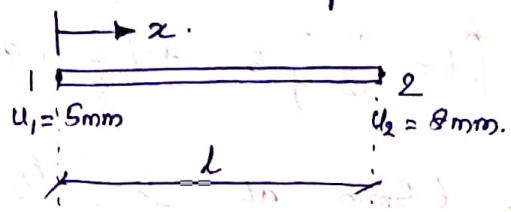
① A two noded truss element is shown below. The nodal displacements are $u_1 = 5mm$, & $u_2 = 8mm$. Calculate displacement at $x = \frac{l}{4}, \frac{l}{3}$ & $\frac{l}{2}$.



To find:-

Displacement u at $x = l/4, l/3$ & $l/2$.

Soln:-

displacement function for two noded truss element is

$$u = N_1 u_1 + N_2 u_2 \quad \rightarrow (A) \qquad N_1 = \frac{l-x}{l}$$

Sub $x = l/4$, $u_1 = 5$ & $u_2 = 8$ $\rightarrow$ ①

$$u = \left(\frac{l-x}{l}\right) u_1 + \left(\frac{x}{l}\right) u_2 \quad \rightarrow ① \qquad N_2 = \frac{x}{l}$$

$$\Rightarrow u = \left[\frac{l - l/4}{l}\right] 5 + \left[\frac{\frac{l}{4}}{l}\right] \times 8$$

$$= \left[1 - \frac{1}{4}\right] 5 + \left[\frac{1}{4}\right] 8.$$

$$\boxed{u = 5.75\,mm} \quad \text{at} \quad x = l/4$$

* Substituting $x = l/3$, $u_1 = 5mm$ & $u_2 = 8\,mm$ in eqn. ①

$$u = \left[\frac{l - \frac{l}{3}}{l}\right] 5 + \left[\frac{\frac{l}{3}}{l}\right] 8$$

$$= \left[1 - \frac{1}{3}\right] 5 + \left(\frac{1}{3}\right) 8$$

$$\boxed{u = 6\,mm.} \quad \text{at} \quad x = l/3$$

* Substituting $x = \frac{l}{2}$, $u_1 = 5$ mm & $u_2 = 8$ mm in eqn (1)

$$u = \left[1 - \frac{1}{2}\right] 5 + \left(\frac{1}{2}\right) 8.$$

$$u = 6.5\text{mm} \quad \text{at} \quad x = l/2$$

Result:

$u = 5.75$ mm at $x = l/4$

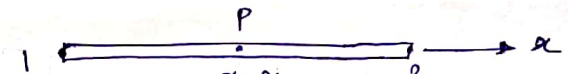
$u = 6$mm at $x = l/3$

$u = 6.5$ mm at $x = l/2$

(2) A one dimensional bar is shown below. Calculate the following.

(i) Shape function N_1 & N_2 at point P.

(ii) If $u_1 = 3$mm & $u_2 = -5$mm, Calculate the displacement u at Point P.



$x_1 = 20$mm, $x_2 = 34$mm

$u_1 = 3$mm, $u_2 = -5$mm

Soln:-

Actual length of the bar, $l = x_2 - x_1$

$= 36 - 20$

$\boxed{l = 16\text{mm}}$

The distance b/w point 1 & point P is

$x = 24 - 20.$

$\boxed{x = 4\text{ mm}}$

Displacement function for two noded bar element

$u = N_1 u_1 + N_2 u_2$

$N_1 = \frac{l - x}{l} = \frac{16 - 4}{16} = 0.75$mm

$N_2 = x/l = \frac{4}{16} = 0.25$mm

$(0.75)(3) + (0.25)(-5)$

$u = 1$mm.

Result

* Shape Function

$N_1 = 0.75$mm

$N_2 = 0.25$ mm

* Displacement u at Point P = 1mm