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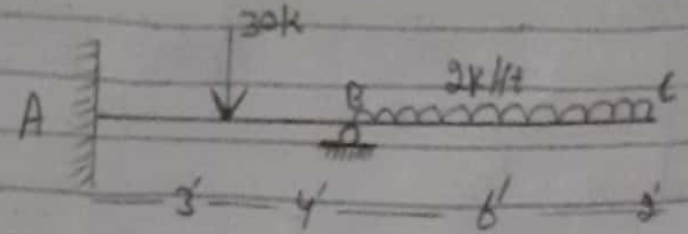
Subject : Structure Analysis -II

Date : 25/9/2020

Q 01

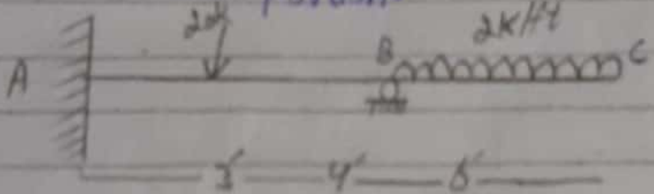


Solution:. Step#01

Determine kinamatic indetemnancy

$K.I = 5^\circ$

We have to reduce the extended portion.



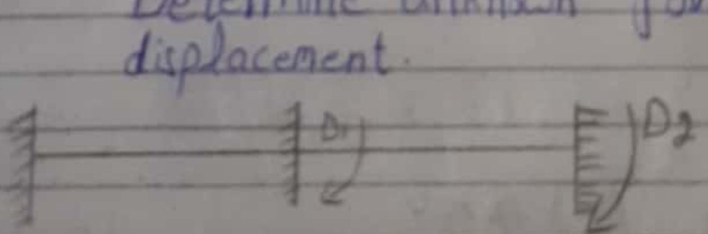
$$\Rightarrow \frac{2(2)}{1} = 4k/ft$$

Now,

$K.I = 2^\circ$

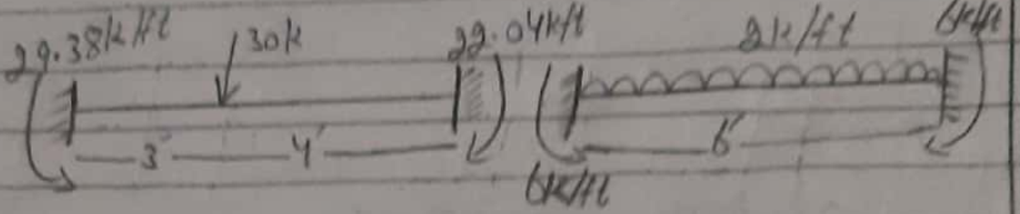
Step#02:

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#03: Comput (ADL) Matrix



⇒ For point load (Not at mid):

For left end:

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

For right end:

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

⇒ For UDL :-

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

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

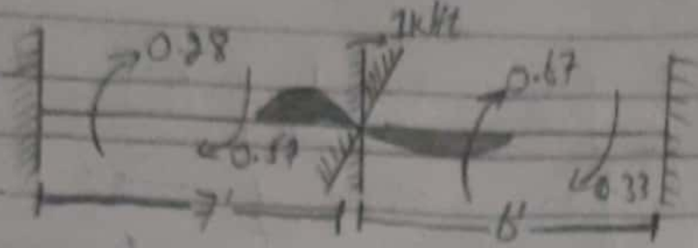
$$ADL_2 = 6k/ft$$

Step#04 Compute [S] Matrix

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

P#03

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



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

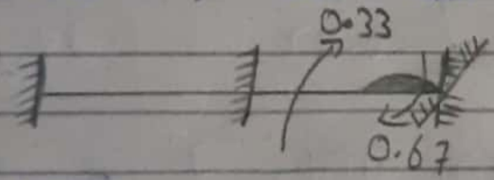
$$\frac{4EI}{6} = 0.67 \qquad \frac{2EI}{7} = 0.28$$

$S_{11} = 0.57 + 0.67$

$= 1.24EA$

$S_{21} = 0.33EA$

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



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

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

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

Step#05 Compute (D) Matrix

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

$$= \frac{1}{\begin{bmatrix} 1.24 & 0.33 \\ 0.33 & 0.67 \end{bmatrix}} \times Adj A \times \begin{bmatrix} 0 \\ 4 \end{bmatrix} - \begin{bmatrix} 16.04 \\ 6 \end{bmatrix}$$

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

$$= 0.8308 - 0.1089$$

$$|S| = 0.7219$$

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

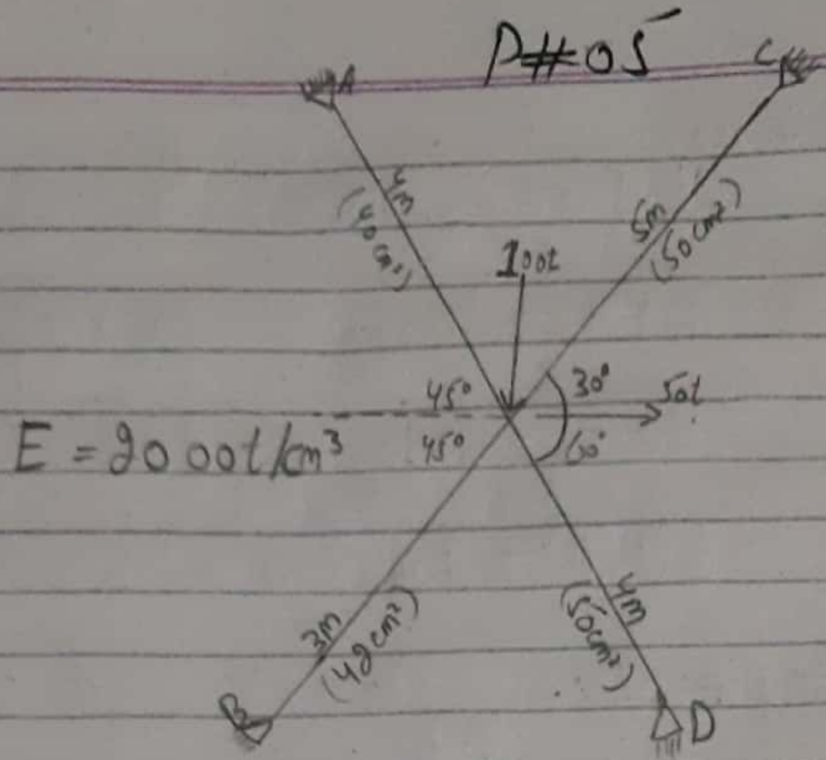
Now, $\begin{bmatrix} AD_1 & ADL_1 \\ AD_2 & ADL_2 \end{bmatrix} = \begin{bmatrix} 0 & -16.04 \\ 4 & -6 \end{bmatrix}$

$$= \begin{bmatrix} 16.04 \\ -2 \end{bmatrix} E$$

$$\begin{bmatrix} D_1 \\ D_2 \end{bmatrix} = \begin{bmatrix} -13.915 \\ 3.894 \end{bmatrix}$$

P#05

Q 2



Solution:.

For A :.

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

$$\Rightarrow P = 2.628 m$$

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

$$\Rightarrow b = 2.828 m$$

For B :.

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

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

$$\Rightarrow b = 2.12 m$$

For C :. $\sin 30^\circ = \frac{P}{h=5}$

$$\Rightarrow D = 2.5 m$$

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

$$\Rightarrow b = 4.33 m$$

Now,

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

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

$$EA(C) = 2000 \times 50 = 1000,000t$$

$$EA(D) = 2000 \times 50 = 1000,000t$$

Step # 01 :.

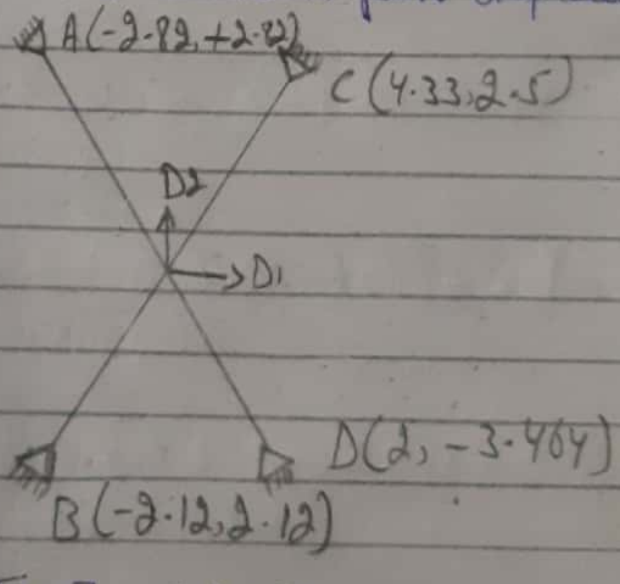
$k.I$

$$k.I = 2j - r$$

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

Step # 02 :.

Select unknown Joint displacement



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

Step#03: $[AMD]_{4\times2}$ & $[S]_{2\times2}$

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

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

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

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

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

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

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

$$= \frac{80,000}{(400)^3}(282)^2 + \frac{80,000}{(300)^3}(212)^2 + \frac{100,000}{(500)^3}(-433)^2$$

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

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

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

$$S_{12} = S_{21} = \sum_{i=1}^{m} \frac{EA}{L^2} (x_k - x_j)(y_k - y_j)$$

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

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

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

(ii) $D_1 = 0$, $D_2 = 1k'$

$$AMD = \frac{EA}{L^3}(y_k - y_j)$$

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

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

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

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

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

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

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

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

Step# 04:-

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

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

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

Step# 05:-

$$[AM]$$

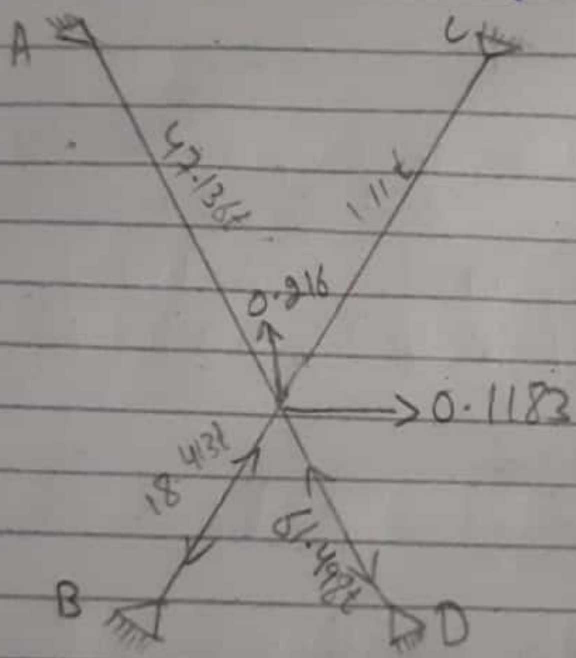
$$\begin{bmatrix} AM_1 \\ AM_2 \\ AM_3 \\ AM_4 \end{bmatrix} = \begin{bmatrix} 141 & -141 \\ 188.44 & 185.44 \\ -173.2 & -100 \\ -125 & 216.25 \end{bmatrix} \times \begin{bmatrix} 0.1183 \\ -0.216 \end{bmatrix}$$

$$\begin{bmatrix} 141 \times 0.1183 + (-141) \times (0.216) \\ 188.44 \times 0.1181 + 188.44 + (-0.216) \\ -173.2 \times 0.1183 + (-100) \times (-0.210) \\ -125 \times 0.1183 + 216.25 \times (0.216) \end{bmatrix}$$

P#10

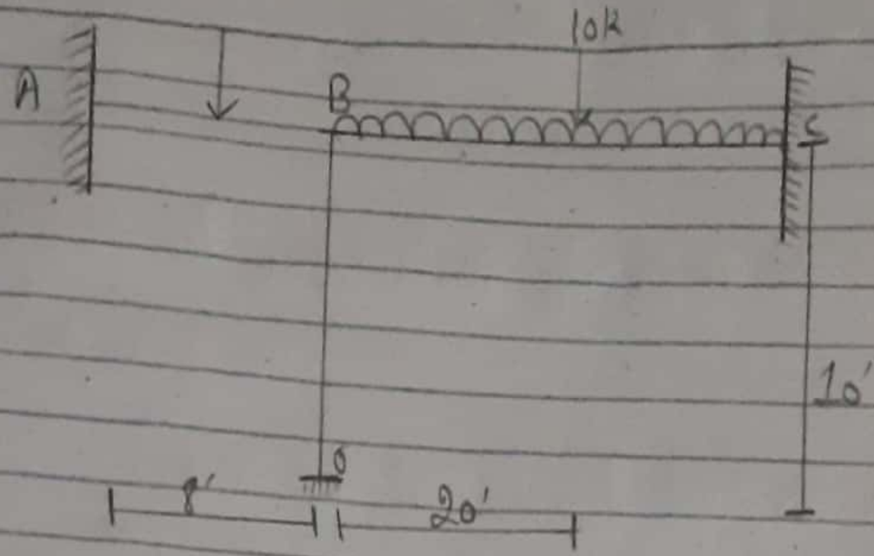
$$\begin{bmatrix} A_{m1} \\ A_{m2} \\ A_{m3} \\ A_{m4} \end{bmatrix} = \begin{bmatrix} 16.68 + 30.46 \\ 22.29 - 40.70 \\ -20.49 + 21.6 \\ -14.79 - 46.71 \end{bmatrix}$$

$$\begin{bmatrix} A_{m1} \\ A_{m2} \\ A_{m3} \\ A_{m4} \end{bmatrix} = \begin{bmatrix} 47.136t \\ -18.413t \\ 1.11t \\ -61.498t \end{bmatrix}$$



P# 11

Q 3

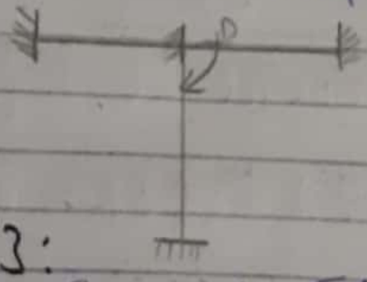


Solution:.

Step # 01: Determine Knamatic indeterminancy

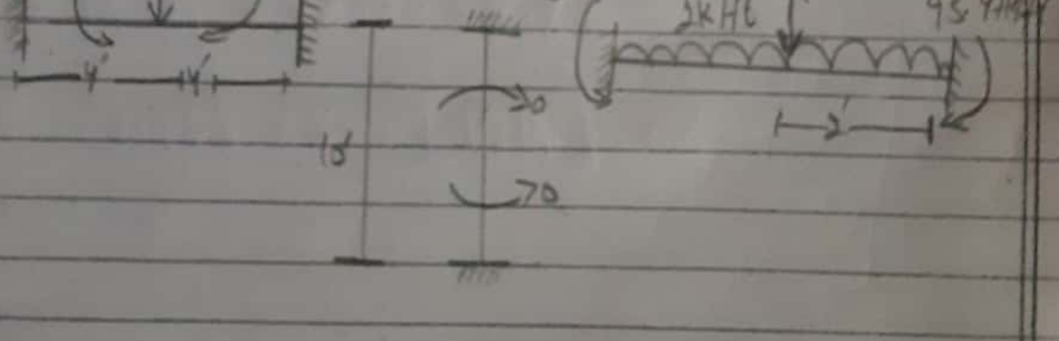
K·I = 1

Step # 02: Determine unknow Joint Displacement



Step # 03:

Compute [ADL] Matrix



P#12

⇒ Point load at center $= \frac{PL}{8} = \frac{(15)(8)}{8}$

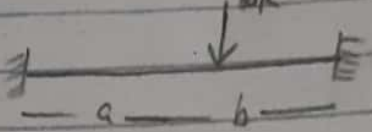
$= 15\ k/ft$

⇒ Uniformly Distributed load $= \frac{WL^2}{12}$

$= \frac{2(20)^2}{12} = 66.67\ k/ft$

⇒ Point load (Not at mid):

Suppose,



For left end:

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

For right end: $\frac{Pa^2b}{L^2} = \frac{(10)(12)^2(8)}{(20)^2} = 28.8\ k\cdot ft$

⇒ So total moment at left end:

$19.2 + 66.67 = 85.87\ k/ft$

⇒ Similarly at righ end:

$28.8 + 66.67 = 95.49\ k\cdot ft$

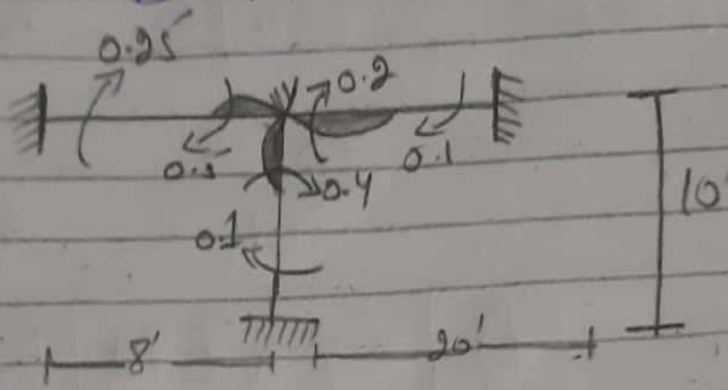
So, $[ADL] = -85.87 + 15 = -70.87\ k/ft$

Step #04: Determine [S] Matrix

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

Now,

$D = 1k$



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

$$\Rightarrow \frac{4EI}{20} = 0.2 \qquad \frac{2EI}{20} = 0.25$$

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

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

$$= 1.1EI$$

$$[S] = 1.1EI$$

Step # 05 :

Compute [D] Matrix

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

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

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

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