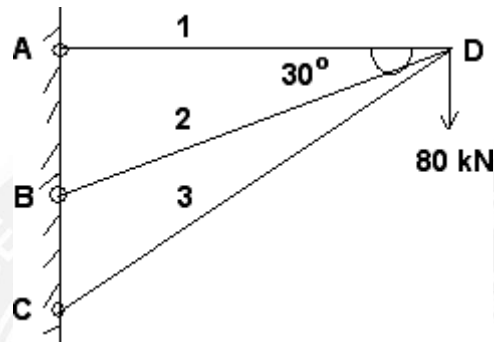


5.5. ANALYSIS OF RIGID FRAMES BY STIFFNESS MATRICES METHOD

5.5.1. NUMERICAL PROBLEMS ON PIN JOINTED FRAMES;

PROBLEM NO:01

Using matrix stiffness method, analyze the truss for the member forces in the truss loaded as shown in figure. AE and L are tabulated below for all the three members.

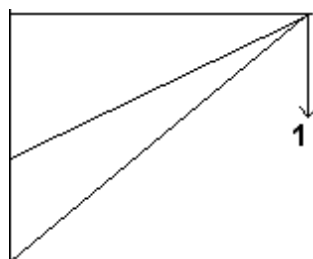


Member	AE	L
AD	400	400
BD	461.9	461.9
CD	800	800

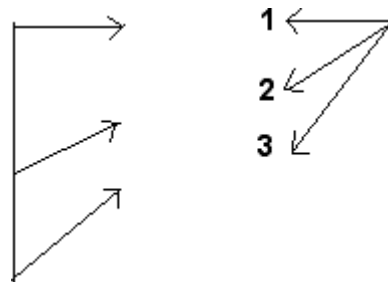
Solution:

- Assigned Co-Ordinates:

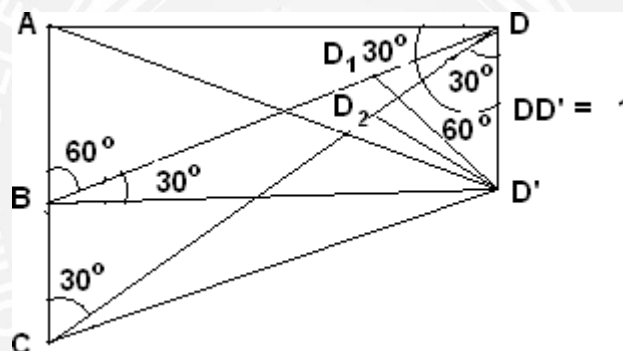
Global Co-Ordinates



Local Co-Ordinates



- Displacement Diagrams:**



- Formation of [A] Matrix:**

Apply unit displacement in DD' . Displacement along 1 , $AD = 0$

Displacement along 2 and 3 ,

$$DD_1 = \cos 60^\circ = 0.5 \text{ and } DD_2 = \cos 30^\circ = 0.866$$

$$A = \begin{bmatrix} 0 \\ -0.5 \\ -0.866 \end{bmatrix}$$

- Stiffness Matrix [K]:**

$$K = \frac{AE}{L} \begin{bmatrix} K_1 & 0 & 0 \\ 0 & K_2 & 0 \\ 0 & 0 & K_3 \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

- **System Stiffness Matrix(J):**

$$J = A^T \cdot K \cdot A$$

$$= \begin{bmatrix} 0 & -0.5 & -0.866 \end{bmatrix} \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 0 \\ -0.5 \\ -0.866 \end{bmatrix}$$

$$= \begin{bmatrix} 0 & -0.5 & -0.866 \end{bmatrix} \begin{bmatrix} 0 \\ -0.5 \\ -0.866 \end{bmatrix}$$

$$J = 1$$

$$J^{-1} = 1$$

- **Displacement Matrix(Δ):**

$$\Delta = J^{-1} \cdot W$$

$$= 1 \times 80 = 80 \text{ mm}$$

- **Element Force (P):**

$$P = K \cdot A \cdot \Delta = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 0 \\ -0.5 \\ -0.866 \end{bmatrix} 80$$

$$= \begin{bmatrix} 0 \\ -0.5 \\ -0.866 \end{bmatrix} 80$$

- **Final Force (P):**

$$= \begin{bmatrix} 0 \\ -40 \\ -69.28 \end{bmatrix}$$

