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Subject : structure Analysis - II

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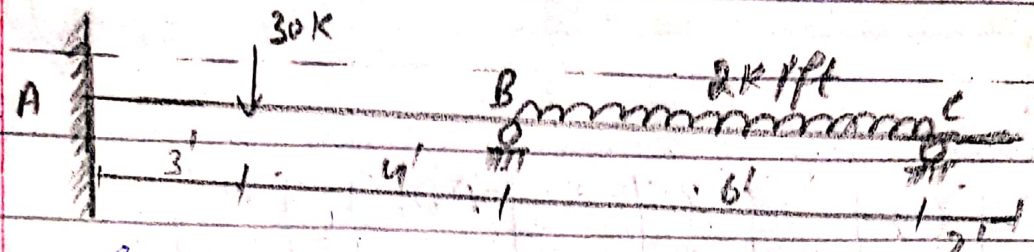
Department : Civil Engineering

Date : 25 sept 2020

Q NO. 1.



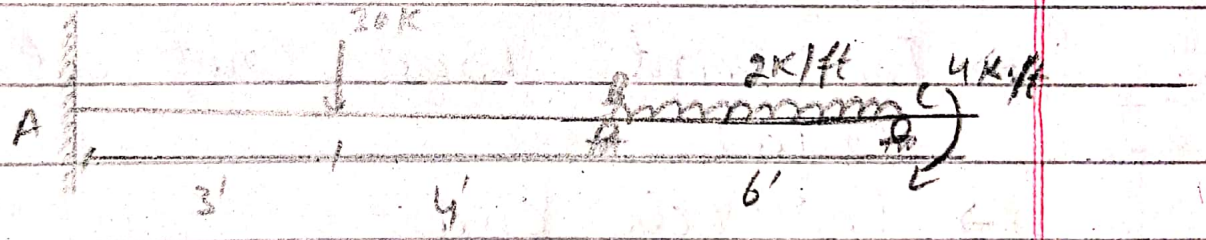
Solution:-

Step # 1.

Determining Kinematic Indeterminancy

K.I = 5°

So we have to reduce the extended portion.

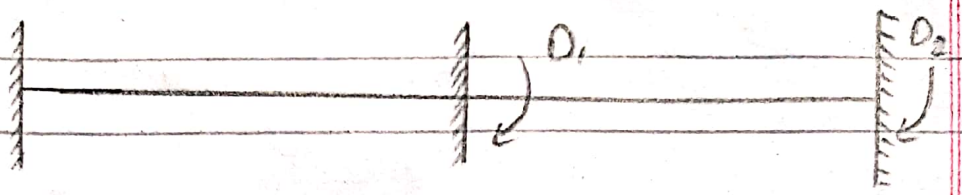


$\frac{2(2)}{1} = 4K.ft.$

NOW K.I = 2°.

Step # 2:

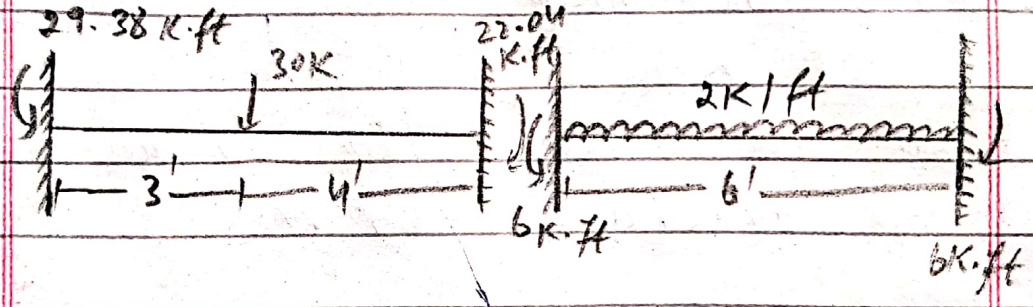
Determine unknown joint Displacement



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

Step #3:

Compute [ADL] matrix.



→ For Point Load (not at mid)

→ For Left end:-

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

→ For right end:-

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

For uniformly Distributed load :-

$\frac{WL^2}{12} \Rightarrow \frac{(2)(6)^2}{12} = 6\,K.Ft$

$ADL_1 = +22.04 - 6 = 16.04\,K.ft$

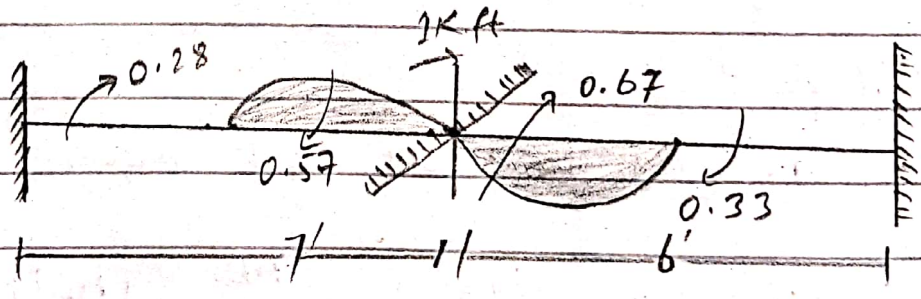
$ADL_2 = 6\,K.ft$

Step # 4:

Now compute [S] matrix.

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

a) $D_1 = 1K$, $D_2 = 0$.



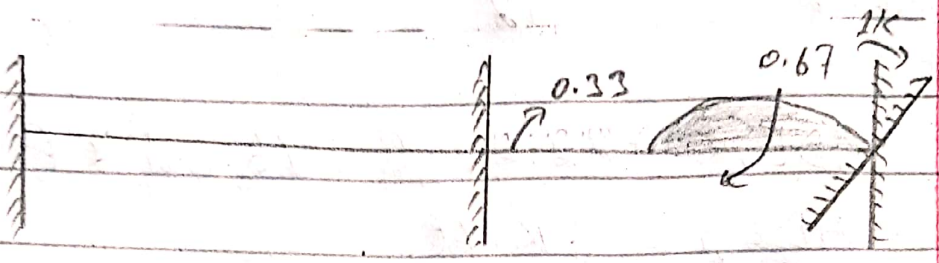
$\frac{4EI}{7} = 0.57$ $\frac{2EI}{6} = 0.33$

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

$S_{11} = 0.57 + 0.67$

$S_{11} = 1.24\,EA$ $S_{21} = 0.33EA$

b). $D_1 = 0$ $\quad D_2 = 1K$



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

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

$$\boxed{S_{12} = 0.33} \quad \boxed{S_{22} = 0.67}$$

$$S = \begin{bmatrix} 1.94 & 0.33 \\ 0.33 & 0.67 \end{bmatrix}$$

Step # 5:

Now compute [D] matrix.

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

$$\Rightarrow \frac{1}{\begin{bmatrix} 1.94 & 0.33 \\ 0.33 & 0.67 \end{bmatrix}} \times Adj\ A \times \begin{bmatrix} AD_1 \\ AD_2 \end{bmatrix} - \begin{bmatrix} ADL_1 \\ ADL_2 \end{bmatrix}$$

(6)

$$[S] = (1.24 \times 0.67) - (0.33 \times 0.33)$$

$$\Rightarrow 0.8308 - 0.1089$$

$$[S] = 0.7219$$

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

Now

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

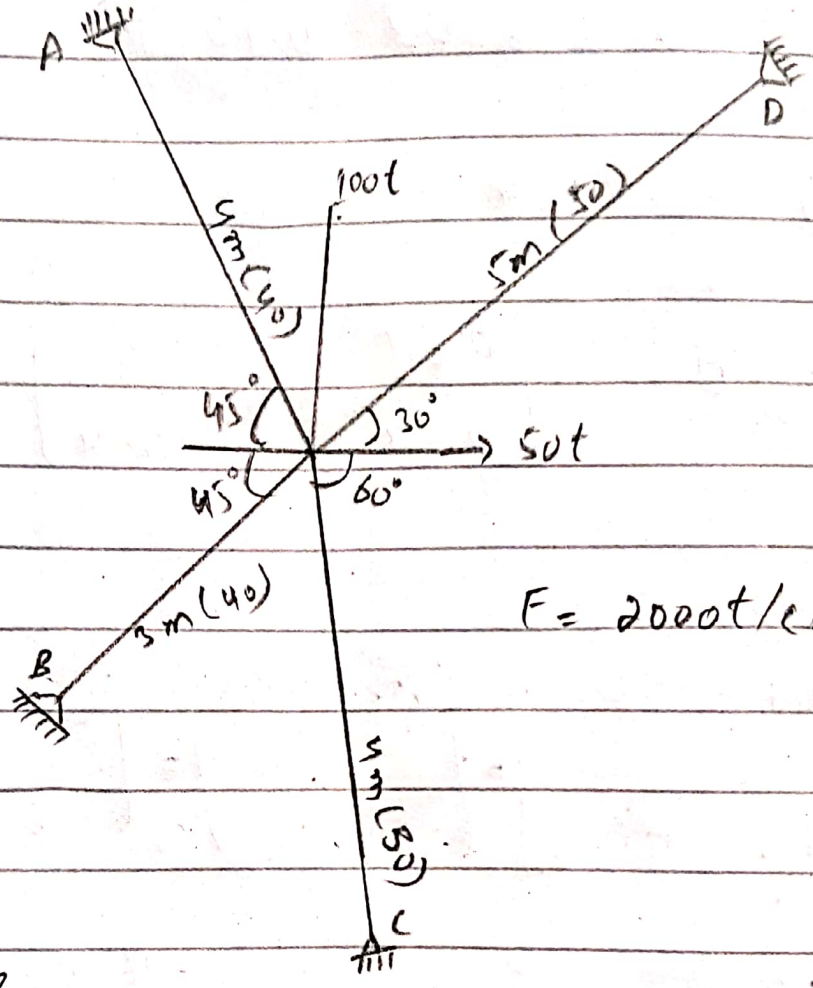
$$\Rightarrow \begin{bmatrix} D_1 \\ D_2 \end{bmatrix} = \frac{1}{151} \times \text{Adj } A \times \begin{bmatrix} -16.04 \\ -2 \end{bmatrix}$$

$$\Rightarrow \frac{\begin{bmatrix} 0.67 & -0.33 \\ -0.33 & 1.24 \end{bmatrix}}{0.729} \times \begin{bmatrix} -16.04 \\ -2 \end{bmatrix}$$

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

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

QNO 2.



$F = 2000 t/cm^2$

Sol:-

For A

$$\sin 45 = P/H = P/4$$

$$\rightarrow P = 2.828\ m$$

$$\cos 45^\circ = b/H = \frac{b}{4}$$

$$\rightarrow b = 2.828\ m$$

For B.

$\sin 45 = P/H = P/3$

$\rightarrow P = 2.12\ m$

$\cos 45 = b/H = b/3$

$\rightarrow b = 2.12\ m$

For C.

$\sin 60 = P/H = P/4$

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

$\rightarrow P = 3.46$

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

$\cos 60 = b/H = b/4$

$\cos 60 \times 4 = b.$

For D

$\sin 30 = P/5$

$\rightarrow P = 2.5\ m$

$\cos 30 = b/5$

~~$b = 2.5m$~~

$b = 4.33m$

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 #1 :-

$KI = 2j - r$

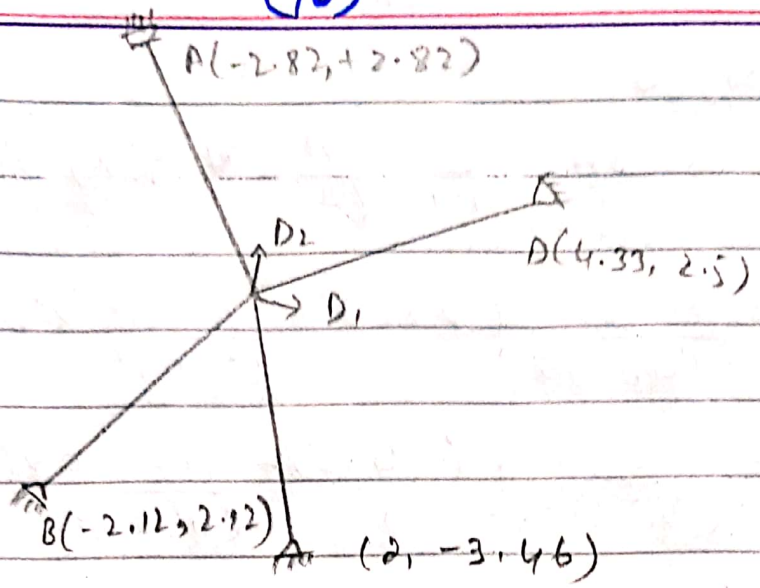
$= 2(5) - 8$

$KI = 2^{\circ}$

Step # 2 :-

Select Unknown joint displacement :

(10)



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

Step # 3 :-

$$[AMD]_{4\times3} \; [S]_{2\times2}$$

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

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

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

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

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

~~$S_{11} = S_{21} = 12.237$~~

$$S_{11} = 445.063$$

$$\Rightarrow S_{12} = S_{21} = \sum_{i=1}^{m} \frac{EA}{L^3} \times (X_K - X_j)(Y_K - Y_j)$$

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

$$(212) + \frac{100,000}{(500)^3} (-433)(0-250) +$$

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

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

ii) $D_1 = 0 \quad D_2 = 1K'$

$$AMD = \frac{EA}{L^2}(Y_K - Y_j)$$

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

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

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

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

$$\text{NOW}, \quad S_{22} = \sum_{i=1}^{m} \frac{EA}{L^3}(X_K - X_j)^2$$

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

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

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

Step # 4:

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

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

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

Step # 5:-

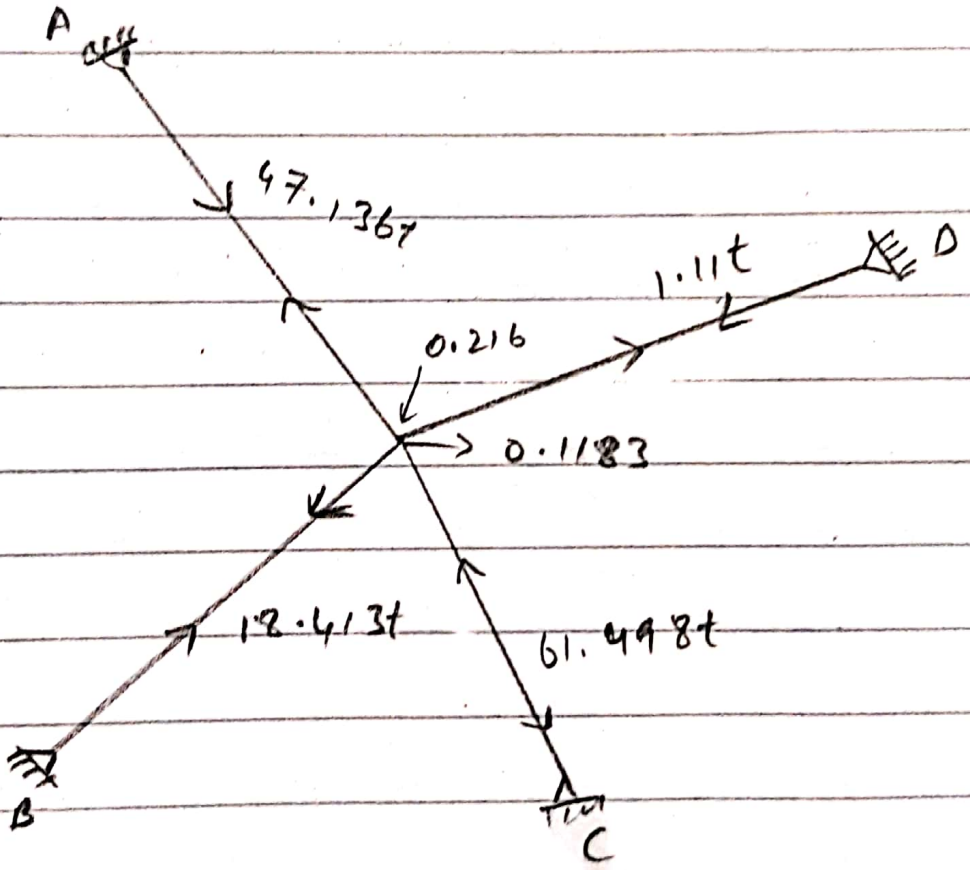
$$[AM]$$

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

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

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

$$\Rightarrow \begin{bmatrix} AM_1 \\ AM_2 \\ AM_3 \\ AM_4 \end{bmatrix} = \begin{bmatrix} 47.136t \\ -18.413t \\ 1.11t \\ -161.498t \end{bmatrix}$$



Q NO. 3.

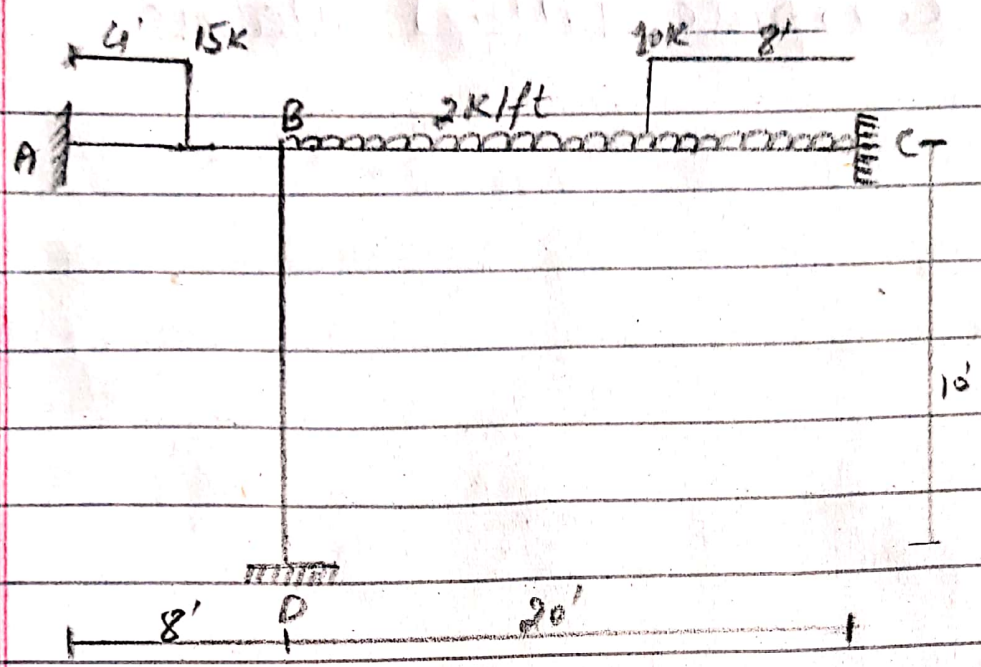


Figure - 2.

Sol:-

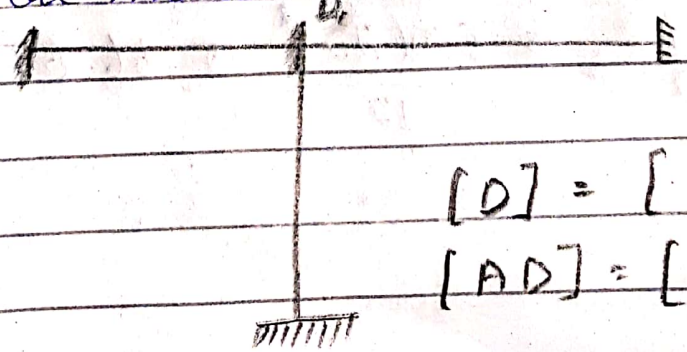
Step # 1.

Determine Kinematic indeterminancy.

K.I = 1°

Step # 2:

Determine UnKnown Joint Displacement.

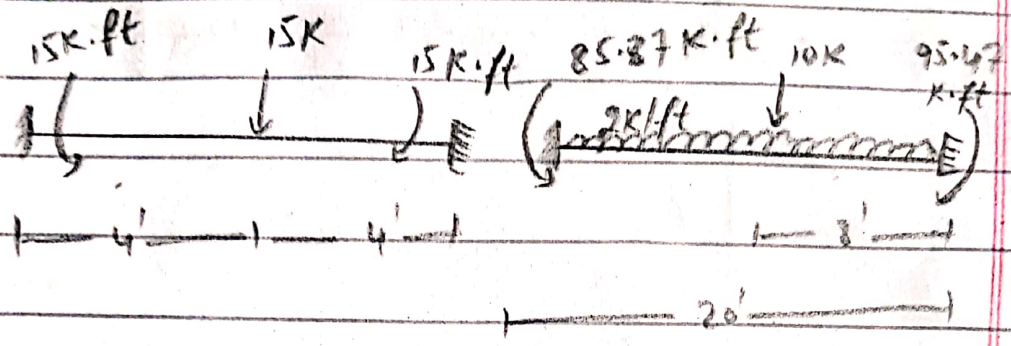


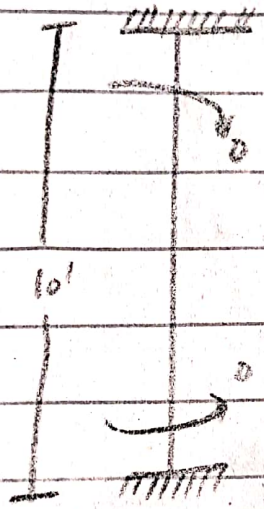
[D] = [?]

[AD] = [0]

Step # 3 :-

Compute [ADL] Matrix





⇒ Point load at center :-

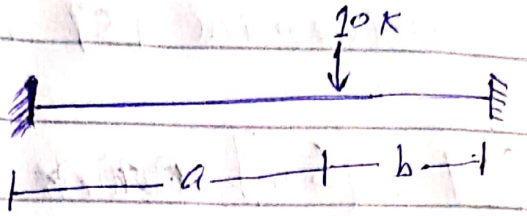
$$\frac{PL}{8} \Rightarrow \frac{(15)(8)}{8} = 15 \text{ Kip.ft}$$

⇒ Uniformly Distributed load :-

$$\frac{wL^2}{12} \Rightarrow \frac{(2)(20)^2}{12} \Rightarrow 66.67 \text{ K.ft.}$$

⇒ 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 :-

$$28.8 + 66.67 = 95.47 \text{ K.ft}$$

So $[ADL] = -85 - 87 + 15 = -70.87$ K.ft

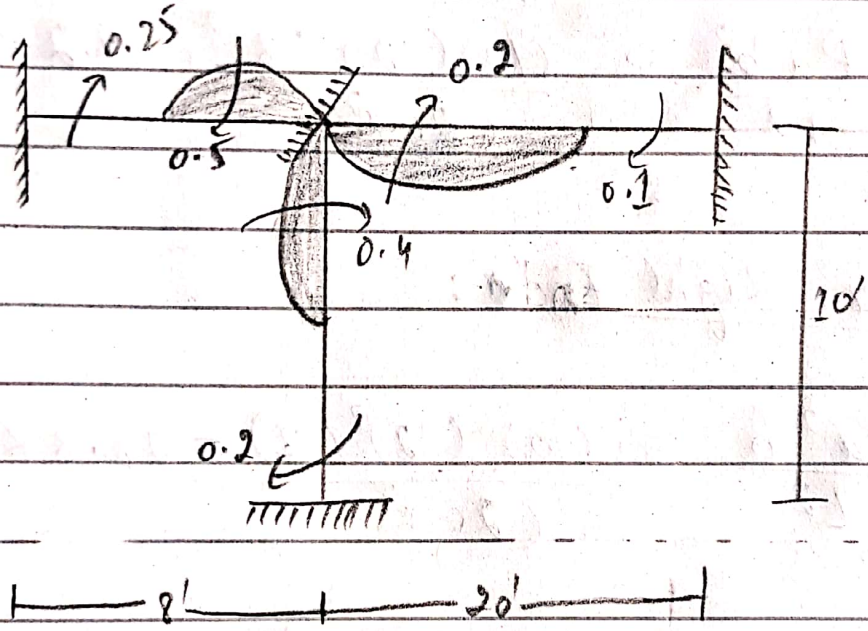
Step # 4 :-

Determine [S] Matrix.

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

Now

D = 1K



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

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

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

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

$= 1.1\ EI$

$[S] = 1.1\ EI$

step # 5 :-

Comput [D] Matrix

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

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

$\Rightarrow \frac{70.87}{1.1}$

$[D] = [64.42]\ 1/EI$