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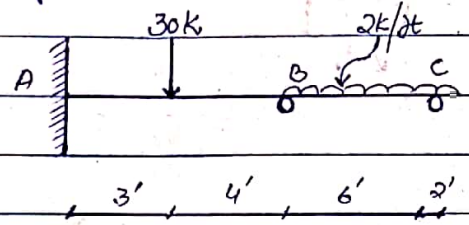
Q No 1) Analyze ---- EI is constant.

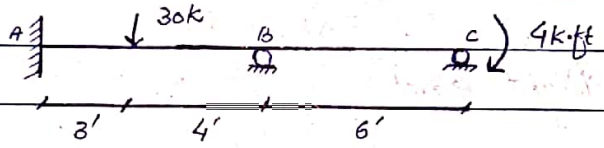


Sol:

Step ① Determining kinamatic Indeterminancy.

$K.I = 5^\circ$

We have to reduce the extended portion.



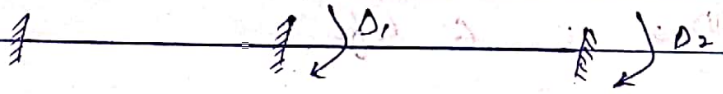
$$\Rightarrow \frac{2(2)}{1} \Rightarrow 4\ k\cdot ft$$

Now:

$K.I = 2^\circ$

Step ②

Determine unknow joint Displacement



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

Step ③

Compute [ADL] Matric

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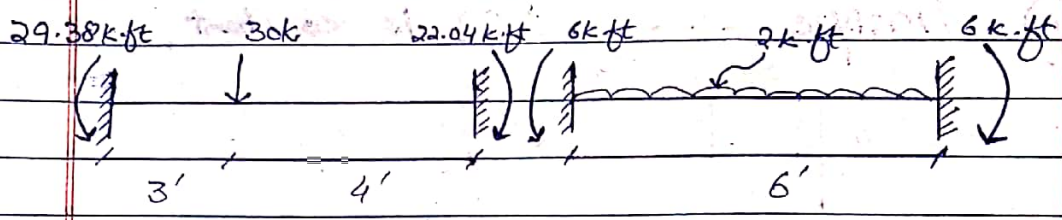

⇒ for pointed load (not at mid)

⇒ 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

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

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

$ADL_2 = 6$ k.ft

Step (4)

Compute [S] matrix

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

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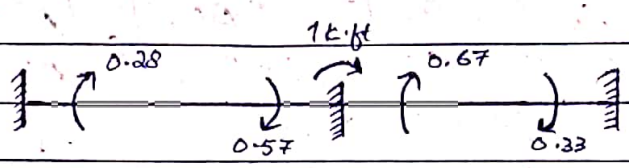
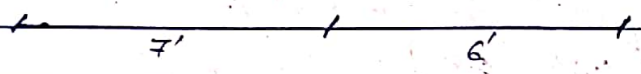
a) $D_1 = 1\ K \qquad D_2 = 0$





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

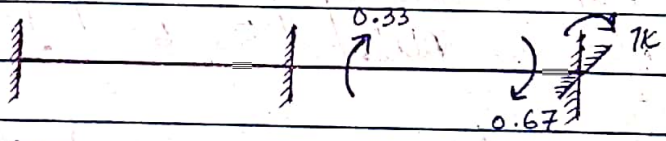
$\frac{4EI}{6} = 0.67 \qquad \frac{2EI}{7} = 0.28$

$S_{11} = 0.57 + 0.67$

$= 1.24\ EA$

$S_{21} = 0.33\ EA$

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



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

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

$S_{12} = 0.33$

$S_{22} = 0.67$

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

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Step (5)

Compute [D] matrix

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

$$= \frac{1}{\begin{bmatrix} 1.24 & 0.33 \\ 0.33 & 0.67 \end{bmatrix}} \times \text{Adj } A$$

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

$$= 0.8308 - 0.1089$$

$$|S| = 0.7219$$

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

Now

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

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

$$\begin{bmatrix} D_1 \\ D_2 \end{bmatrix} = \begin{pmatrix} -13.9711 \\ 3.8902 \end{pmatrix}$$

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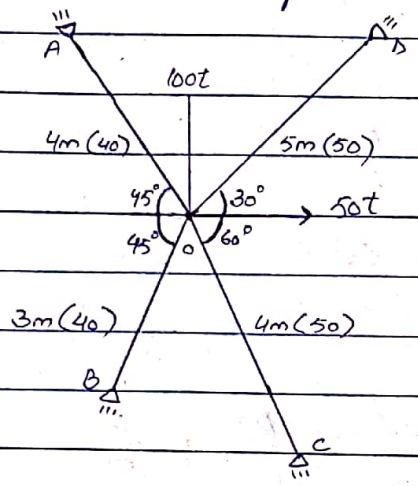
Q2 Analyze the pin-jointed frame ..... E = 2000 t/cm²



Sol:

point "A"

$$\sin 45^\circ = \frac{P}{h} = \frac{P}{4}$$

$$\Rightarrow P = 2.828\ m$$

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

$$b = 2.825\ m$$

point "B"

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

$$\Rightarrow P = 2.12\ m$$

$$\cos 45^\circ = \frac{b}{h}$$

$$b = 2.12\ m$$

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point "C"

$$\sin 60^\circ = \frac{P}{h} = \frac{P}{5}$$

$$= P = 4.330\ m$$

$$\cos 60^\circ = \frac{b}{h}$$

$$b = 2.5m$$

point "D"

$$\sin 30^\circ = \frac{P}{h} = \frac{P}{5}$$

$$\Rightarrow P = 2.5$$

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

$$b = 4.33$$

"So"

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

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

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

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

Step ①

K.I

$K.I = 2j - r$

$= 2(5) - 8 = 2^\circ$

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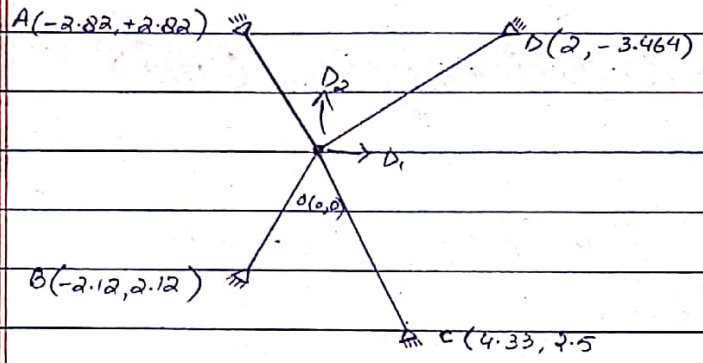
Step ②

Unknown joint displacement



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

Step ③

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

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

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

$$AMD_{11} = \frac{80,000}{(400)^2} \times (0+282) = 141$$

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

$$AMD_{31} = \frac{100,000}{(400)^2} \times (0-200) = 125$$

$$AMD_{41} = \frac{100,000}{(500)^2} \times (0-433) = -173.2$$

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

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

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

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

$S_{11} = 445.062$

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

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

$+ \frac{100,000}{(400)^3} \times (-200)(0+346) + \frac{100000}{(500)^3} \times (433)(0-250)$

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

(ii) $D_1 = 0$ $D_1 = 1k'$

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

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

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

$AMD_{32} = \frac{100,000 \ (346)}{(400)^2} = 216.25$

$AMD_{42} = \frac{100,000 \ (-250)}{(500)^2} = -100$

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

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

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

$S_{22} = 469.628$

Step (4)

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

$$\begin{bmatrix} D_1 \\ D_2 \end{bmatrix} = \begin{bmatrix} 445.063 & 12.237 \\ 12.237 & 469.628 \end{bmatrix}^{-1} \times \begin{bmatrix} 50 \\ -100 \end{bmatrix}$$

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

Step (5)

$$[AM]$$

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

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

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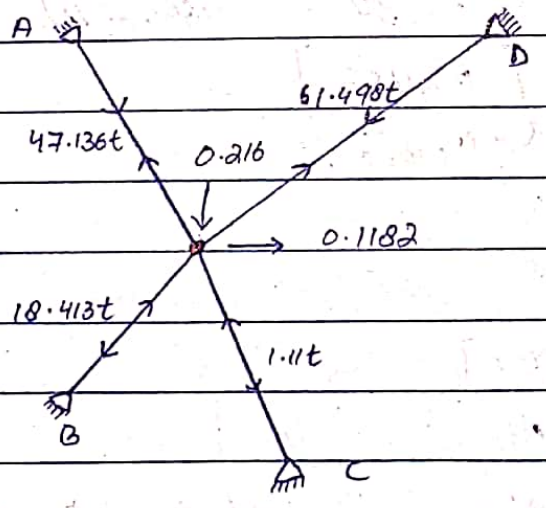
AM_1		16.68 + 30.46
AM_2	=	22.29 − 40.70
AM_3		−14.79 − 46.71
AM_4		−20.49 + 21.6

AM_1		47.136 t
AM_2	=	−18.413 t
AM_3		−61.49 t
AM_4		1.11 t



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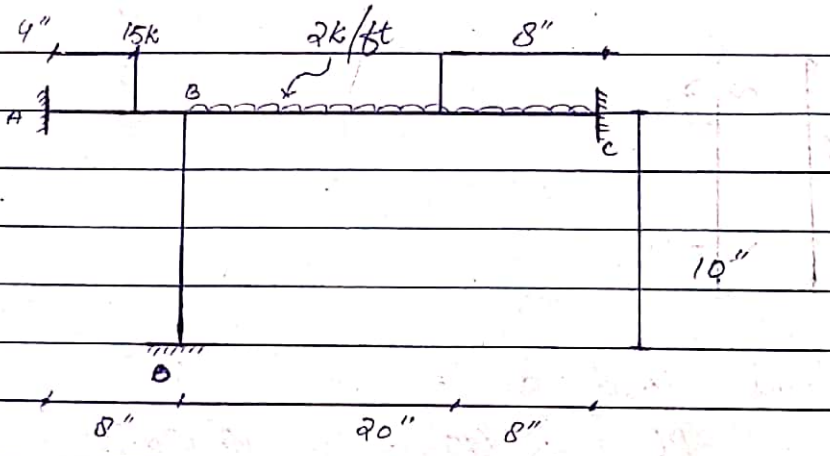
Q no3) Analyze the rigid-joint ---- constant



Solution:

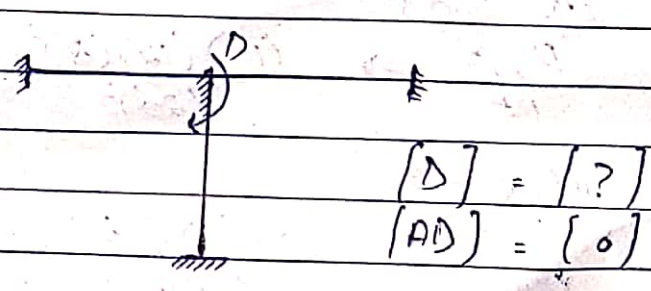
Step ①

Determine Kinamatic Indeterminancy.

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

Step ②

Unknow joint Displacement



$[D] = [?]$

$[AD] = [0]$

Step ③

Compute [ADL] Matric

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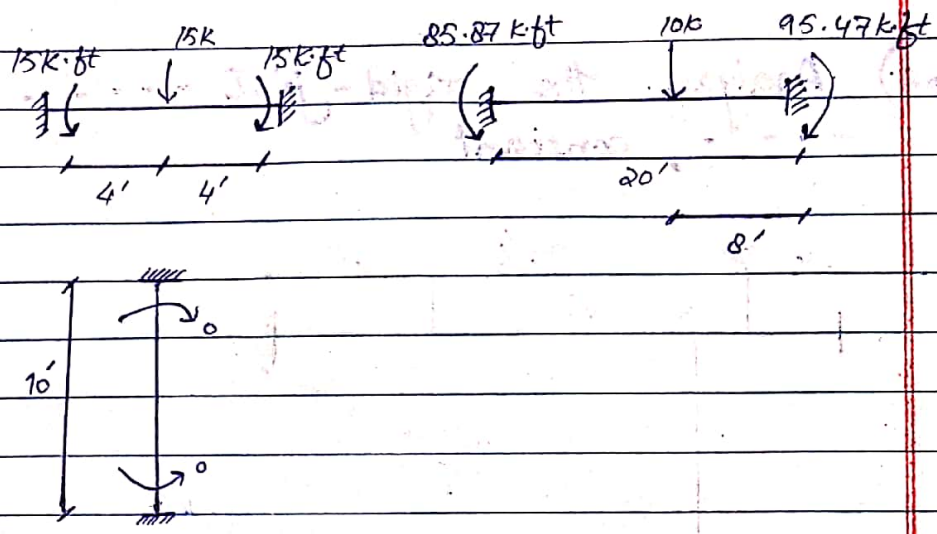


⇒ Point load at center :-

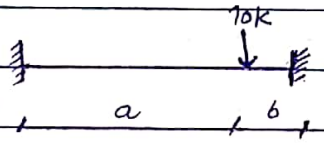
$$\frac{PL}{8} \Rightarrow \frac{(15)(8)}{8} = 15 \text{ kip·ft}$$

⇒ Uniformly distributed load :-

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

⇒ Point load (not at mid) :-

∴



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 :-

$$19.2 + 66.67 = 85.87 \text{ k·ft}$$

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Similarly at right ends-

$28.8 + 66.67 = 95.47$ k.ft

So:

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

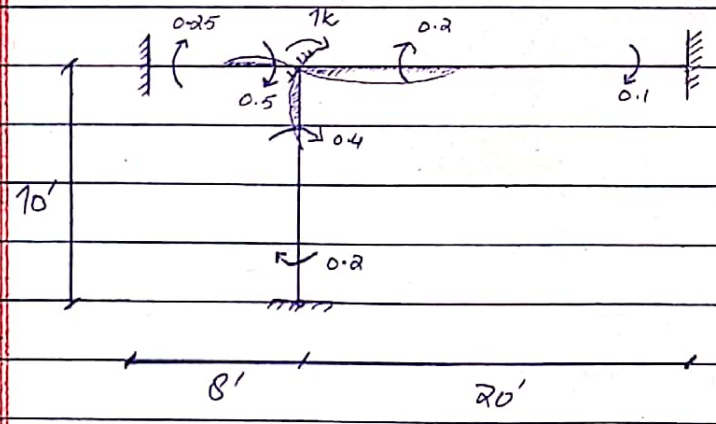
Step (4)

Determine [S] Matric

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

Now

$D = 1$ k



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

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

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

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

$[S] = 1.1 \cdot EI$

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Step (5)

Compute D matrix

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

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

$$= \frac{70.87}{1.1}$$

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