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Subject : Structur = II

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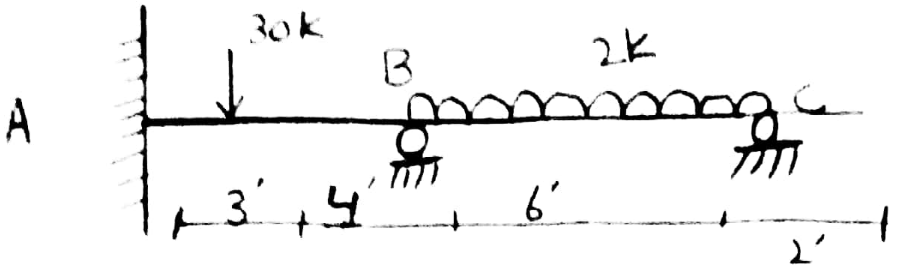
Date : 25.9.2020

Question # 1



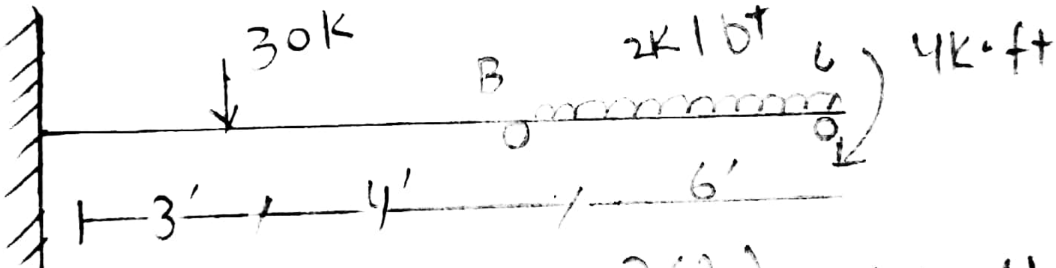
Solution :-

Step # 1

Determining kinematic Indeterminacy

$$K.I = 5^\circ$$

So we have to reduce the extended portion



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

Now

$$K.I = 2^\circ$$

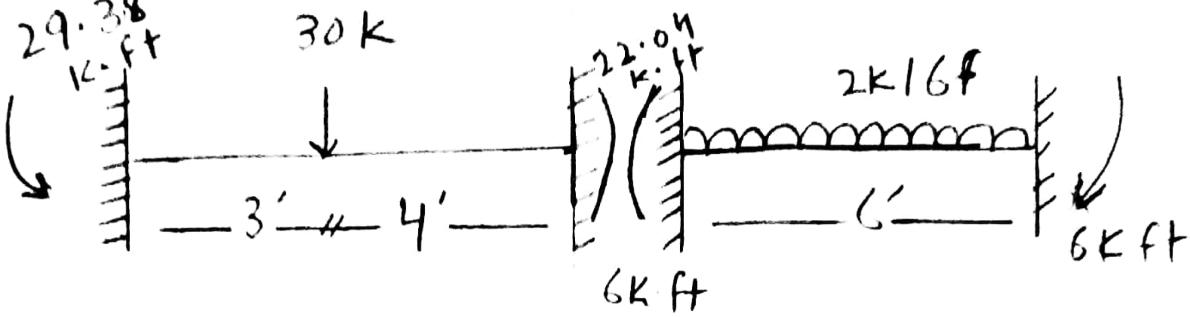
Step # 2

Determine Unknown Joint Displacement

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

(2) Step # 3

Compute [ADL] Matrix



→ For point load (not at mid)

→ For left end

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

→ For right end :

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

→ For uniformly Distributed Load

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

(3) $ADL_1 = +22.04 - 6 = 16.04\ k\cdot ft$

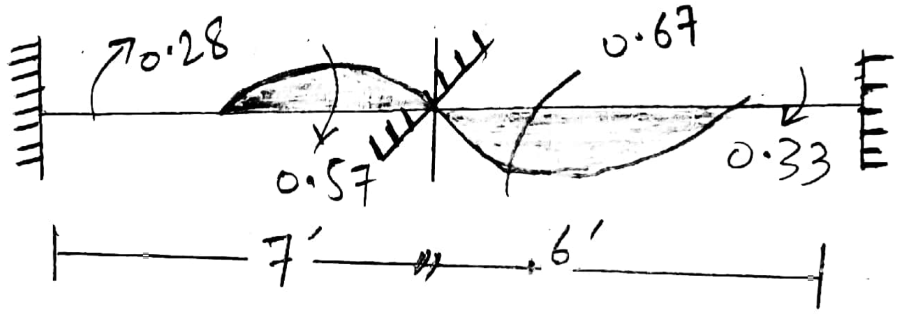
$ADL_2 = 6k\cdot ft$

Step # 04

Now compute [S] Matrix

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

a) $D1 = 1k$ $\quad$ $D_2 = 0$



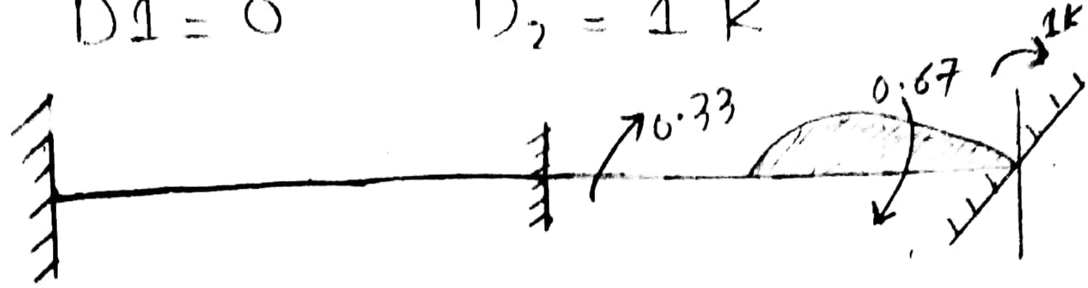
$$\frac{4EI}{7} = 0.57 \qquad \frac{2EI}{6} = 0.33$$

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

$S_{11} = 0.57 + 0.67$

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

(4) b) $D1 = 0 \quad D_2 = 1\,K$



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

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

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

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

Step # 5

Now compute [D] Matrix

$$\begin{bmatrix} D1 \\ D2 \end{bmatrix} = \begin{bmatrix} S_{11} & S_{21} \\ S_{21} & S_{22} \end{bmatrix}^{-1} \times \begin{bmatrix} AD_1 \\ AD_2 \end{bmatrix} - \begin{bmatrix} ADL_1 \\ ADL_2 \end{bmatrix}$$

$$= \frac{1}{\begin{bmatrix} 1.24 & 0.33 \\ 0.33 & 0.67 \end{bmatrix}} \times Adj A = \begin{bmatrix} AD_1 \\ AD_2 \end{bmatrix} - \begin{bmatrix} ADL_1 \\ ADL_3 \end{bmatrix}$$

$$|S| = (1.24 \times 0.67) - (0.33 \times 0.33)$$
$$= 0.8308 - 0.1089$$

$$|S| = 0.7219$$

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

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

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

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

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

$$\begin{bmatrix} D1 \\ D2 \end{bmatrix} = \begin{bmatrix} -13.83 \\ 3.85 \end{bmatrix}$$

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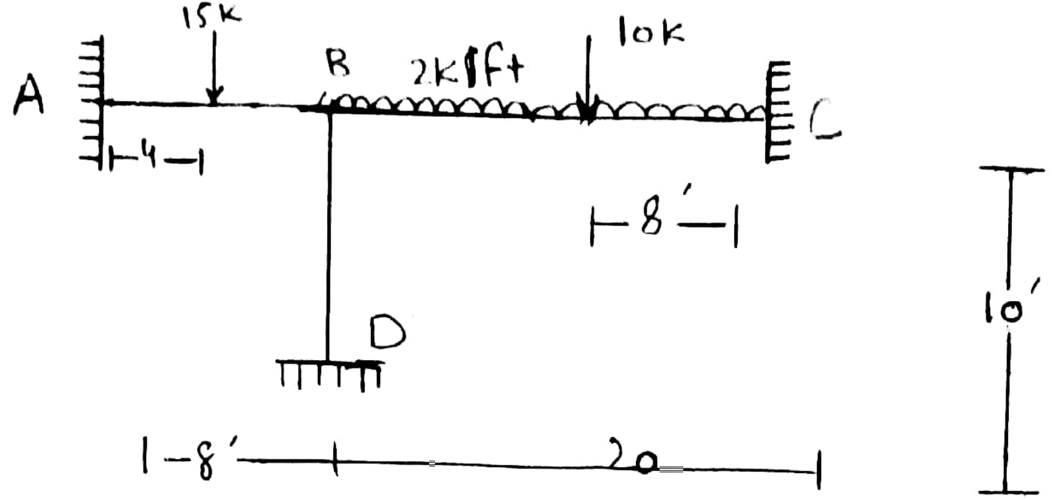
QNo (3)



Sol:-

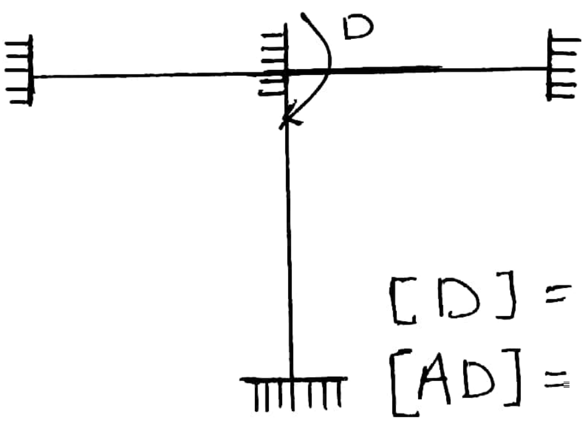
Step # 1:-

Determine Kinematic Indeterminacy

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

Step # 2:-

Determine Unknown Joint Displacement

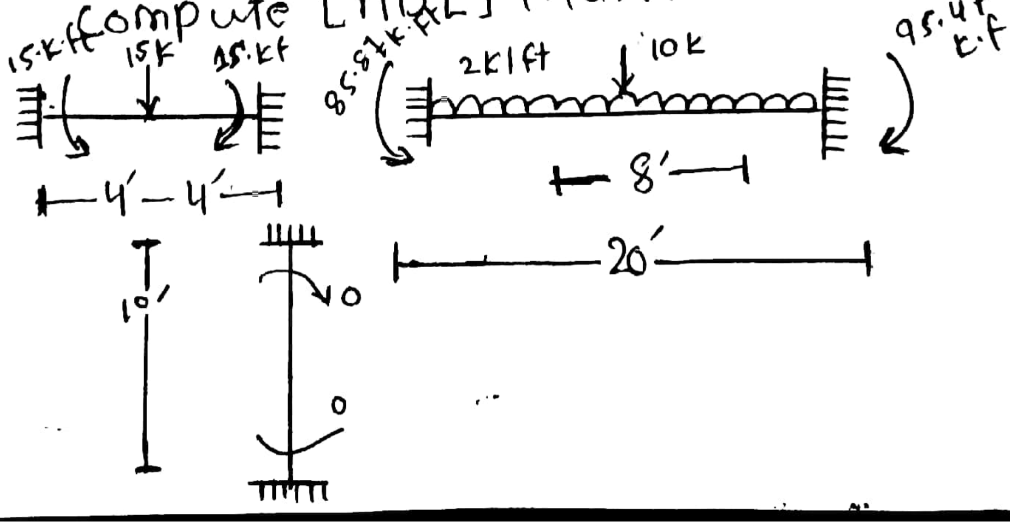


$[D] = [\,?\,]$

$[AD] = [\,0\,]$

Step # 3:-

Compute [ADL] Matrix.



⇒ Point Load at center :-

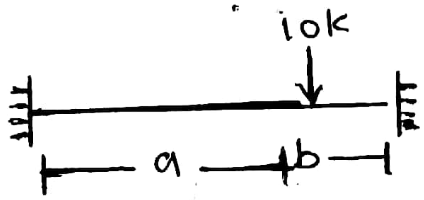
$$\frac{PL}{8} \Rightarrow \frac{(15)(8)}{8} = 15 \text{ Kip.ft}$$

⇒ uniformlu Distributed load :-

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

⇒ 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 :-

$$19.2 + 66.67 = 85.87 \text{ k.ft}$$

Simairlarly at right end :-

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

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

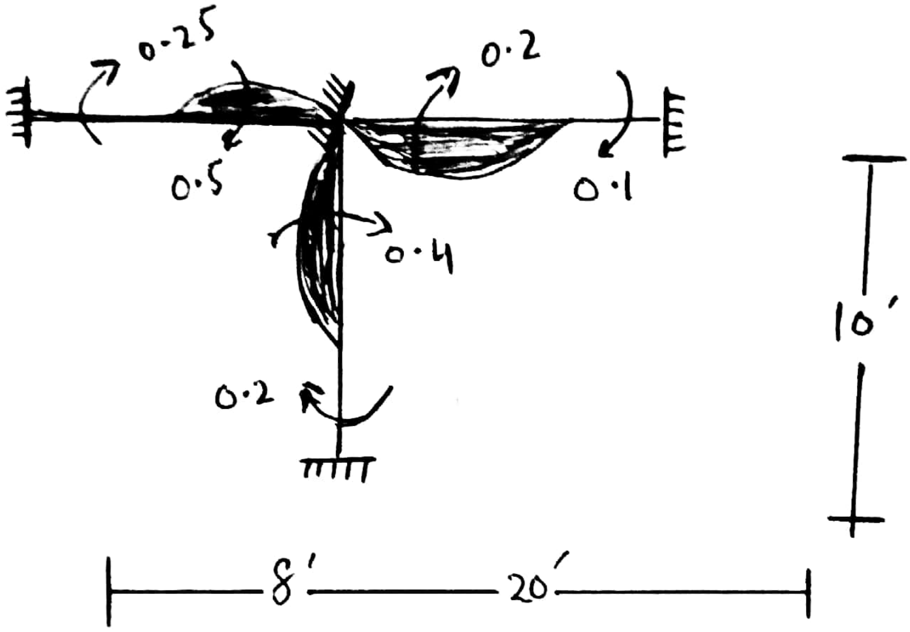
Step 4 #:-

Determin [S] matrix

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

Now

$D = 1K$



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

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

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

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

$= 1.1\ EI$

Step # 5 :- (4)

Compute [D] matrix

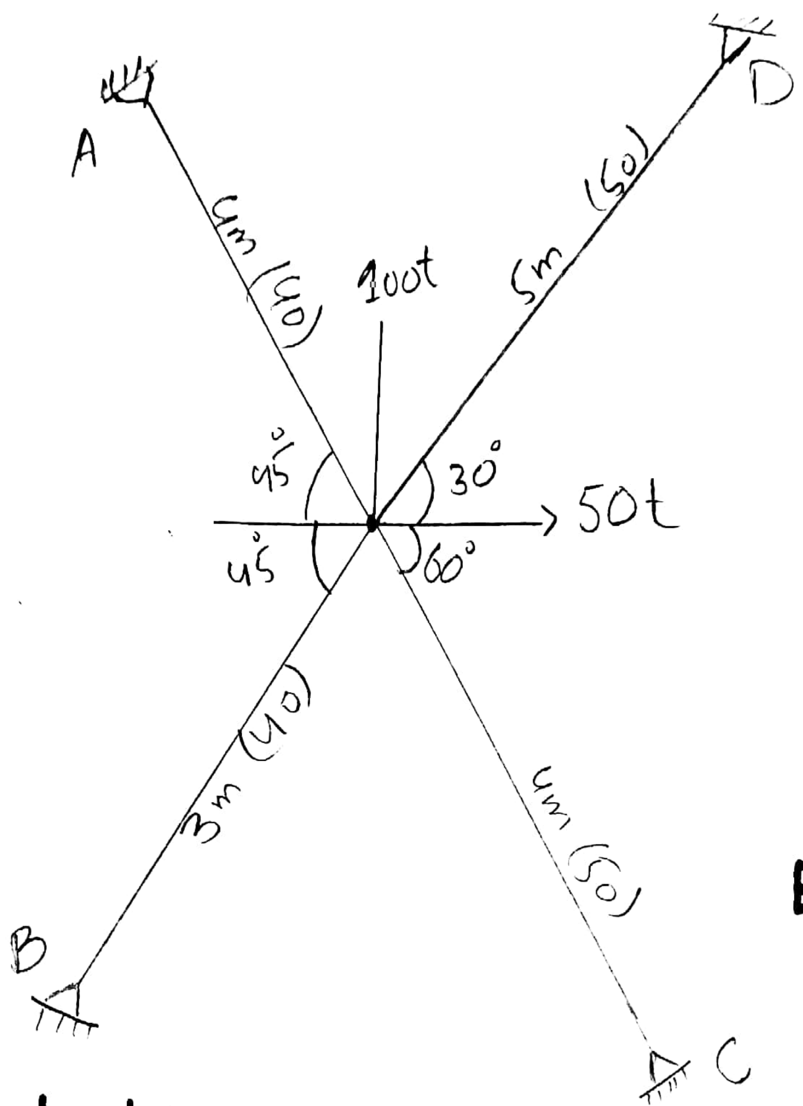
$$[D] = [S]^{-1} \times [AD] - [ADL]$$

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

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

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

Question # 02



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

Solution :-

For A

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

$\rightarrow P = 2.828\ m$

$$\cos 45° = \frac{b}{H} = \frac{b}{4}$$

$\rightarrow b = 2.828\ m$

For B

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

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

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

$$\rightarrow b = 2.12 \text{ m}$$

For C

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

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

$$\rightarrow P = 3.46$$

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

$$\cos 60 \times 4 = b$$

$$\Rightarrow b = 2$$

For D

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

$$\rightarrow P = 2.5 \text{ m}$$

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

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

Now

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

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

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

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

Step # 01 KI

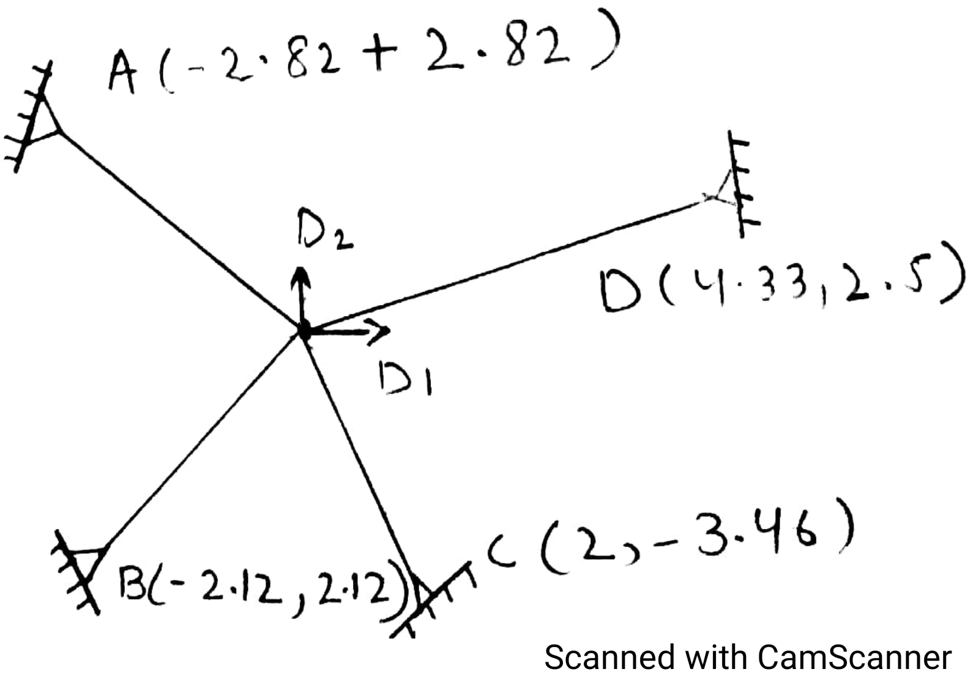
$$KI = 2j - r$$

$$= 2(5) - 8$$

$$KI = 2^{\circ}$$

Step # 2

Select unknown Joint Displacement



$$\begin{array}{cccc} D_1 & ? & AD_1 & 50 \\ D_2 & ? & AD_2 & -100 \end{array}$$

Step #03

AMD S

i) $D_1 = 1k \quad D_2 = 0$

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

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

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

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

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

Now

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

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

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

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

$$S_{11} = 445.063$$

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

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

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

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

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

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

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

$$AMD_{22} = \frac{80{,}000}{(400)^2}(212) = 188.44$$

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

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$$AMD_{22} = \frac{100,000}{(500)^2}(-250) = -100$$

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

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

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

$$+ \frac{10,000}{(500)^3}(-250)^2 + \frac{100,000}{(400)^3}(346)^2$$

$$S_{22} = 469.628$$

Step # 4

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

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

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

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

Step # 05

[AM]

$$\begin{bmatrix} Am_1 \\ AM_2 \\ AM_3 \\ AM_4 \end{bmatrix} = \begin{bmatrix} 141 & -141 \\ 188.44 & 188.44 \\ 173.2 & -100 \\ -125 & 216.25 \end{bmatrix} \times \begin{bmatrix} 0.1183 \\ -0.216 \end{bmatrix}$$

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

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

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

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