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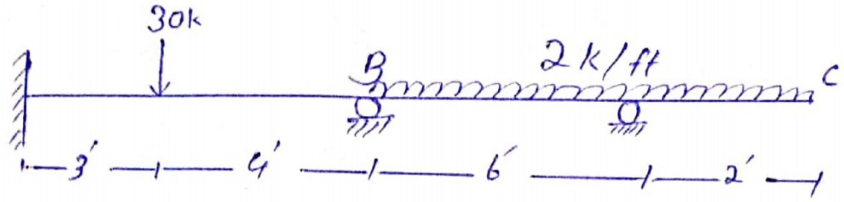
Section "B"

Subject Structure Analysis II

Teacher Engr Adeed khan

Q No # 01



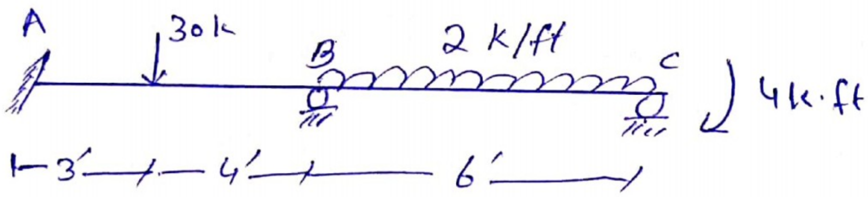
Sol: 01

Step#1

Determining kinematic Inderminancy,

$K.I = 5^{\circ}$

So we have to reduce the external portion.



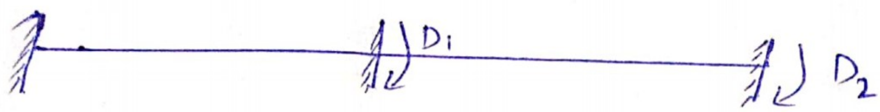
$$\Rightarrow \frac{2(2)}{1} = 4 \text{ k.ft}$$

Now:

$K.I = 2^{\circ}$

Step#2

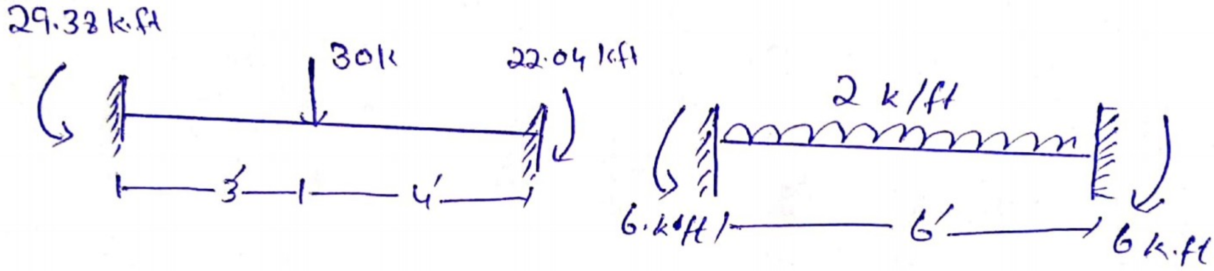
Determine unknown Joint Displacement.



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

Step#03

Compute [ADL] Matrix



=> For Pointed load (not at mid)

=> For Left end:

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

=> For Right end:

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

=> For UDL:

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

$ADL_1 = +22.04 - 6 \quad = 16.04 \text{ k.ft}$

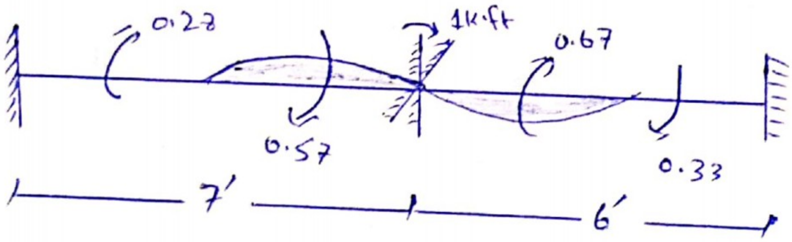
$ADL_2 = 6 \text{ k.ft.}$

Step # 04

Compute [S] Matrix

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

(a) $D_1 = 1k, \quad D_2 = 0$



$$\frac{4EI}{7} = 0.57$$

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

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

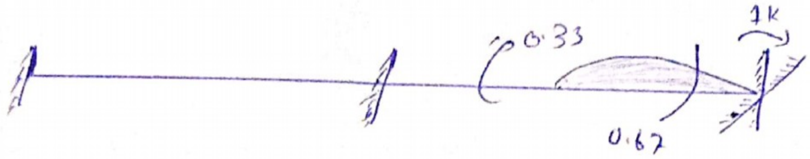
$$\frac{2EI}{7} = 0.28$$

$S_{11} = 0.57 + 0.67$

$$\boxed{= 1.24 \, EA}$$

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

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



θ $\frac{4EI}{6} = 0.67$

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

$\boxed{S_{12} = 0.33}$

$\boxed{S_{22} = 0.67}$

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

Step #05

Compute [D] Matrix

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

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

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

$$= 0.8308 - 0.1089$$

$$|S| = 0.7219$$

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

Now

$$\begin{bmatrix} AD_1 & -ADL_1 \\ AD_2 & ADL_2 \end{bmatrix} = \begin{bmatrix} 0 - 16.04 \\ 4 - 6 \end{bmatrix} = \begin{bmatrix} -16.04 \\ -2 \end{bmatrix} E$$

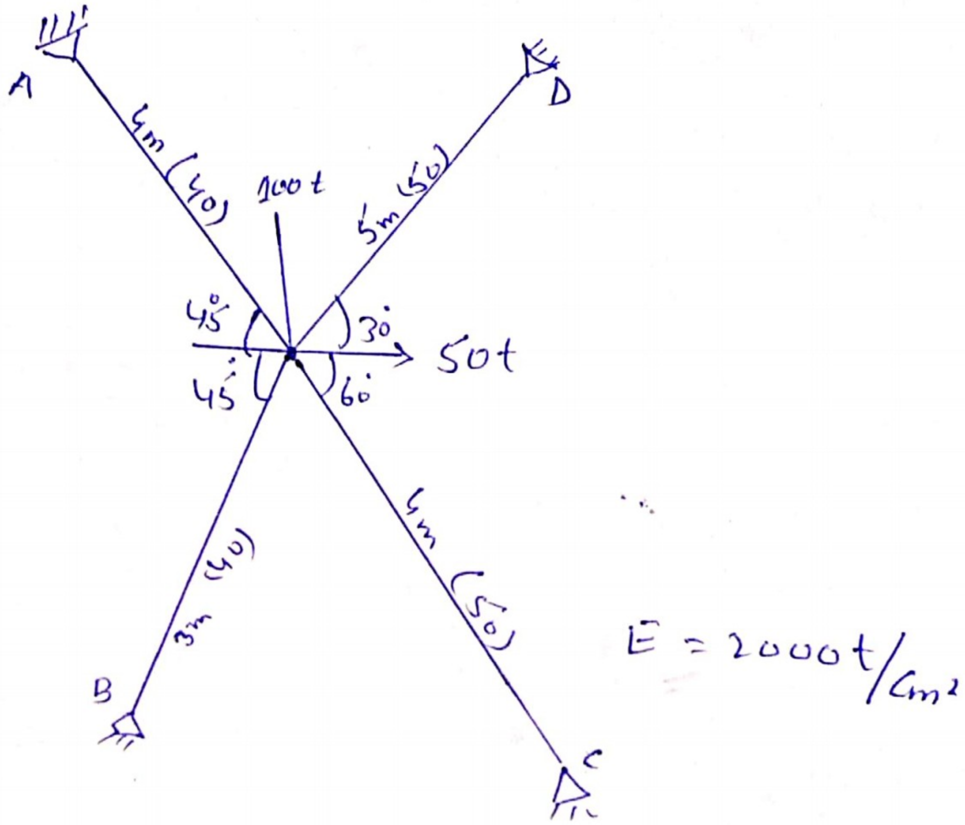
$$\begin{bmatrix} D_1 \\ D_2 \end{bmatrix} = \frac{\begin{bmatrix} 0.67 & -0.33 \\ -0.33 & 1.24 \end{bmatrix}}{0.7219} \times \begin{bmatrix} -16.04 \\ -2 \end{bmatrix}$$

$$\begin{bmatrix} D_1 \\ D_2 \end{bmatrix} = \begin{bmatrix} 0.919 & -0.452 \\ -0.452 & 1.70 \end{bmatrix} \times \begin{bmatrix} -16.04 \\ -2 \end{bmatrix}$$

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

Ans.

QNO#02



Solution:

For A

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

$$\rightarrow P = 2.828\,m$$

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

$$\rightarrow 2.828\,m$$

For B.

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

$\rightarrow P = 2.12\,m$

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

$\rightarrow b = 2.12\,m$

For C

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

$\cancel{\rightarrow P =}$ $(\sin 60)\,4 = P$

$\rightarrow P = 3.46\,m$

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

$\cos 60 \times 4 = b$

$\rightarrow b = 2\,m$

For D:

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

$\rightarrow P = 2.5\,m$

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

$\rightarrow P = 4.33\,m$

Now

$EA(A) = 2000 \times 40 = 80{,}000\,t$

$EA(B) = 2000 \times 40 = 80{,}000\,t$

$EA(C) = 2000 \times 50 = 100{,}000\,t$

$EA(D) = 2000 \times 50 = 100{,}000\,t$

Step #01 K.I

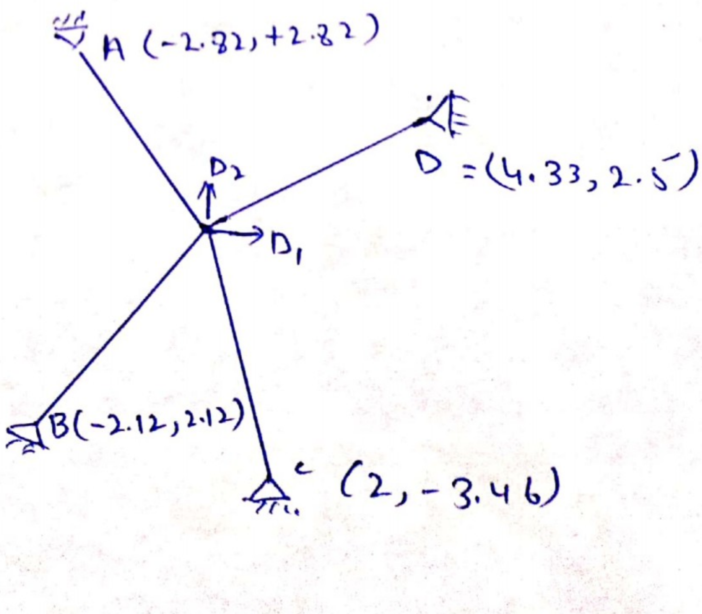
$KI = 2j - r$

$= 2(5) - 8$

$KI = 2°$

Step # 02

Slect unknown joint displacement



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

Step#03

$$[AMD]_{4\times2} \qquad [S]_{2\times2}$$

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

$$AMD = \frac{EA}{L^2}(x_k - x_j)$$

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

$$AMD_{21} \; \frac{80,000}{(300)^2} \times (0+212) = 188.44$$

$$AMD_{31} = \frac{100,000}{(500)^2} \times (0-433) = -173.2$$

$$AMD_{41} = \frac{100,000}{(400)^2} \times (0-200) = -125$$

Now

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

$$= \frac{80,000}{(400)^3} \times (282)^2 + \frac{80,000}{(300)^3} \times (212)^2$$

$$+ \frac{100,000}{(500)^3} \times (-433)^2 + \frac{100,000}{(400)^3} \times (-200)^2$$

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

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

$\Rightarrow$

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

$$= \frac{80,000}{(400)^3} (282) \times (-282) + \frac{80,000}{(300)^3} \times (212)(212)$$

$$+ \frac{100,000}{(500)^3} \times (-4.33) \times (0-250) + \frac{100,000}{(400)^3} (-200)(0+346)$$

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

(ii) $D_1 = 0$ $\quad D_2 = 1k'$

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

$$AMD_{12} = \frac{80,000}{(400)^2} (-282) = -141$$

Scanned with CamScanner

Scanned by CamScanner

$$AMD_{22} = \frac{80,000}{(300)^2}(212) = 188.44$$

$$AMD_{32} \quad \frac{100,000}{(500)^2}(-250) = -100$$

$$AMD_{42} = \frac{100,000}{(400)^2}(346) = 216.25$$

Now

$$S_{22} = \sum_{i=1}^{m} \frac{EA}{L^3}(y_{1i} - y_j')^2$$

$$\frac{80,000}{400^3}(-282)^2 + \frac{80,000}{300^3}(212)^2$$

$$+ \frac{100,000}{(500)^3}(-250) + \frac{100,000}{(400)^3}(346)^2$$

$$\boxed{S_{22} = 469.628}$$

Step#04

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

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

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

Step # 05

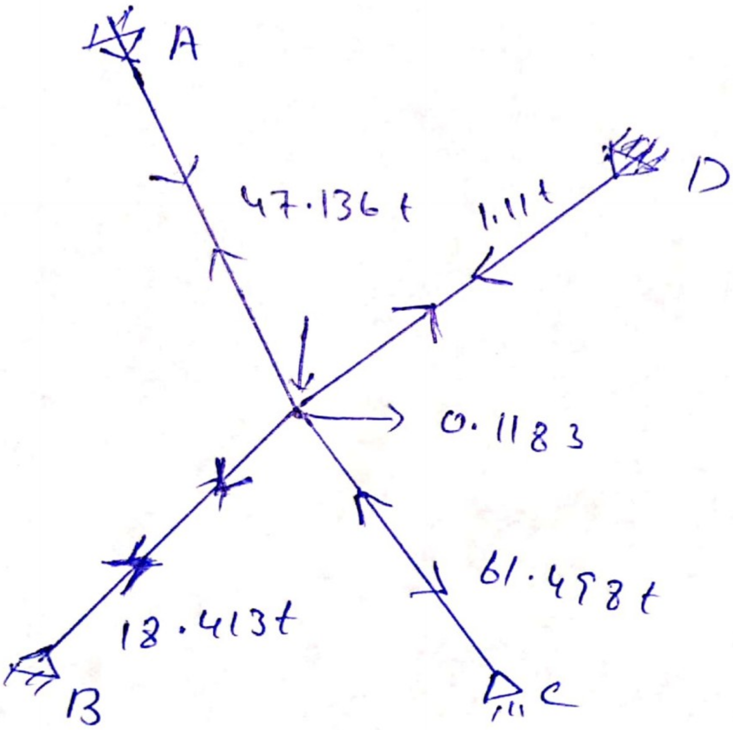
$$[AM]$$

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

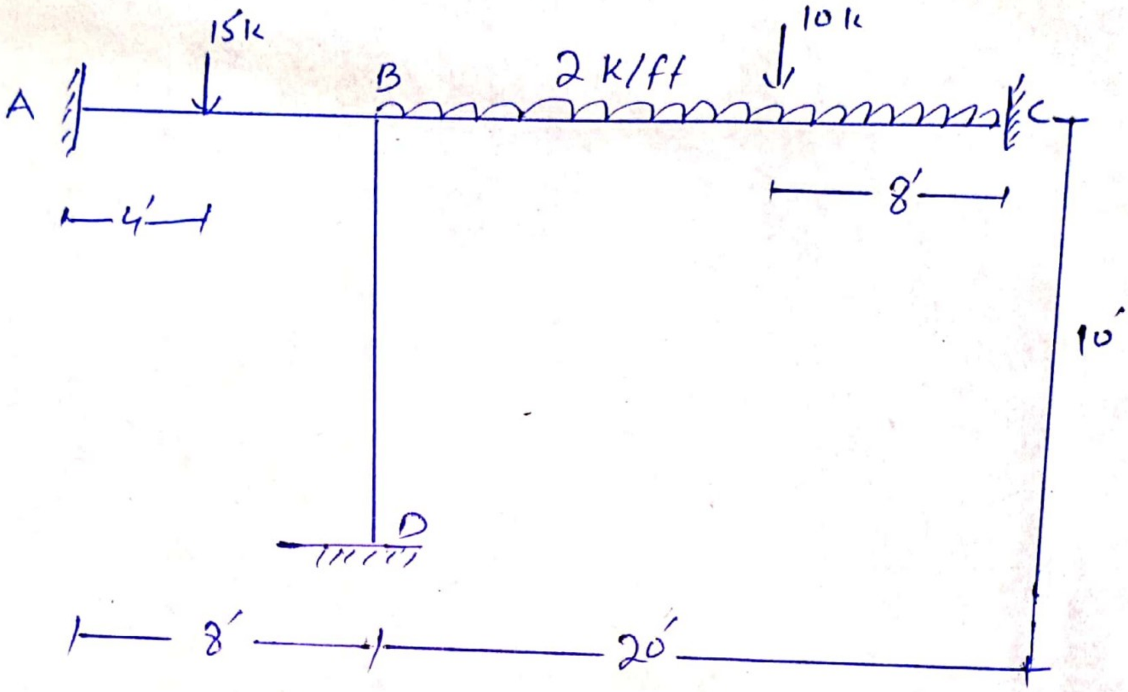
$$= \begin{bmatrix} 141 \times 0.1183 + (-141) \times (0.216 \\ 188.44 \times 0.1183 + (188.44) \times (-0.216) \\ -173.2 \times 0.1183 + (-100)(-0.216) \\ -125 \times 0.1183 + 216.25 \times (-0.1216) \end{bmatrix}$$

$$\begin{bmatrix} AM_1 \\ AM_2 \\ AM_3 \\ AM_4 \end{bmatrix} \begin{bmatrix} 16.68 + 30.46 \\ 22.29 - 40.70 \\ -20.49 + 21.6 \\ -14.79 + 46.71 \end{bmatrix}$$

$$\begin{bmatrix} AM_1 \\ AM_2 \\ AM_3 \\ AM_4 \end{bmatrix} = \begin{bmatrix} 47.136t \\ -18.413t \\ 1.11t \\ 61.498t \end{bmatrix}$$



Q NO # 03



Sol:.

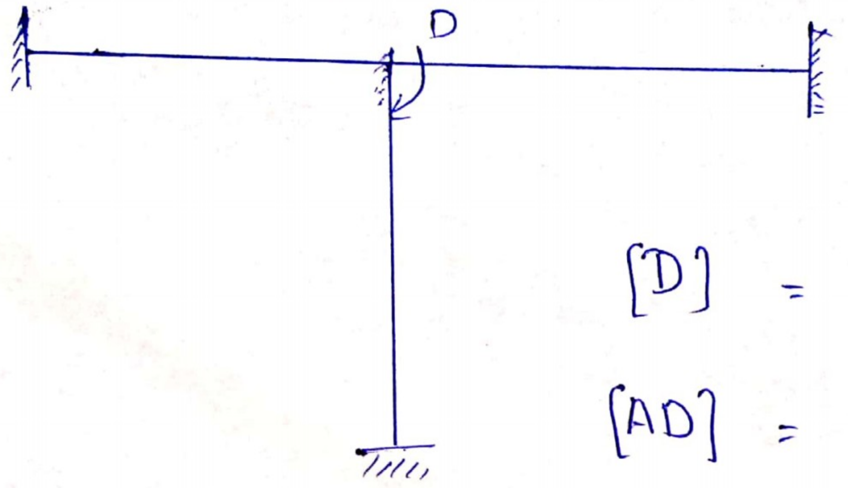
Step# 1

Determine kinematic Idetermina ncy.

$K.I = 1^{\circ}$

Step # 2

Determine unknown Joint Displacement

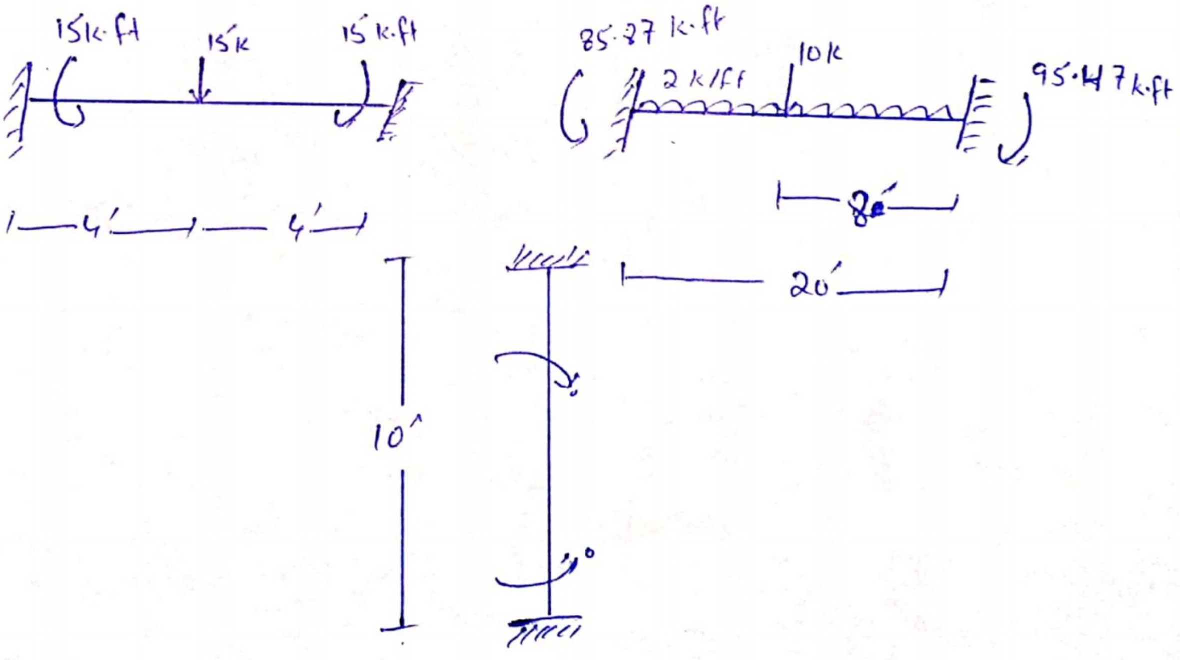


$$[D] = [?]$$

$$[AD] = [0]$$

Step#3 :.

Compute [ADL] Matrix



=> point load at center:.

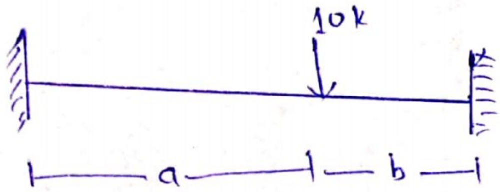
$$\frac{PL}{8} \Rightarrow \frac{(15)(8)}{8} = 15 \text{ kip.ft}$$

=> Uniformly Distributed load:.

$$\frac{WL^2}{8} \Rightarrow \cancel{8}\ \frac{2(20)^2}{12} = 66.67 \text{ k.ft}$$

=> Point load (Not at mid):.

Suppose:.



For Left end:.

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

For Right end:.

$$\frac{Pa^2b}{L^2} = \frac{(10)(12)^2(8)}{(20)^2} = 28.8 \text{ k.ft.}$$

So Total Moment at left end:

$$19.2 + 66.67 = 85.87 \text{ k-ft}$$

Similarly at Right End:.

$$23.8 + 66.67 = 95.47 \text{ k.ft}$$

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

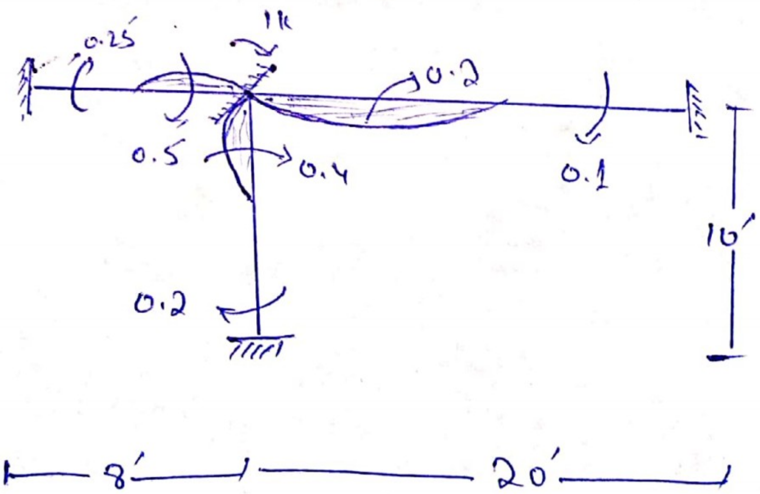
Step # 4

Determine [S] Matrix

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

Now

$D = 1k$



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

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

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

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

$= 1.1\ EI$

$[S] = 1.1\ EI$

Step # 05

compute [D] Matrix

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

$D = \cancel{[S]^{-1}}\ \frac{1}{1.1} \times [0] - [-70.87]$

$= \frac{70.87}{1.1}$

$D = [64.42]\ \frac{1}{EI}$