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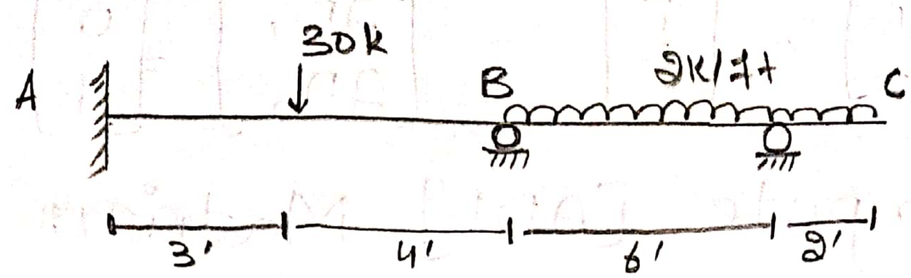
SEC: "A"

SUBJECT: STRUCTURE II

# QUESTION # 1

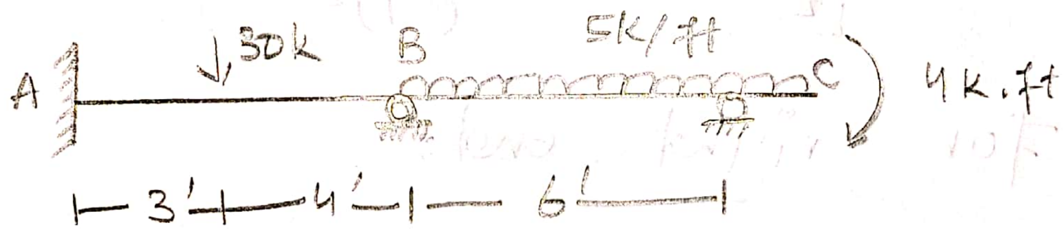



SOLUTION:

Determining kinematic Indetermi-nacy

K.I = 5°

So we have to reduce the extended portion.

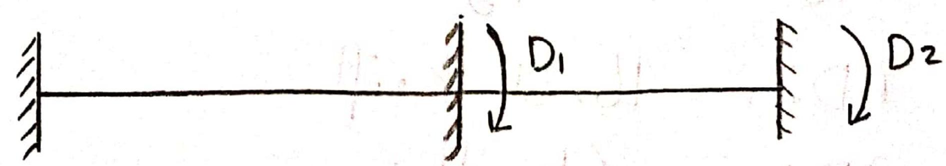



$$\Rightarrow \frac{2(2)}{1} = 4 \text{ k.ft}$$

Now

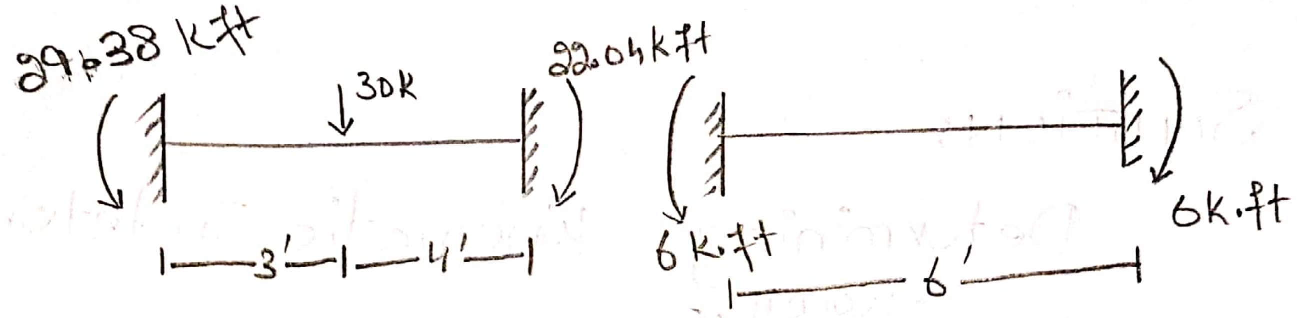
K.I = 2°

★ Determine unknow joint displacement



$$\begin{bmatrix} D_1 \\ D_2 \end{bmatrix} = \begin{bmatrix} ? \\ ? \end{bmatrix} \qquad \begin{bmatrix} AD_1 \\ AD_2 \end{bmatrix} = \begin{bmatrix} 0 \\ 4 \end{bmatrix}$$

* Compute [ADL] Matrix:




⇒ For point load (not at mid)

⇒ For left end

$$\frac{Pab^2}{L^2} = \frac{(30)(3)^2(4)^2}{(7)^2} = 29.38 \text{ K ft}$$

⇒ for right end:

$$\frac{Pa^2b}{L^2} = \frac{(30)(3)^2(4)}{(7)^2} = 22.04 \text{ K.ft}$$

⇒ For UDL:

$$\frac{WL^2}{12} = \frac{(2)(6)^2}{12} = 6 \text{ K.ft}$$

$ADL_1 = 16.04$ K.ft

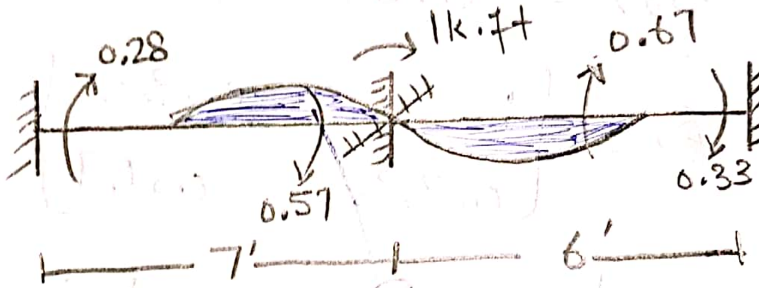
$ADL_2 = 6$ K.ft.

* compute [S] matrix:

$$S = \begin{bmatrix} S_{11} & S_{12} \\ S_{21} & S_{22} \end{bmatrix}$$

~~a = $D_1$~~

a) $D_1 = 1k$ , $D_2 = 0$



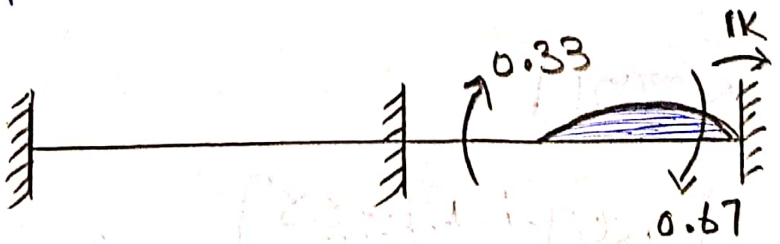

$$\frac{4EI}{7} = 0.57 \qquad \frac{2EI}{6} = 0.33$$

$$\frac{4EI}{6} = 0.67 \qquad \frac{2EI}{7} = 0.28$$

$$S_{11} = 0.57 + 0.67 = 1.24\,EA$$

$$S_{21} = 0.33\,EA$$

b) $D_1 = 0$ $D_2 = 1k$



$$\frac{4EI}{6} = 0.67$$

$$\frac{2EI}{6} = 0.33$$

$S_{12} = 0.33$

$S_{22} = 0.67$

$$S = \begin{bmatrix} 1.24 & 0.33 \\ 0.33 & 0.67 \end{bmatrix}$$

★ Compute D matrix,

$$\begin{bmatrix} D_1 \\ D_2 \end{bmatrix} = \begin{bmatrix} S_{11} & S_{12} \\ S_{21} & S_{22} \end{bmatrix}^{-1} \times \begin{bmatrix} AD_1 \\ AD_2 \end{bmatrix} - \begin{bmatrix} ADL_1 \\ ADL_2 \end{bmatrix}$$

$$= \frac{1}{\begin{vmatrix} 1.24 & 0.33 \\ 0.33 & 0.67 \end{vmatrix}} \times \text{Adj } A \times \begin{bmatrix} AD_1 \\ AD_2 \end{bmatrix} - \begin{bmatrix} ADL_1 \\ ADL_2 \end{bmatrix}$$

$$|S| = (1.24 \times 0.67) - (0.33 \times 0.33)$$

$$= 0.8308 - 0.1089$$

$$|S| = 0.7219$$

$$\text{Adj } A = \begin{bmatrix} 0.67 & -0.33 \\ -0.33 & 1.24 \end{bmatrix}$$

Now

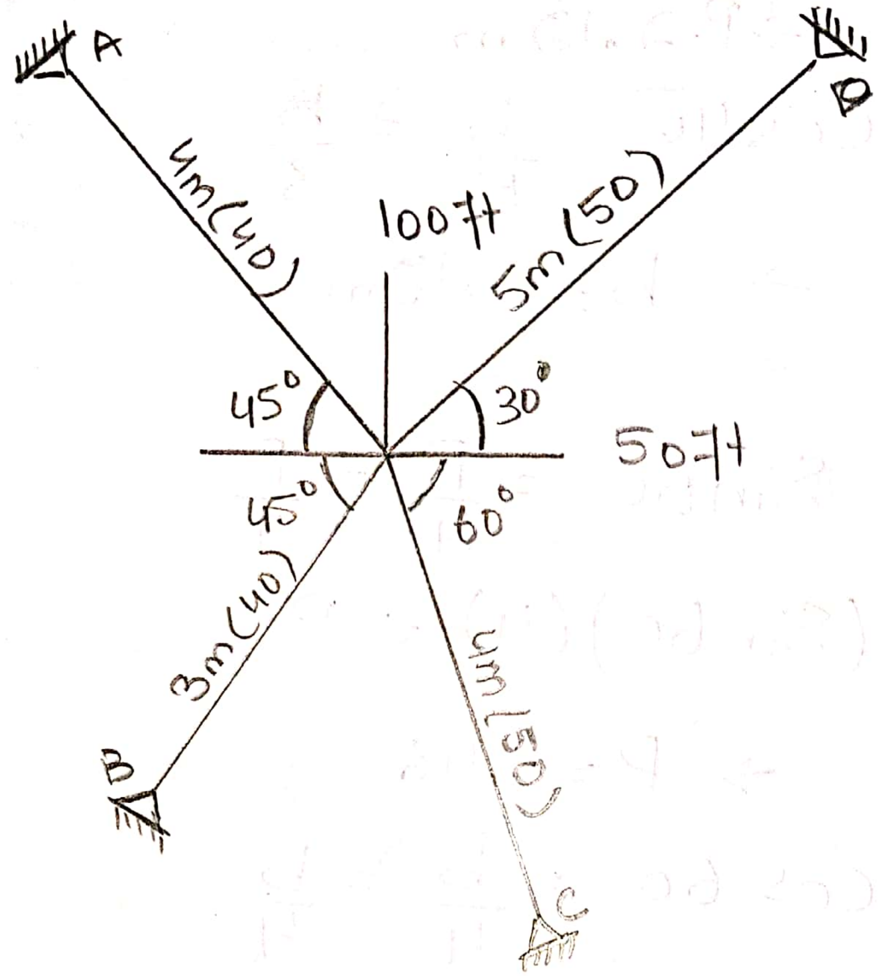
$$\begin{bmatrix} AD_1 - ADL_1 \\ AD_2 - ADL_2 \end{bmatrix} = \begin{bmatrix} 0-16.04 \\ 4-6 \end{bmatrix}$$

$$= \begin{bmatrix} -16.04 \\ -2 \end{bmatrix} E$$

$$\begin{bmatrix} D_1 \\ D_2 \end{bmatrix} = \frac{\begin{bmatrix} 0.67 & -0.33 \\ -0.33 & 1.24 \end{bmatrix}}{0.7219} \times \begin{bmatrix} -16.04 \\ -2 \end{bmatrix}$$

$$\begin{bmatrix} D_1 \\ D_2 \end{bmatrix} = \begin{bmatrix} -13.83 \\ 3.85 \end{bmatrix}$$

# QUESTION # 2:




# SOLUTION:

For A:

$$\sin 45 = \frac{P}{H} = \frac{P}{4}$$

$\rightarrow P = 2.828m$

$$\cos 45° = \frac{b}{H} = \frac{b}{4}$$

$\rightarrow b = 2.828m$

For B:

$$\sin 45 = \frac{P}{H} = \frac{P}{3}$$

$\rightarrow P = 2.12\ m$

$$\cos 45 = \frac{b}{H} = \frac{b}{3}$$

$\rightarrow b = 2.12m$

For C:

$$\sin 60 = \frac{P}{H} = \frac{P}{4}$$

$$(\sin 60)(4) = P$$

$\rightarrow P = 3.46$

$$\cos 60 = \frac{b}{H} = \frac{b}{4}$$

$$\cos 60 \times 4 = b$$

$\rightarrow b = 2$

For D:

$$\sin 30 = \frac{P}{5}$$

$\rightarrow P = 2.5m$

$$\cos 30 = \frac{b}{5}$$

$b = 4.33m$

Now

$EA(A) = 2000 \times 40 = 80000t$

$EA(B) = 2000 \times 40 = 80000t$

$EA(C) = 2000 \times 50 = 100000t$

$EA(D) = 2000 \times 50 = 100000t$

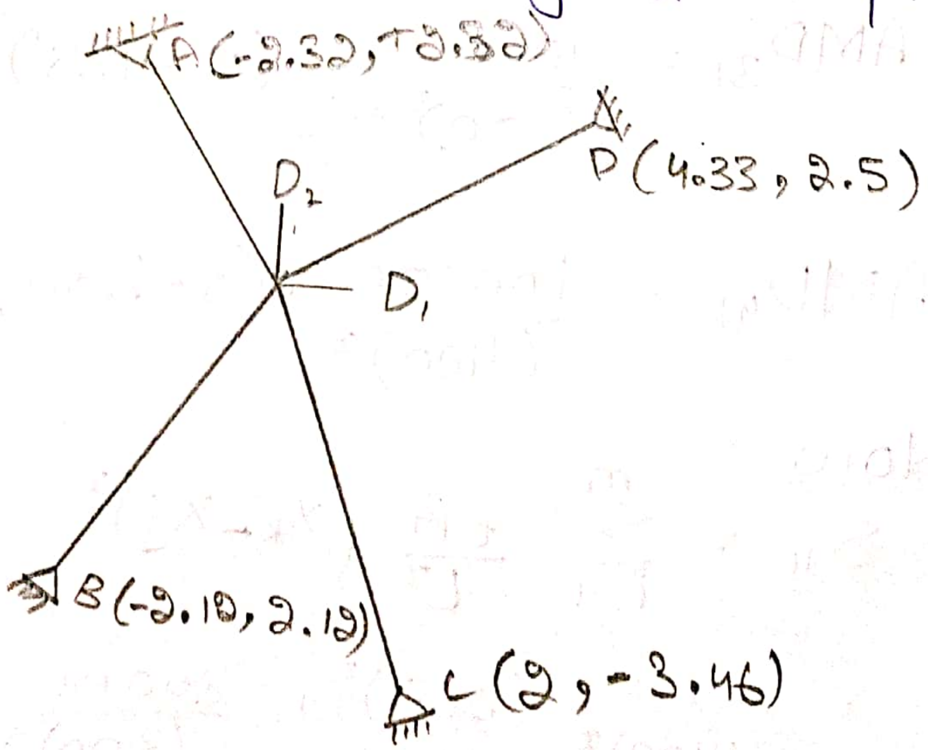
★ KI

$KI = 2j - r$

$= 2(5) - 8$

$KI = 2^{\circ}$

★ select unknown joint displacement



$$\begin{bmatrix} D_1 \\ D_2 \end{bmatrix} = \begin{bmatrix} ? \\ ? \end{bmatrix} * \quad \begin{bmatrix} AD_1 \\ AD_2 \end{bmatrix} = \begin{bmatrix} 50 \\ -100 \end{bmatrix}$$

☆ $[AMD]_{4\times2}$ $\quad [S]_{2\times2}$,

i) $D_1 = 1k$ , $D_2 = 0$

$$AMD = \frac{EA}{L^2}(X_k - X_j)$$

$$AMD_{11} = \frac{80000}{(400)^2} \times (0 + 282) = 141$$

$$AMD_{21} = \frac{80000}{(300)^2}(0 + 212) = 188.44$$

$$AMD_{31} = \frac{100000}{(500)^2} \times (0 - 433) = -173.2$$

$$AMD_{41} = \frac{100000}{(400)^2} \times (0 - 200) = -125$$

Now

$$S_{11} = \sum_{i=1}^{m} \frac{EA}{L^3}(x_k - x_j)^2$$

$$= \frac{80000}{(400)^3}(282)^2 + \frac{80000}{(300)^3} \times (212)^2$$

(500)

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$$+ \frac{100000}{(500)^3}(-433)^2 + \frac{100000}{(400)^3}(-200)^2$$

$$S_{11} = 99.405 + 133.107 + 149.991 + 62.5$$

$$\underline{\underline{S_{11}}} = \underline{\underline{445.063}}$$

$$\Rightarrow S_{12} = S_{21} = \sum_{i=1}^{m} \frac{EA}{L^3} \times (x_k - x_j)(y_k - y_j)$$

$$= \frac{80000}{(400)^3}(282)(-282) + \frac{80000}{(300)^3}(212)(212)$$

$$+ \frac{100000}{(500)^3}(-433)(0-250) + \frac{100000}{(400)^3}(-200)(0+346)$$

$$\underline{\underline{S_{12} = S_{21}}} = \underline{\underline{12.237}}$$

ii) $D_1 = 0 \qquad D_2 = 1K$

$$AMD = \frac{EA}{L^2}(y_k - y_j)$$

$$AMD_{12} = \frac{80000}{(400)^2}(-282) = -141$$

$$AMD_{22} = \frac{80000}{(300)^2}(212) = 188.44$$

$$AMD_{32} = \frac{100000}{(500)^2}(-250) = -100$$

$$AMD_{42} = \frac{100000}{(400)^2}(346) = 216.25$$

Now $$S_{22} = \sum_{i=1}^{m} \frac{EA}{L^3}(Y_K - Y_j)^2$$

$$= \frac{80000}{400^3}(-282)^2 + \frac{80000}{300^3}(212)^2 + \frac{100000}{500^3}(-250)^2 + \frac{100000}{400^3}(346)^2$$

$$S_{22} = 469.628$$

★ $$[D] = [S]^{-1} \times [AD]$$

$$\begin{bmatrix} D_1 \\ D_2 \end{bmatrix} = \begin{bmatrix} 445.003 & 12.237 \\ 12.237 & 469.628 \end{bmatrix}^{-1} \times \begin{bmatrix} 50 \\ -100 \end{bmatrix}$$

$$\begin{bmatrix} D_1 \\ D_2 \end{bmatrix} = \begin{bmatrix} 0.1183 \\ -0.216 \end{bmatrix}$$

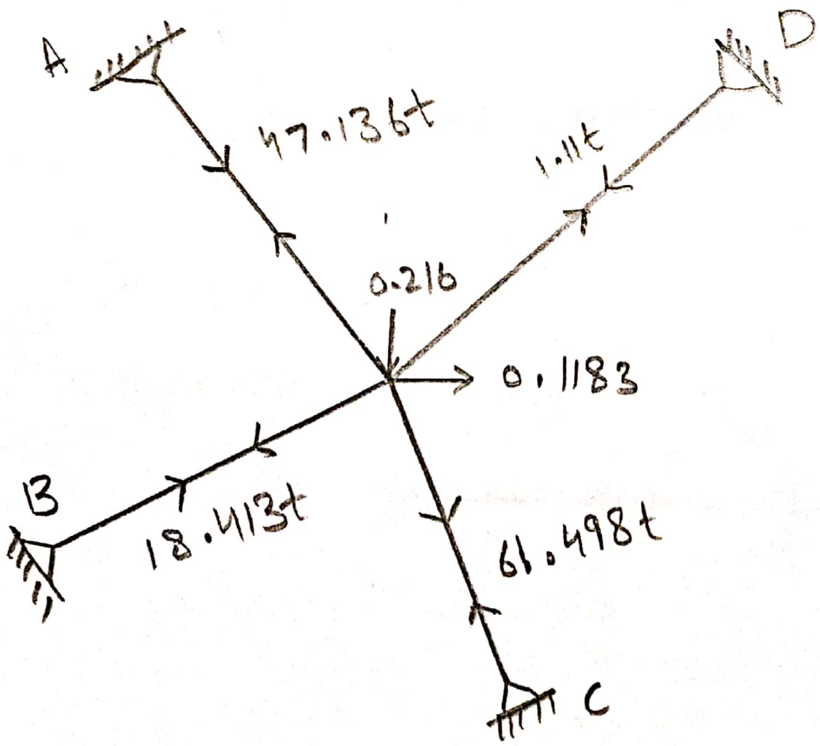
★ [AM]

$$\begin{bmatrix} AM_1 \\ AM_2 \\ AM_3 \\ AM_4 \end{bmatrix} = \begin{bmatrix} 141 & -141 \\ 188.44 & 188.44 \\ -173.2 & -100 \\ -125 & 216.25 \end{bmatrix} \times \begin{bmatrix} 0.1183 \\ -0.216 \end{bmatrix}$$

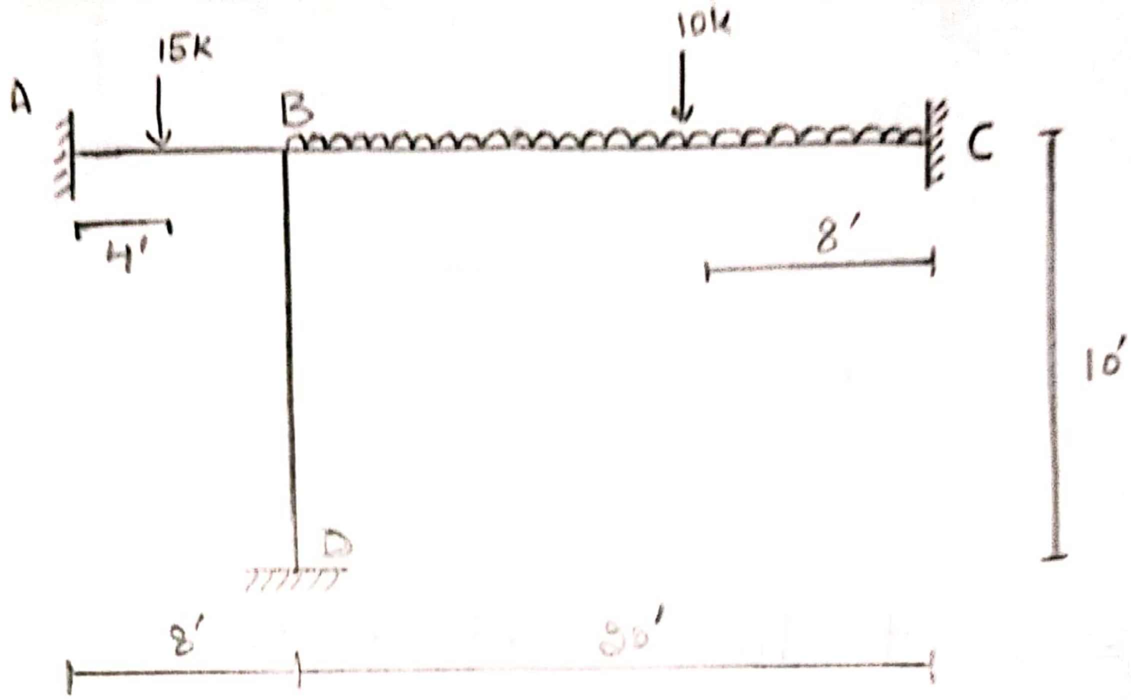
$$= \begin{bmatrix} 141 \times 0.1183 + (-141) \times (-0.216) \\ 188.44 \times 0.1183 + (188.44) \times (-0.216) \\ -173.2 \times 0.1183 + (-100)(-0.216) \\ -125 \times 0.1183 + 216.25 \times (-0.216) \end{bmatrix}$$

$$\begin{bmatrix} AMD_1 \\ AMD_2 \\ AMD_3 \\ AMD_4 \end{bmatrix} = \begin{bmatrix} 16.68 + 30.46 \\ 22.29 - 40.70 \\ -20.49 + 21.6 \\ -14.79 + 46.71 \end{bmatrix}$$

$$\begin{bmatrix} AMD_1 \\ AMD_2 \\ AMD_3 \\ AMD_4 \end{bmatrix} = \begin{bmatrix} 47.136t \\ -18.413t \\ 1.11t \\ -61.498t \end{bmatrix}$$



# Question #3.

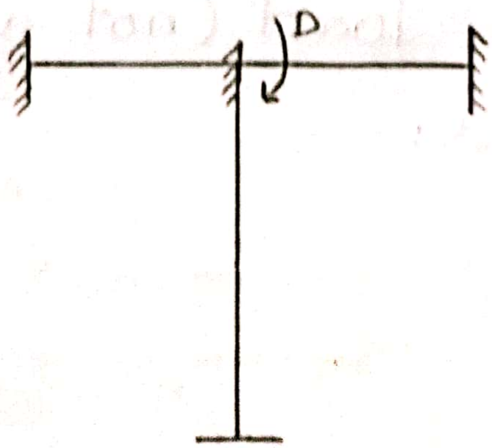



## Solution:

* Determine Kinematic Indeterminacy

$$K.I = 1$$

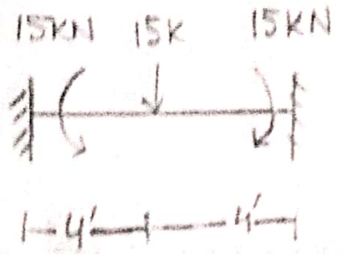
* Determine unknown joint displacement

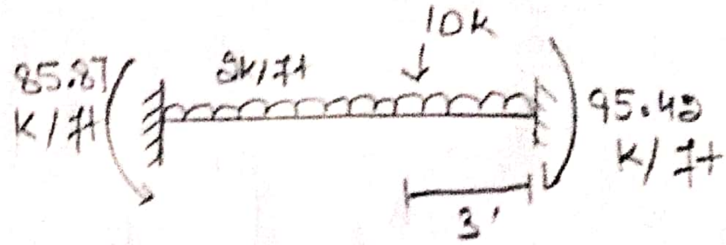


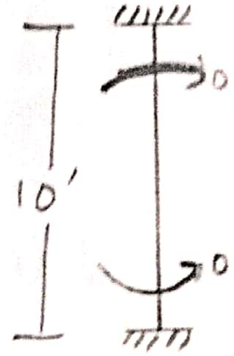

$[D] = ?$

$[AD] = [0]$

* Compute [ADL] matrix.




⇒ point load at centre:

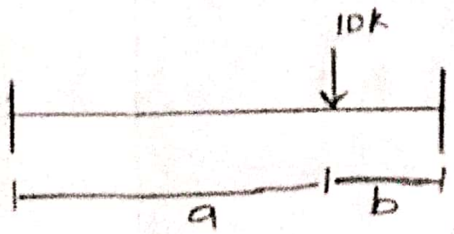
$$\frac{PL}{8} = \frac{(15)(8)}{8} = 15 \text{ kip}\cdot\text{ft}$$

⇒ Uniform distributed load:

$$\frac{WL^2}{12} = \frac{(2)(20)^2}{12} = 66.67 \text{ k}\cdot\text{ft}$$

⇒ Point load (not at mid):

Suppose:



For left end:

$$\frac{Pab^2}{L^2} = \frac{(10)(12)(8)^2}{(20)^2} = 19.2\ k.ft$$

For right end:

$$\frac{Pa^2b}{L^2} = \frac{(10)(12)^2(8)}{(20)^2} = 23.8\ k.ft$$

So total moment at left end:

$$19.2 + 66.67 = 85.87\ k.ft$$

similarly at right end:

$$28.8 + 66.67 = 95.47\ k.ft$$

So

$$[ADL] = -85.87 + 15 = -70.87\ k.ft$$

★ Determine [S] matrix:

$$[S] = [S_{11}]$$

Now

$$D = 1k$$

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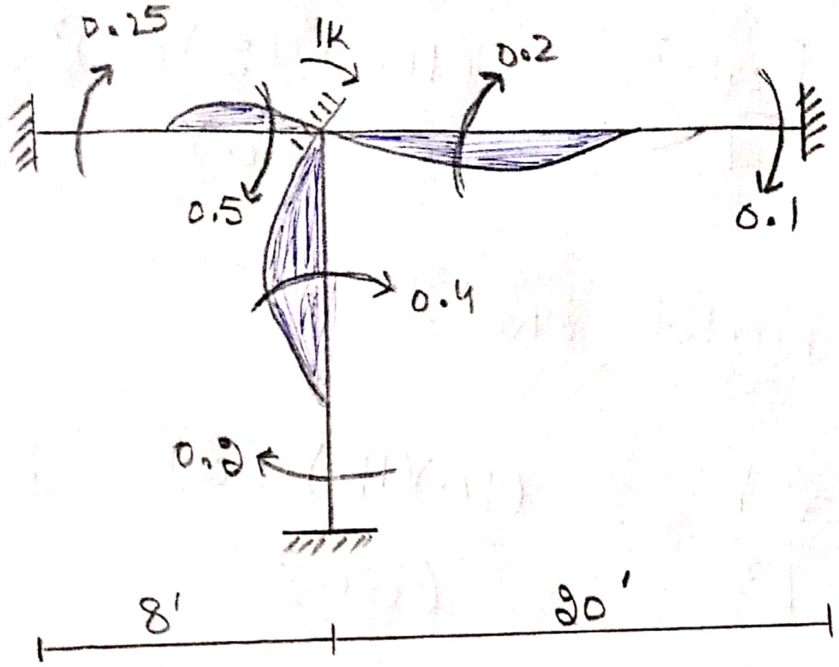


$\Rightarrow \frac{4EI}{8} = 0.5 \qquad \frac{2EI}{8} = 0.25$

$\Rightarrow \frac{4EI}{20} = 0.2 \qquad \frac{2EI}{20} = 0.1$

$\Rightarrow \frac{4EI}{10} = 0.4 \qquad \frac{2EI}{10} = 0.2.$

$[S] = (0.5 + 0.4 + 0.2)EI$

$= 1.1\,EI$

$[S] = 1.1EI$

$[D] = [S]^{-1} \times [AD] - [ADL]$

$[D] = 1/1.1 \times [0] - [-70.87] = \frac{70.87}{1.1}$

$[D] = [64.42]\, 1/EI$ ANSWER.