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Subject : Structure Analysis II

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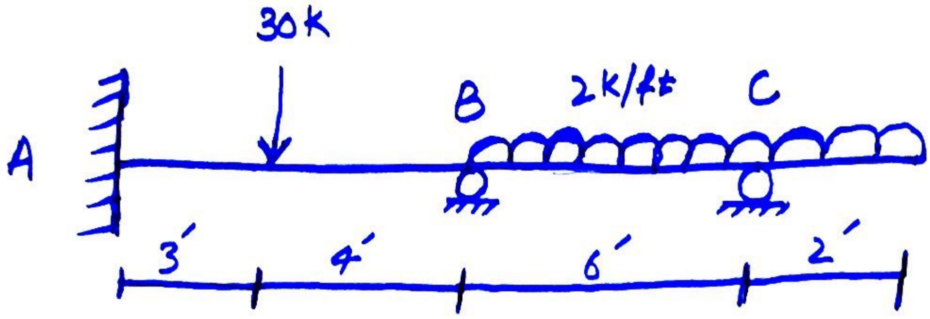
Question #01 Answer



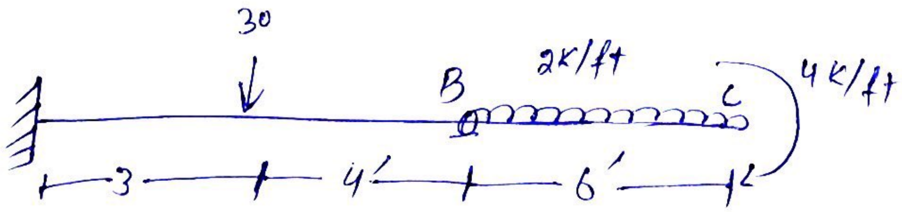
Solution:-

Step #01

Determining Kinematic Indeterminacy

$K.I = 5^\circ$

So we have to deduce the extended portion

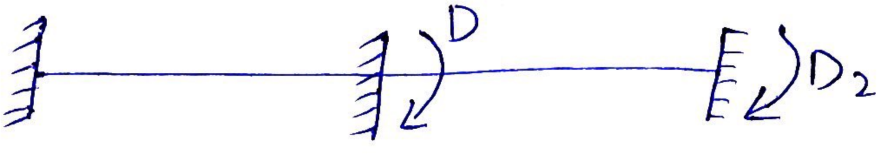


$\frac{2(2)}{1} = 4k.ft$

$\boxed{\text{Now } K.I = 2^\circ}$

Step # 02

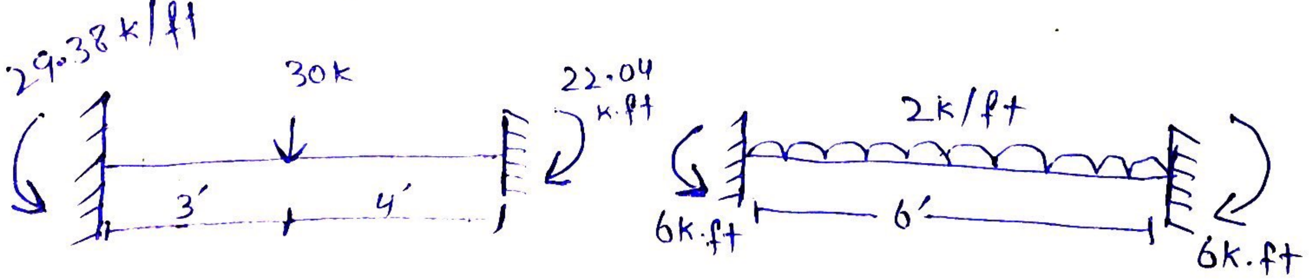
Determine unknown joint Displacement



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

Step # 03

Compute [ADL] matrix



→ For point 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 :

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

→ For unifomly distributed Load :

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

$$ADL_1 = 22.04 - 6 = 16.04\ k.ft$$

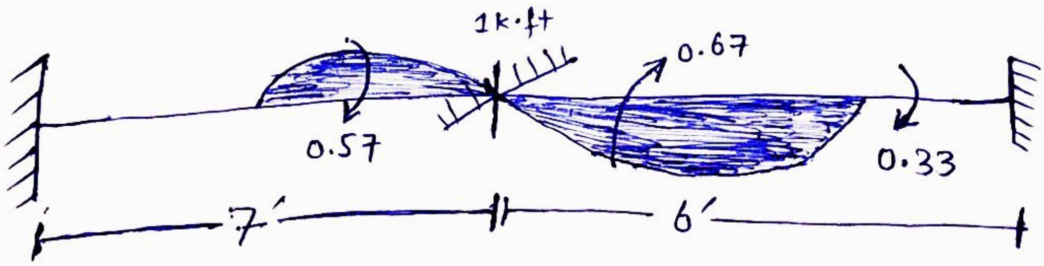
$$ADL_2 = 6\ k.ft$$

Step #04

Now Compute [S] matrix

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

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



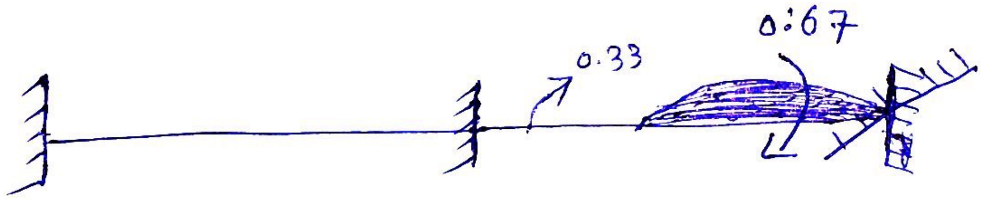
$\frac{4EI}{7} = 0.57$ $\frac{2EI}{6} = 0.33$

$\frac{4EI}{6} = 0.67$ $\frac{2EI}{7} = 0.27$

$S_{11} = 0.57 + 0.67$

$\boxed{S_{11} = 1.24EI}$ $\boxed{S_{21} = 0.33EA}$

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



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

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

$S_{12} = 0.33$ $S_{22} = 0.67$

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

Step #05

Now Compute [D] matrix

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

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

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

$$= 0.8308 - 0.1089$$

$$|S| = 0.7219$$

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

NOW

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

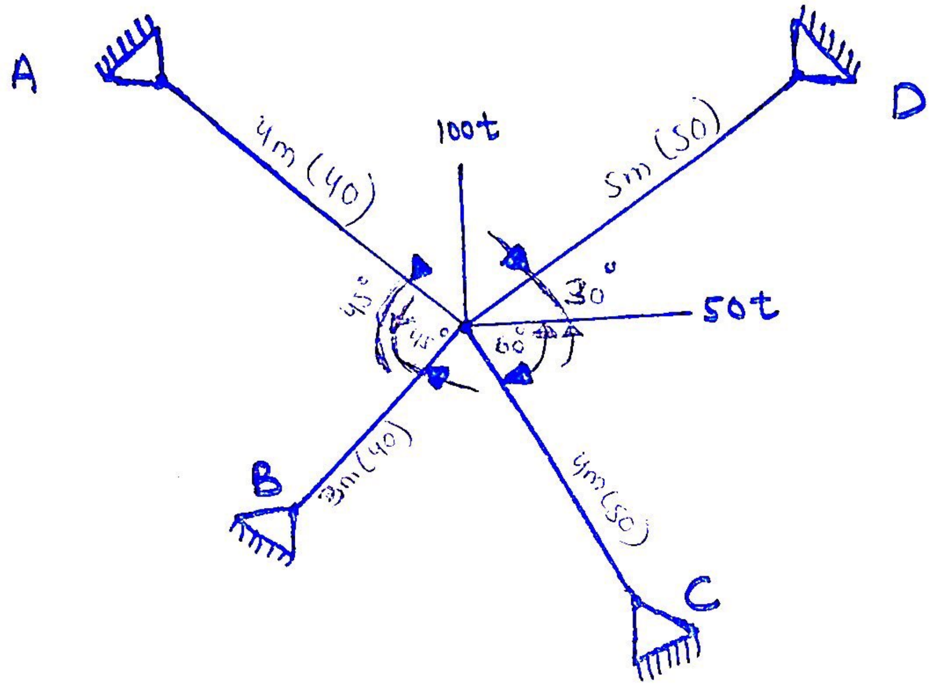
$$\begin{bmatrix} D_1 \\ D_2 \end{bmatrix} = \frac{1}{|S|} \times \text{Adj } A \times \begin{bmatrix} -16.04 \\ -2 \end{bmatrix}$$

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

$$= \begin{bmatrix} 0.919 & -0.452 \\ -0.452 & 1.72 \end{bmatrix} \times \begin{bmatrix} -16.04 \\ -2 \end{bmatrix}$$

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

Question #2 Answer



$E = 2000\,t/cm^2$

Solution:-

For "A"

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

$$\boxed{\Rightarrow P = 2.828\,m}$$

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

$$\boxed{\Rightarrow b = 2.828 \text{ m}}$$

For "B"

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

$$P = 2.12 \text{ m}$$

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

$$\boxed{\Rightarrow b = 2.12}$$

For "C"

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

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

$$\Rightarrow P = 3.46$$

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

$$\cos 60 \times 4 = b \Rightarrow \boxed{b = 2}$$

For "D"

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

$$P = 2.5m$$

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

$$\boxed{b = 4.33m}$$

Now

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

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

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

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

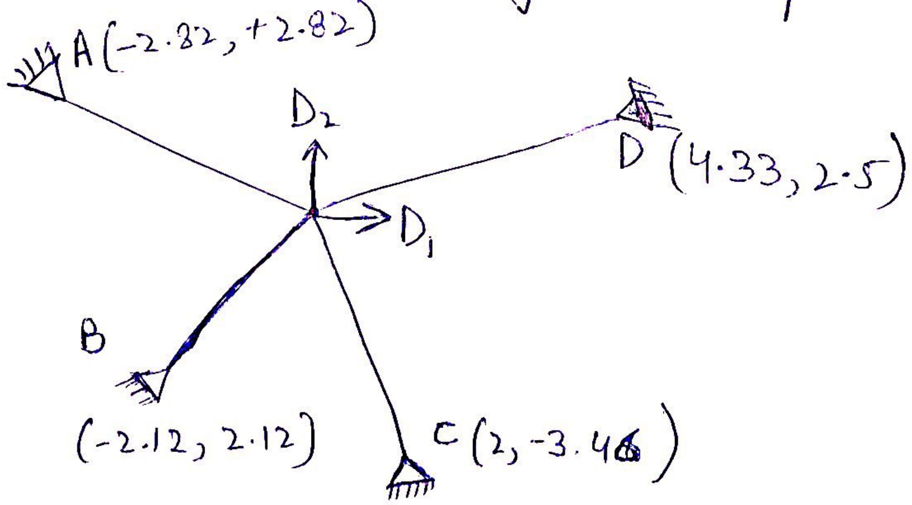
Step #01

KI

$$KI = 2j - r$$
$$= 2(5) - 8$$
$$KI = 2$$

Step #02

Select unknown joint displacement



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

Step #03

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

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

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

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

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

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

Now,

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

$$= \frac{80,000}{(400)^3}(282)^2 + \frac{8000}{(300)^2} \times (212)^2$$

$$+ \frac{100000}{(500)^3} \times (-433)^2 + \frac{100,000}{(400)^3} \times (-200)^2$$

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

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

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

$$= \frac{80000}{(400)^3}(282)(-282) + 80,000(212)(212) + \frac{100000}{(500)^3}(433)$$

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

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

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

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

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

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

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

$$AMD_{42} = \frac{100{,}000}{(400)^3}(346) = 216.25$$

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

$$= \frac{80000}{(400)^3}(-282)^2 + \frac{80000}{(300)^3}(212)^2 + \frac{100{,}000}{(500)^3}(-250)^2 + \frac{100000}{(400)^3}(346)^2$$

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

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

$$[AM]$$

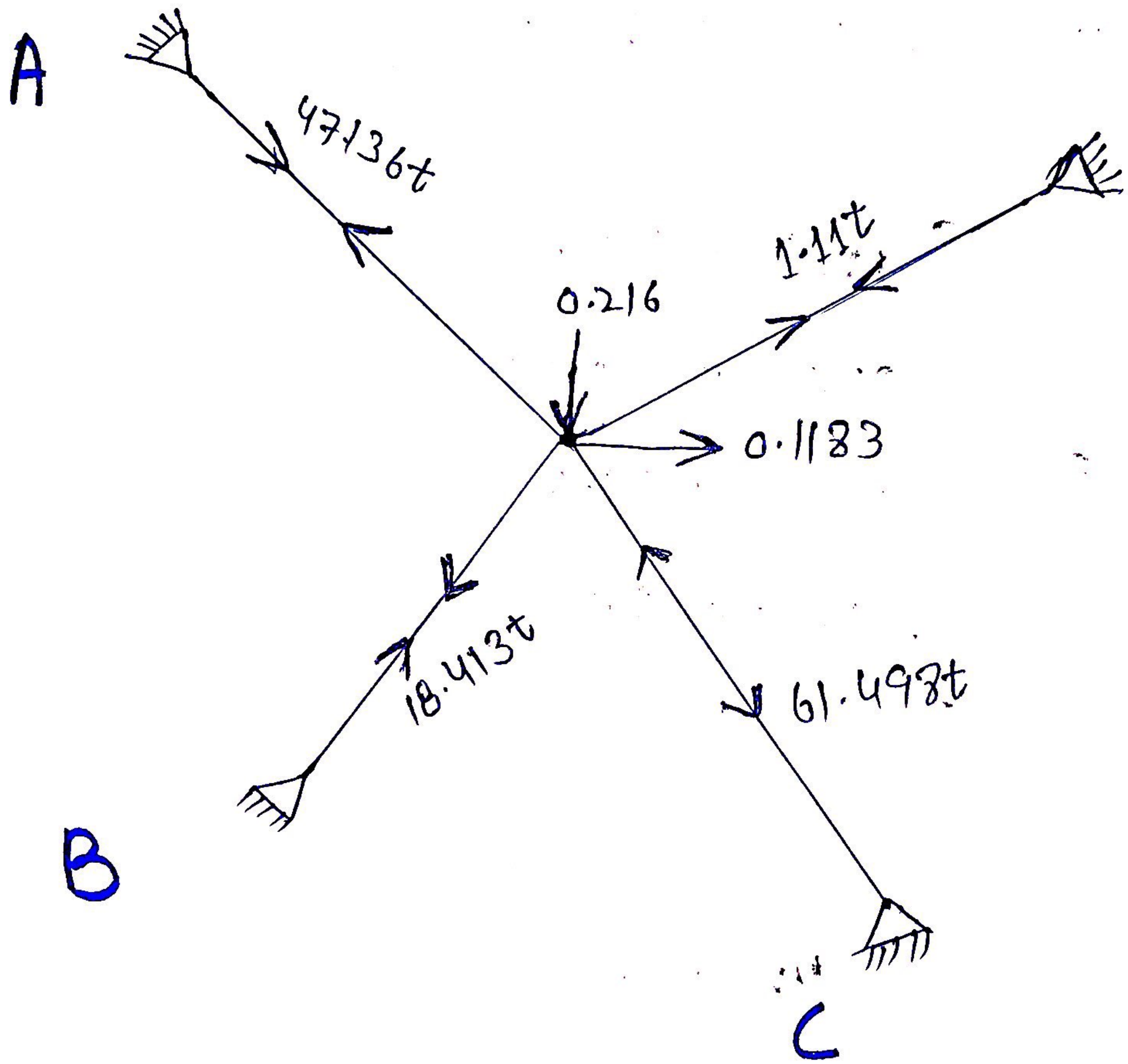
$$\begin{bmatrix} AM_1 \\ AM_2 \\ AM_3 \\ AM_4 \end{bmatrix} = \begin{bmatrix} 141 & -141 \\ 188.44 & 188.44 \\ -173.2 & -100 \\ -125 & 216.25 \end{bmatrix} \times \begin{bmatrix} 0.1183 \\ -0.216 \end{bmatrix}$$

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

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

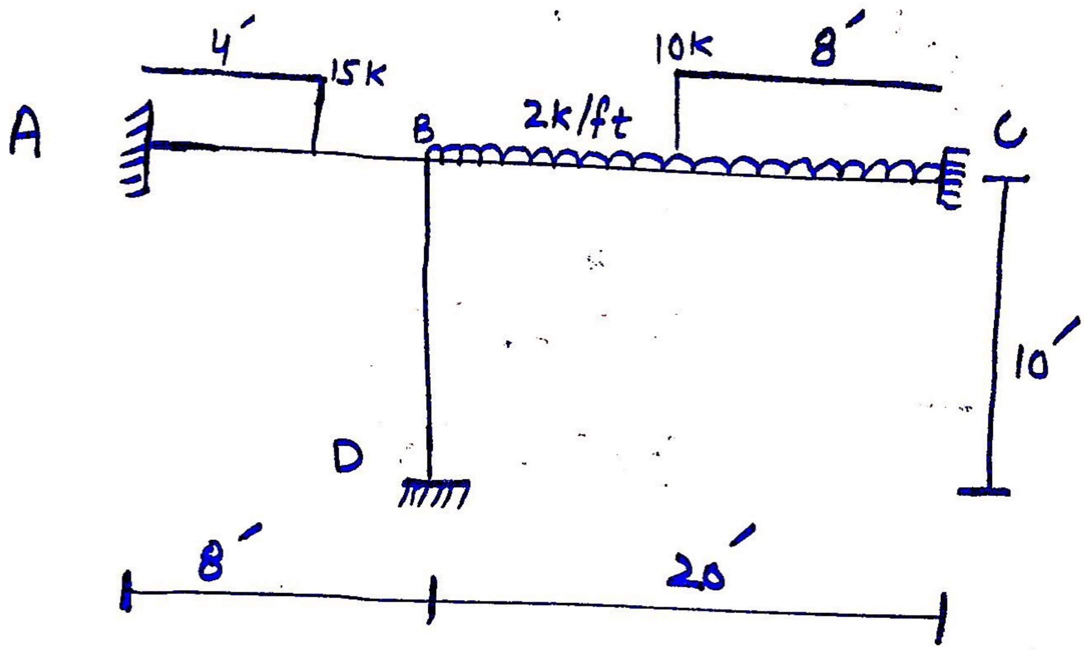
$$\begin{bmatrix} AM_1 \\ AM_2 \\ AM_3 \\ AM_4 \end{bmatrix} = \begin{bmatrix} 47.136t \\ -18.413t \\ 1.11t \\ 61.498t \end{bmatrix}$$

Answer



Scanned with CamScanner

Question # 3 Answer



Sol:~

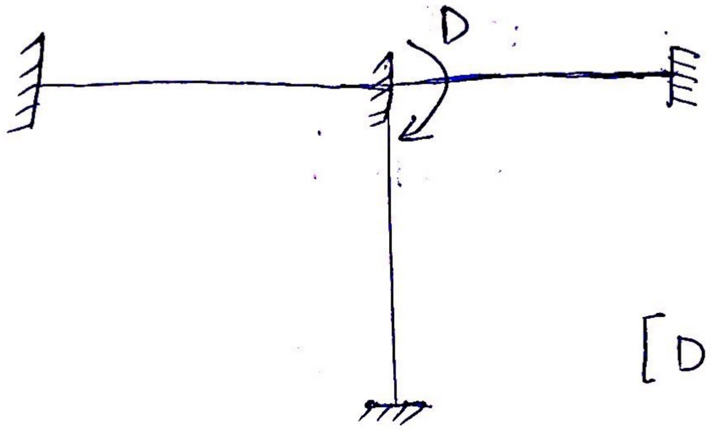
Step # 01

Determine Kinematic Indeterminancy

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

Step # 02

Determine unknown joint Displacement

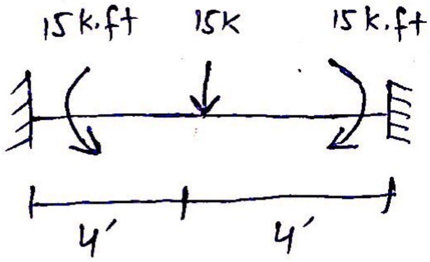


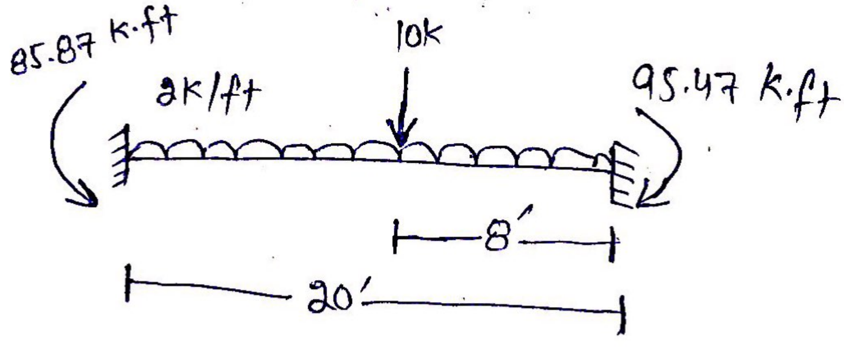
[D] = [?]

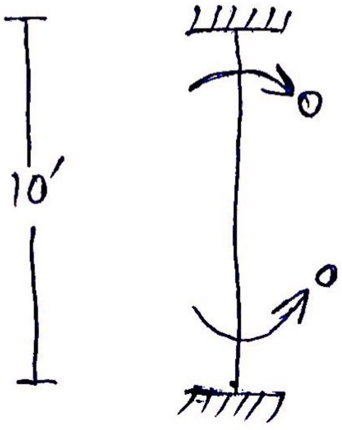
[AD] = [0]

Step # 03

Comput [ADL] Matrix.







⇒ Point Load at Center :-

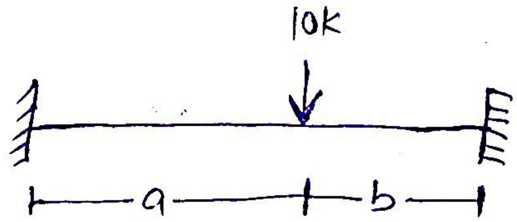
$$\frac{PL}{8} \Rightarrow \frac{(15)(8)}{8} = 15 \text{ Kip.ft}$$

⇒ Uniformly Distributed Load :-

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

⇒ Point load Not at mid :-

Suppose :-



For left End :-

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

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

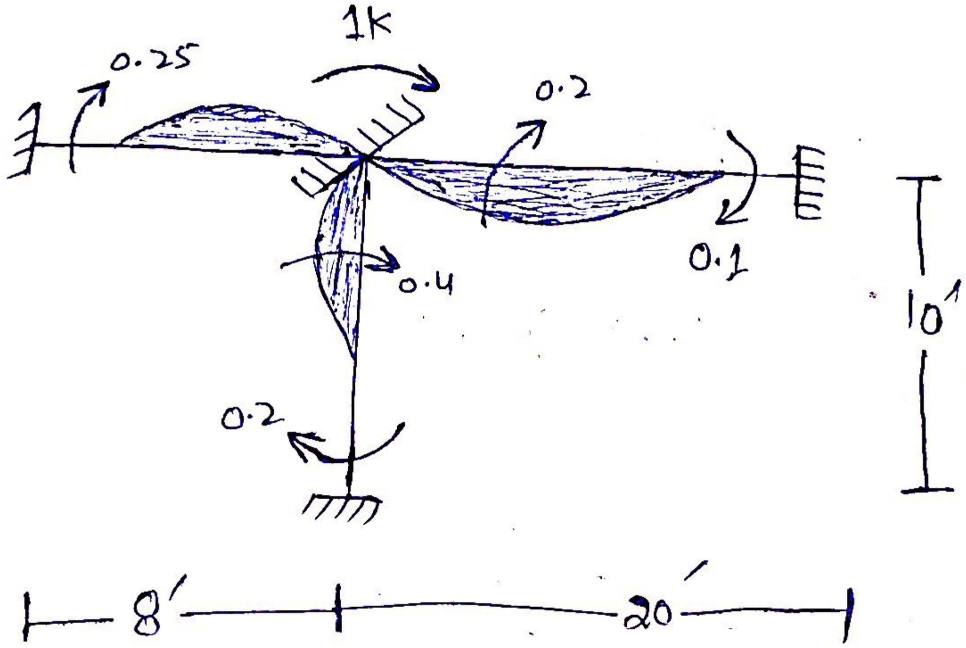
$$[ADL] = -85.87 + 15 = -70.87 \text{ k.ft}$$

Step #04

Determine $[S]$ Matrix

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

NOW :- D = 1K



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

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

$$\Rightarrow \frac{4EI}{10} = 0.4 \quad , \quad \frac{2EI}{10} = 0.2$$

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

$= 1.1\ EI$

$[S] = 1.1\ EI$

Step # 05

Compute $[D]$ Matrix

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

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

$$[D] = \frac{70.87}{1.1}$$

$$\boxed{[D] = 64.42\ ^{1}/_{EI}}$$

Answer