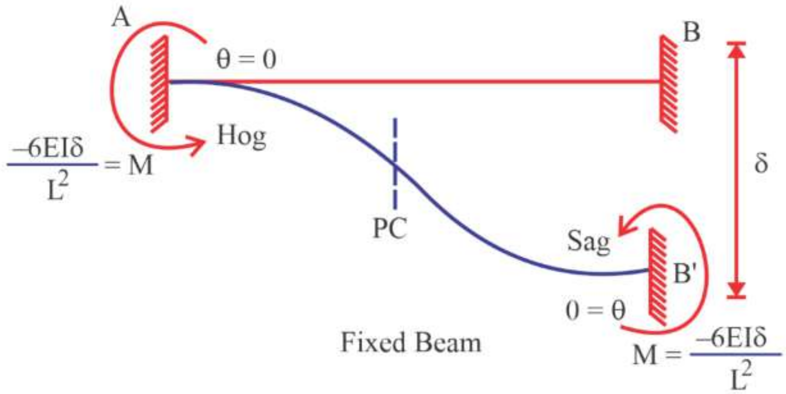
4.4.1. Sinking of Support

Relative to A, support B sinks by δ value.



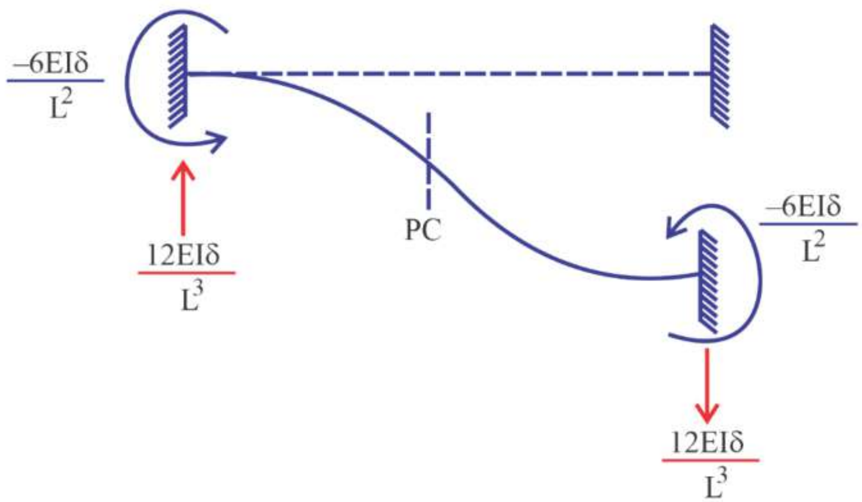
Simple Supported Beam

If A & B are made fixed $\theta = 0$.

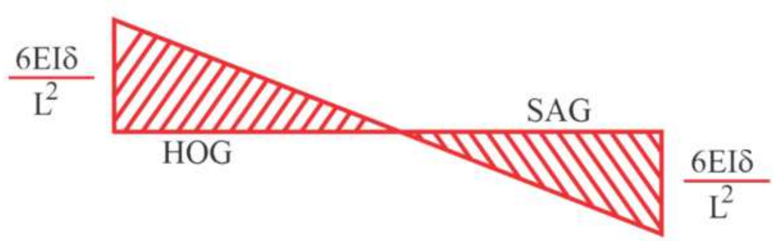


Fixed Beam

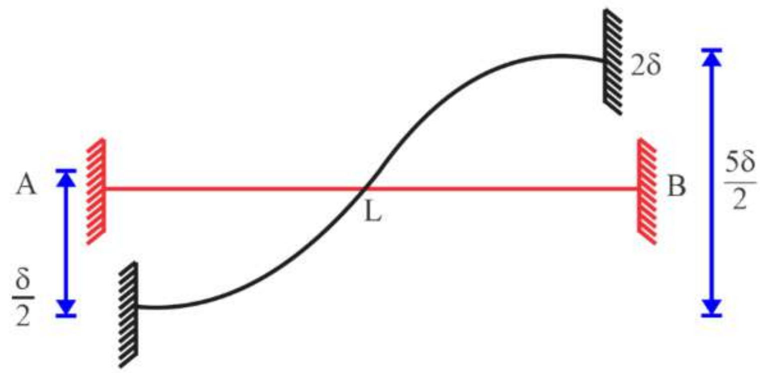
End Reaction



Bending Moment diagram



Example:

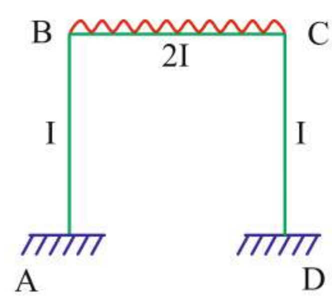


- A setells by $\frac{\delta}{2}$
- B rises by 2δ

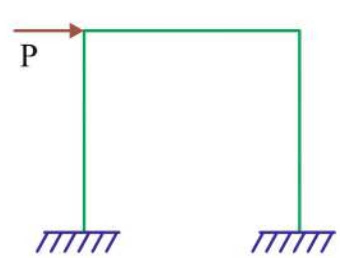
$$M_{AB} = \frac{-6EI\left(\frac{5}{2}\delta\right)}{L^2}, \qquad \text{Relative disp} = 2\delta + \frac{\delta}{2} = \frac{5}{2}\delta$$

4.5. Portal frame with sway – Moment distribution method

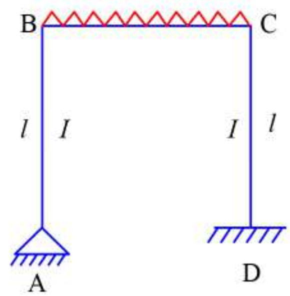
(1) If the structure and loading are symmetrical, then the frame will not in any direction.



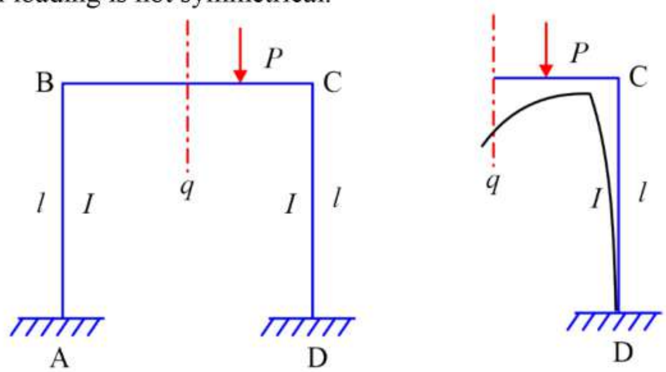
(2) (a) Pure sway (Due to 'P' frame sways right words)



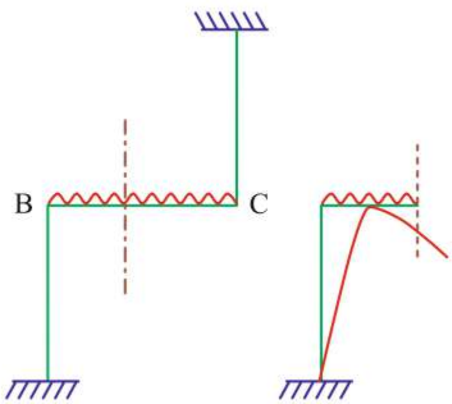
(b) In this case loading is symmetrical but structure is not symmetrical so, frame sways towards weak column side. i.e frame sway left.



(c) Structure is symmetrical loading is not symmetrical.



(d) Cut the frame at centre and check the deflected shape of the cut frame in that direction frame also sways. In the above frame sways to the left.



Frame sways to the right

(3) Causes of side sway of frames:

(a) Unsymmetrical loading

(b) Unsymmetrical out line.

(c) Different end conditions of columns

(d) Non - uniform section of members

(e) Horizontal loading on columns

(f) Settlement of supports

(g) Combination of above.