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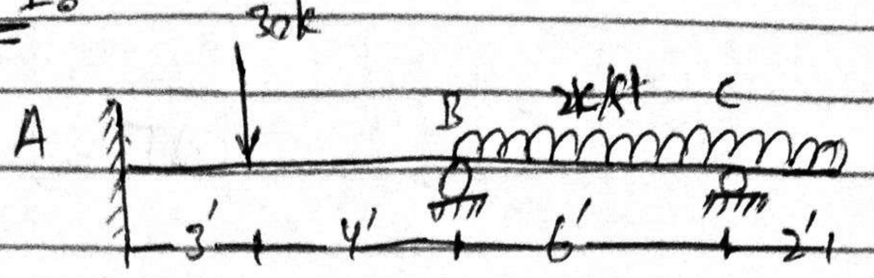
Subject # Structure (2)

Qno 1:



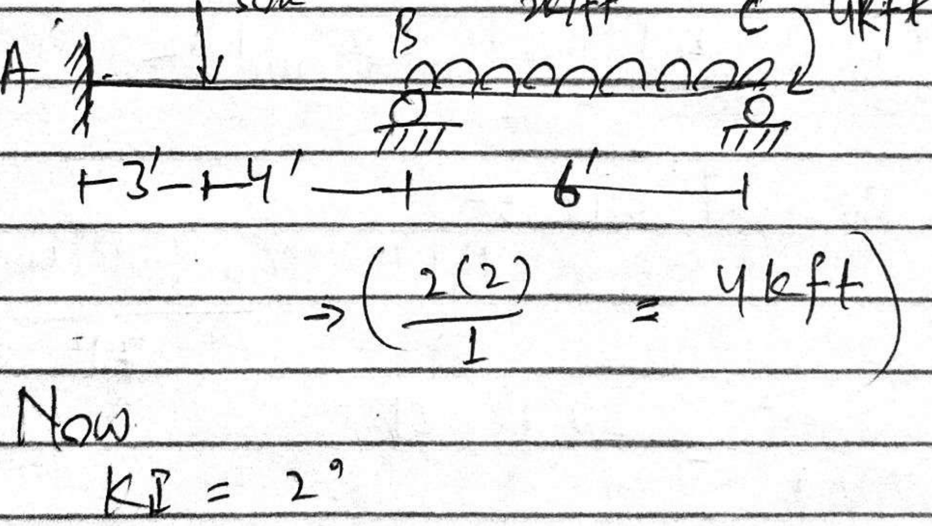
Solutions:

Step 1:

Determine Kinematic Indeterminity

$KI = 5°$

So we have to reduce the extended portion.



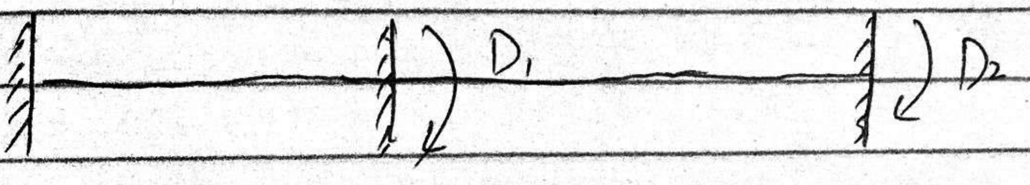
$\rightarrow \left(\frac{2(2)}{1} = 4kft \right)$

Now

$KI = 2°$

Step # 2:

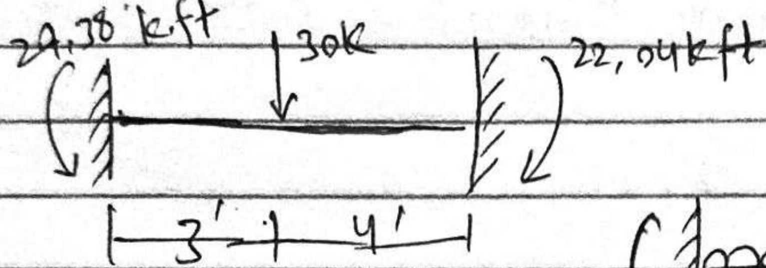
Determine Unknown Joint Displacement

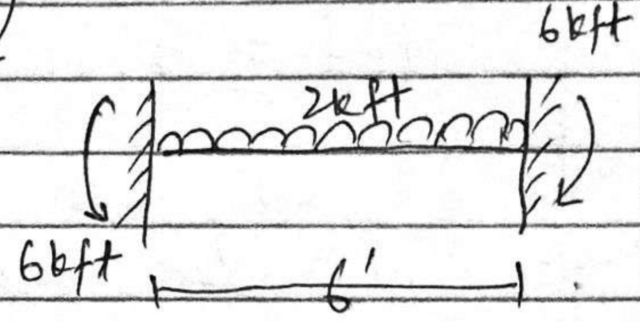


$$\begin{bmatrix} D_1 \\ D_2 \end{bmatrix} = \begin{bmatrix} ? \\ ? \end{bmatrix} \quad \begin{bmatrix} AD_1 \\ AD_2 \end{bmatrix} = \begin{bmatrix} 0 \\ 4 \end{bmatrix}$$

Step 3:

Compute [ADL] Matrix





For Pointed Load (not at mid):-

for left end :-

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

$$\frac{Pab^2}{L^2} = 29.38\,kft$$

for right end :-

$$\frac{Pa^2b}{L^2} = \frac{(30)(3)^2(4)}{7^2} = 22.04\,kft$$

③

For UDL :-

$$\frac{WL^2}{12} = \frac{(2)(6)^2}{12} = 6\,kft$$

$ADL_1 = +22.04 - 6 = 16.04\ kft$

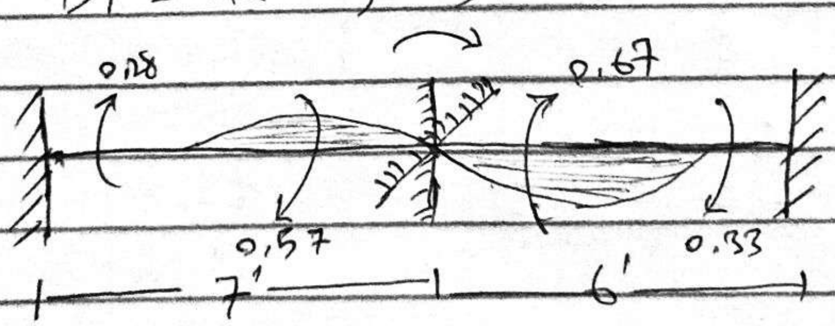
$ADL_2 = 6\,kft$

Step 4c

Compute [S] Matrix

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

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



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

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

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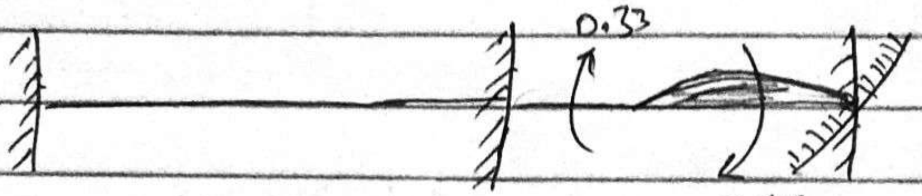
$S_{11} = 0.57 + 0.67$

$\boxed{S_{11} = 1.24 \ EA}$

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

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



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

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

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

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

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

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Step # 5:

Compute [D] Matrix

$$\begin{bmatrix} D_1 \\ D_2 \end{bmatrix} = \begin{bmatrix} S_{11} & S_{12} \\ S_{21} & S_{22} \end{bmatrix}^{-1} \times \begin{bmatrix} AD_1 \\ A_2 \end{bmatrix} - \begin{bmatrix} ADL_1 \\ ADL_2 \end{bmatrix}$$

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

$$|S| = 0.7219$$

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

Now

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

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

X ⟶ Y.

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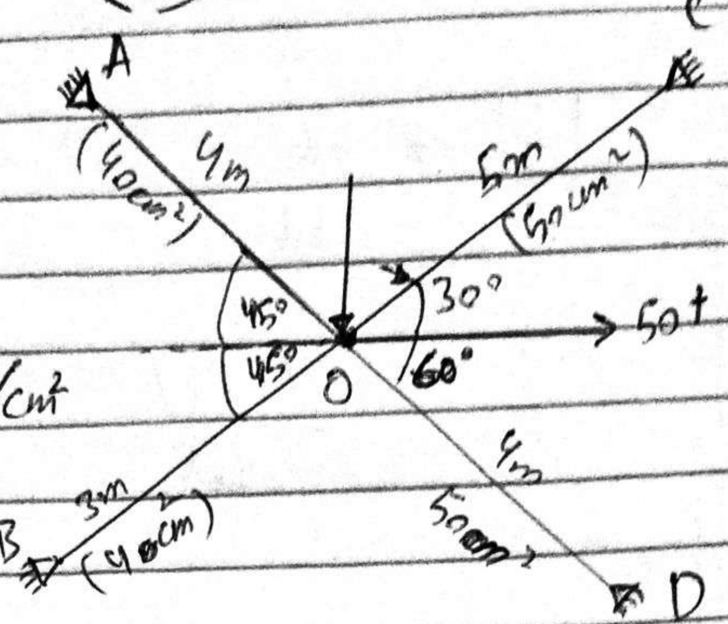
Q no 2:



$E = 2000\ t/cm^2$

Solution:

For A:

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

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

$$\cos 45^\circ = \frac{b}{4} \Rightarrow \boxed{b = 2.828 m}$$

For B:

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

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

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

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

For C :-

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

$$\boxed{P = 2.5 m}$$

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

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

Now

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

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

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

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

Step # 1:

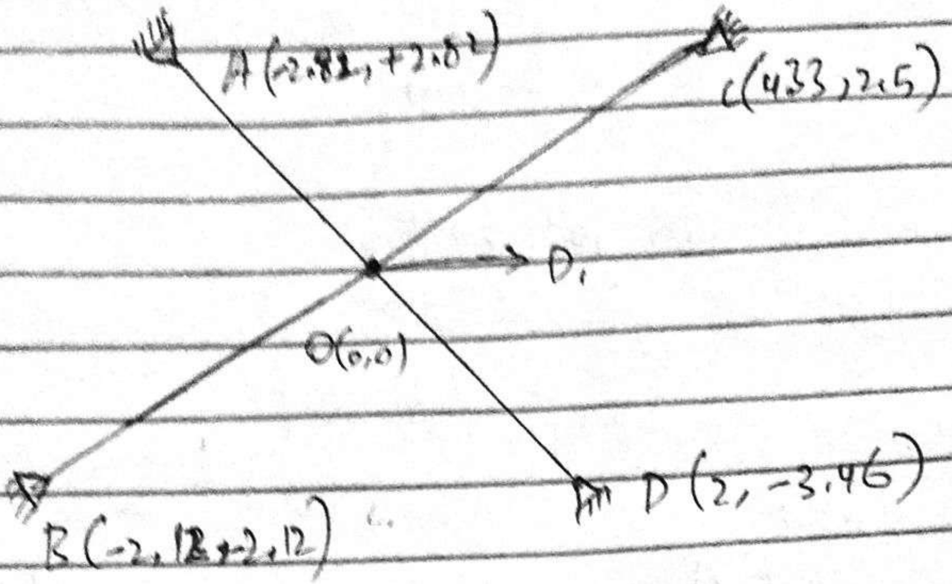
K.I

$$K.I = 2j - r = 2(5) - 8$$

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

Step 2:

Select 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:

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

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

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

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

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

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

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

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

$$= \frac{80000}{(400)^3} \times (282)^2 + \frac{80000}{(300)^3} \times (212)^2 + \frac{100000}{(500)^3} \times (433)^2$$

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

$$S_{11} = 99.405 + 133.107 + 149.991 + 82.5$$

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

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

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

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

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

ii) $D_1 = 0$, $D_i = 1k'$

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

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

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

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

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

Now

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

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

$$+ \frac{100000}{400^2}(346)^2$$

$$\boxed{S_{22} = 496.628}$$

Step 4.8

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

$$\begin{bmatrix} D_1 \\ D_2 \end{bmatrix} = \begin{bmatrix} 445.863 & 12.237 \\ 12.237 & 469.028 \end{bmatrix}^{-1} \times \begin{bmatrix} 50 \\ -100 \end{bmatrix}$$

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

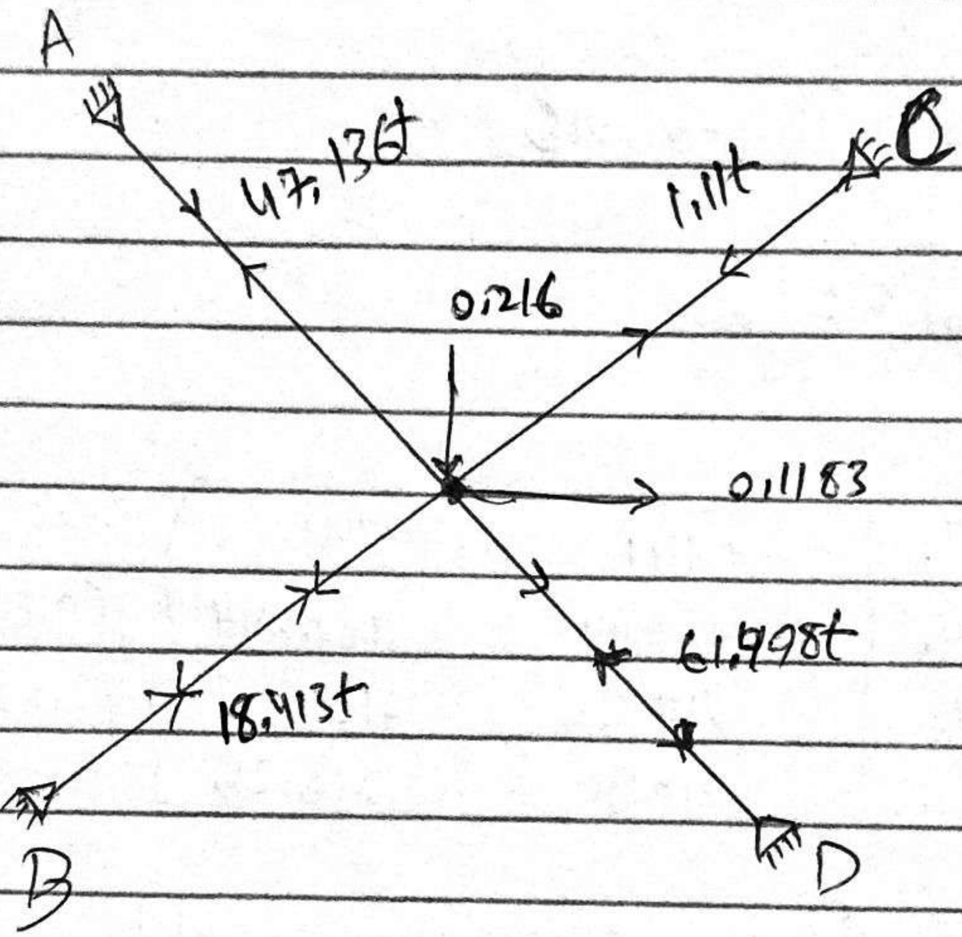
Step 5: $[AM]$

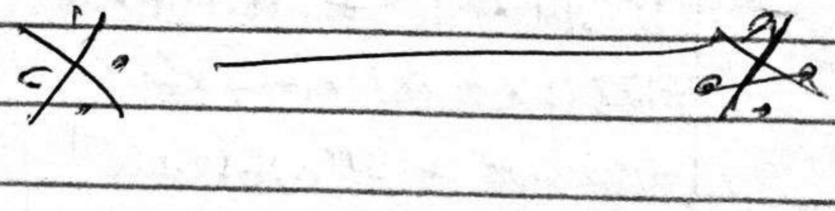
$$\begin{bmatrix} AM_1 \\ AM_2 \\ AM_3 \\ AM_4 \end{bmatrix} = \begin{bmatrix} 141 & -141 \\ 188.44 & 188.44 \\ -173.2 & -100 \\ -125 & 216.25 \end{bmatrix} \times \begin{bmatrix} 0.1183 \\ -0.216 \end{bmatrix}$$

$$= \begin{bmatrix} 141 \times 0.118 + (-141) \times (-0.218) \\ 188.44 \times 0.118 + (188.44)(-0.216) \\ -173.2 \times 0.1183 + (-100) \times (-0.216) \\ -125 \times 0.118 + (216.25)(-0.216) \end{bmatrix}$$

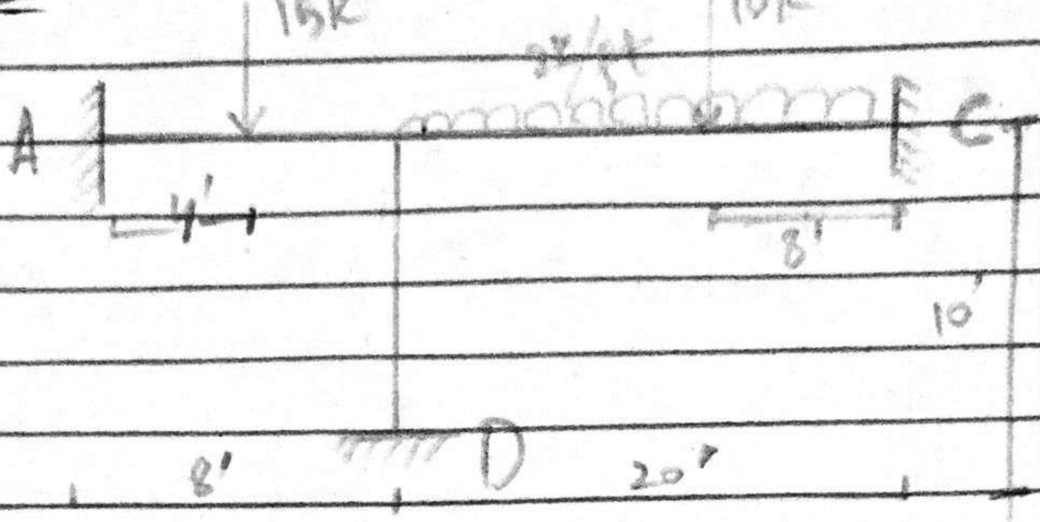
$$\begin{bmatrix} AM_1 \\ AM_2 \\ AM_3 \\ AM_4 \end{bmatrix} = \begin{bmatrix} 16.68 + 30.46 \\ 22.29 - 40.70 \\ -20.49 + 21.6 \\ -14.79 - 46.71 \end{bmatrix}$$

$$\begin{bmatrix} AM_1 \\ AM_2 \\ AM_3 \\ AM_4 \end{bmatrix} = \begin{bmatrix} 47.136t \\ 18.413t \\ 1.11t \\ -61.49t \end{bmatrix}$$





Q no 3:

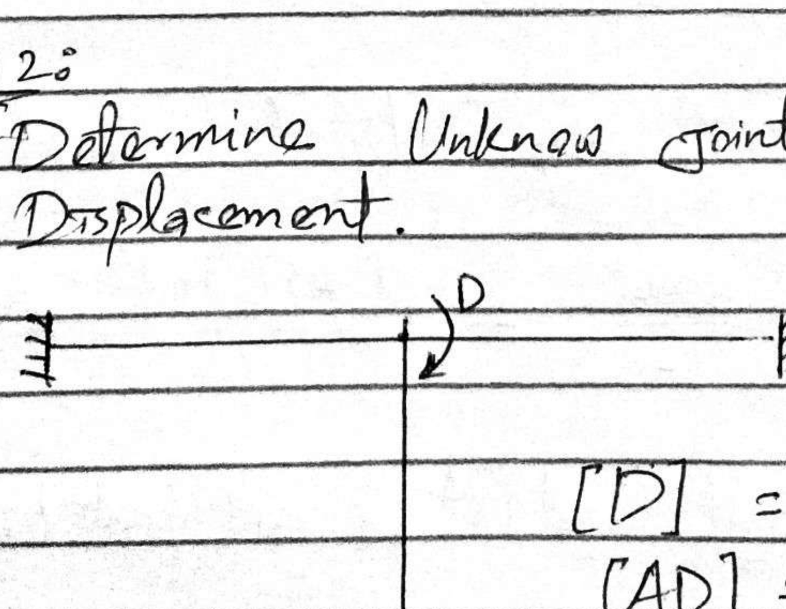


Solution:

Step 1:
Determine Kinematic Indeterminancy

$K.I = 1^{0}$

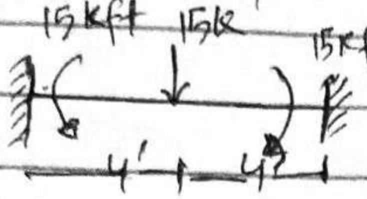
Step 2:
Determine Unknow Joint Displacement.

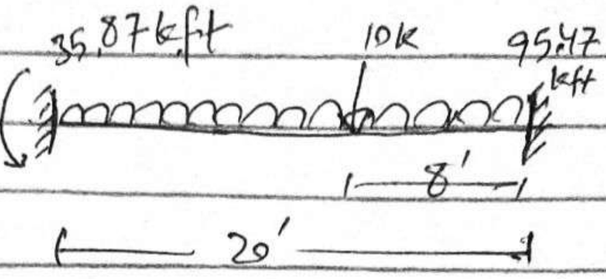


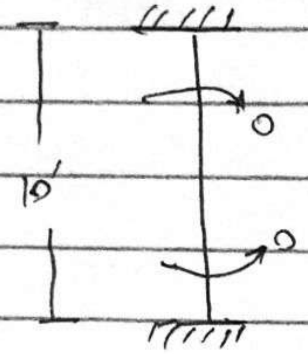
$[D] = [?]$
$[AD] = [0]$

Step 3:

Compute [ADL] Matrix







Point Load at Center:

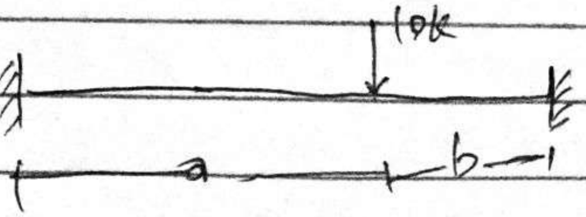
$$\frac{PL}{8} \Rightarrow \frac{(15)(8)}{8} = 15 \, k \cdot ft$$

Uniformly Distributed Load:

$$\frac{WL^2}{12} \Rightarrow \frac{(2)(20)^2}{12} = 66.67 \, kft$$

Point Load (not at mid point):

Suppose



For Left End:-

$$\frac{Pab^2}{L^2} \Rightarrow \frac{(10)(12)(8)^2}{(20)^2} = 19.2\,kft$$

for Right End:

$$\frac{Pa^2b}{L^2} = \frac{(10)(12)^2(8)}{(20)^2} = 28.8\,kft$$

So total moment at left end:-

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

Similarly at right End:

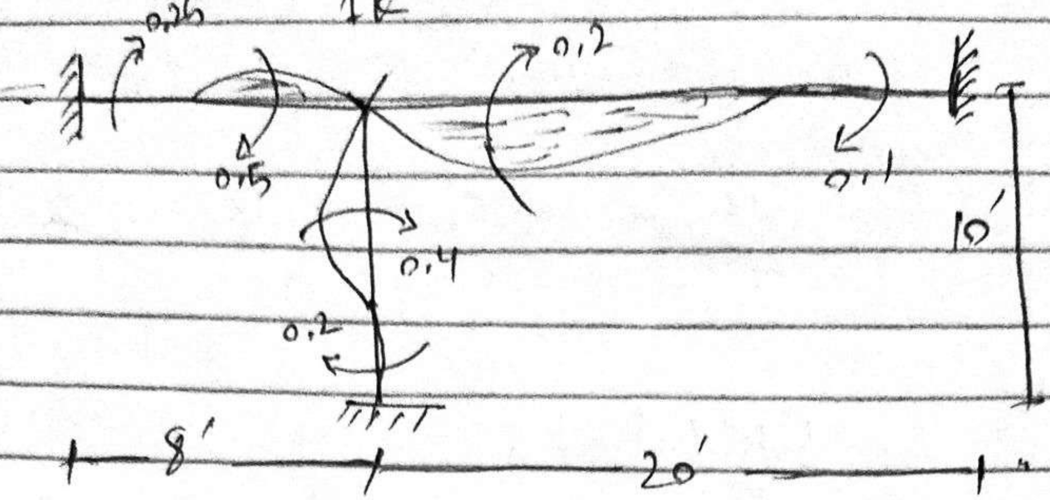
$$28.8 + 66.67 = 95.47\,kft$$

Step#4:

Determine [S] Matrix.

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

Now $D = 1k$



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

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

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

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

$$[S] = 1.1\ EI$$

$$[S] = 1.1\ EI$$

Step 5: Compute [D] Matrix

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

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

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

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