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Final paper

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Section:- B

Subject:- Structural Analysis II

Submitted to:- Eng Adeed

Date:- 25/9/2020

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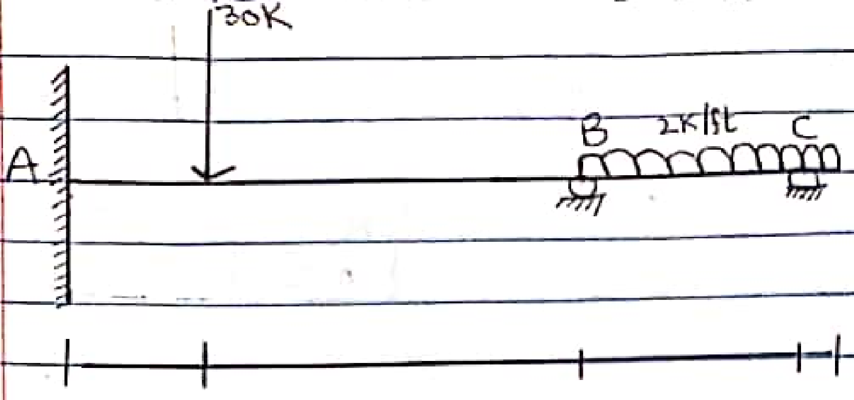
Q#1

Q1 Analyze the beam shown in fig-1 by stifness method. Assume EI constant



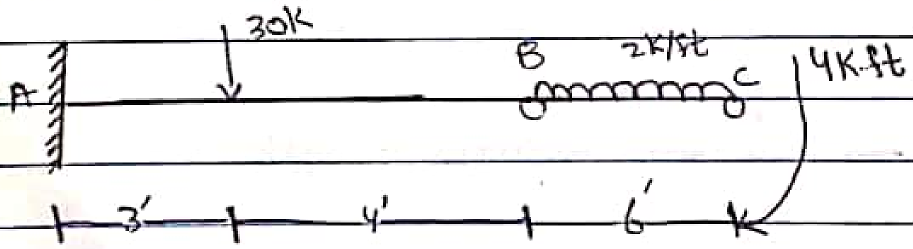
Solution:

* Step#1

Determining Kinematic Indeterminacy.

K·I = 5°

So we have to reduce the extend portion



Now K.I = 2°

* Step#02

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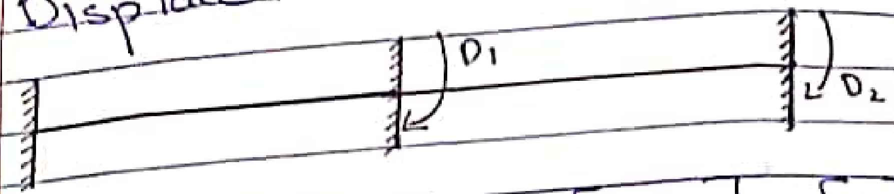
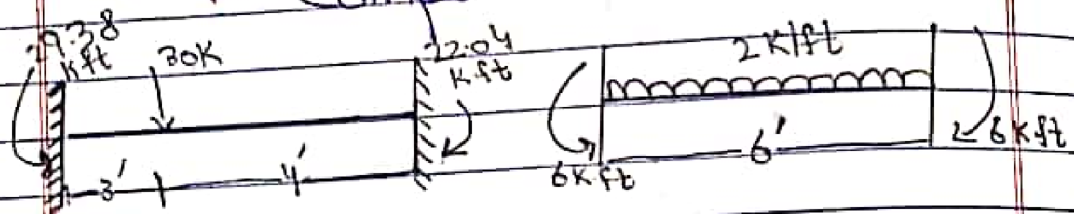
Determine unknown Joint Displacement



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

★ Step# 3

Compute [ADL matrix



→ for point load (not at mid)

→ for left end:

$$\frac{Pab^2}{L^2} = \frac{(30)(3)(4)^2}{(7)^2} = \boxed{29.38 K.ft}$$

→ for right end:

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

$$= \boxed{22.04 K.ft}$$

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→ for uniformly distributed load:

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

$AD_{L1} = +22.04 - 6 = 16.04$ K.ft

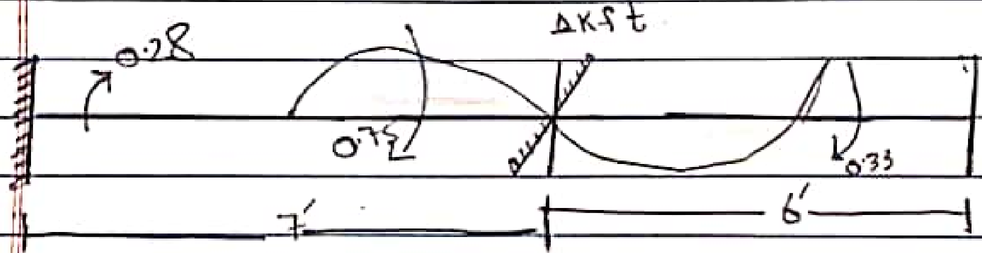
$AD_2 = 6$ K.ft

★ Step#04:

Now compute [S] matrix

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

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



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

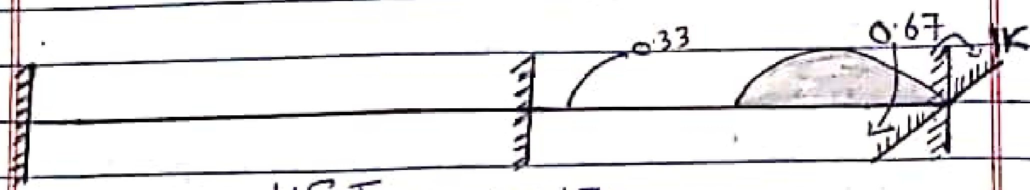
$\frac{4EI}{6} = 0.67$ $\frac{2EI}{7} = 0.28$

$S_{11} = 0.57 + 0.67$

$S_{11} = 1.24$ EA

$S_{21} = 0.33$ EA

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

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

$$= \frac{1}{\begin{bmatrix} 1.24 & 0.33 \\ 0.33 & 0.67 \end{bmatrix}} \times AdJ \times A \begin{bmatrix} AD_1 \\ AD_2 \end{bmatrix} - \begin{bmatrix} ADL \\ ADL \end{bmatrix}$$

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

$= 0.8308 - 0.1089$

$|S| = 0.7219$

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

Now

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

[illegible]

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

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

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

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

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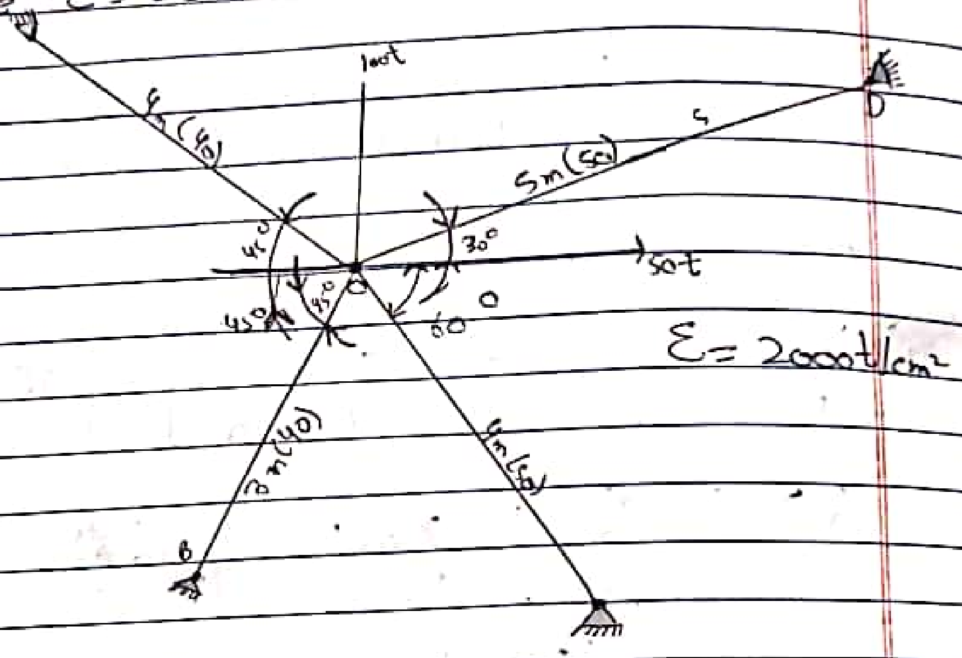
Q No#12 Analyze the pin-jointed frame show by stiffness method. length of member in 'm' and cross section area in cm^2 are show in fig 3 Take $E = 2000\ t/cm^2$



Solution:

⇒ For A

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

$\rightarrow P = 2.828m$

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

$\rightarrow -2.828m$

⇒ For B

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

$\rightarrow = 2.12m$

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

$\rightarrow b = 2.12m$

⇒ 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

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

$\rightarrow p = 2.5m$

$\cos 30 = b/5$

$b = 4.33m$

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Now

$EA_{(A)} = 2000 \times 40 = 80000t$

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

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

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

Step#1 K.I

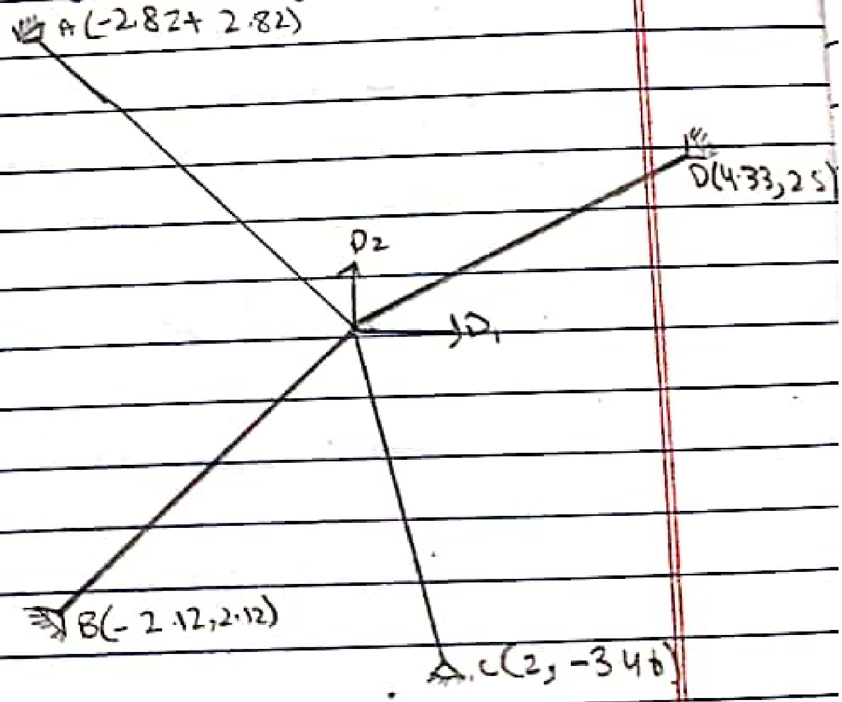
$KI = 2J - 8$

$= 2(5) - 8$

$KI = 2^{\circ}$

☆ Step#2

Select unknown joint displacement



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

★ Step#03

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

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

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

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

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

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

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

Now,

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

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

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

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

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

$$\Rightarrow S_{12} = S_{21} - \sum_{i=1}^{m} \frac{EA}{L^3} \times (xK - xJ)(yK - yJ)$$

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

$$+ \frac{100,000}{(500)^3}(-433)(0.250) + \frac{100,000}{(400)^3}(-200)(0.346)$$

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

(2) $D_1 = 0$, $D_2 = 1K'$

$$AMD = \frac{EA}{L^2}(yK - yJ)$$

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

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

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

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

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

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

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

$S_{22} = 469.628$

Step # 4

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

$\begin{bmatrix} D_1 \\ D_2 \end{bmatrix} = \begin{bmatrix} 445.003 & 12.237 \\ 12.237 & 469.628 \end{bmatrix}^{-1} \times \begin{bmatrix} 50 \\ -100 \end{bmatrix}$

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

Step # 5

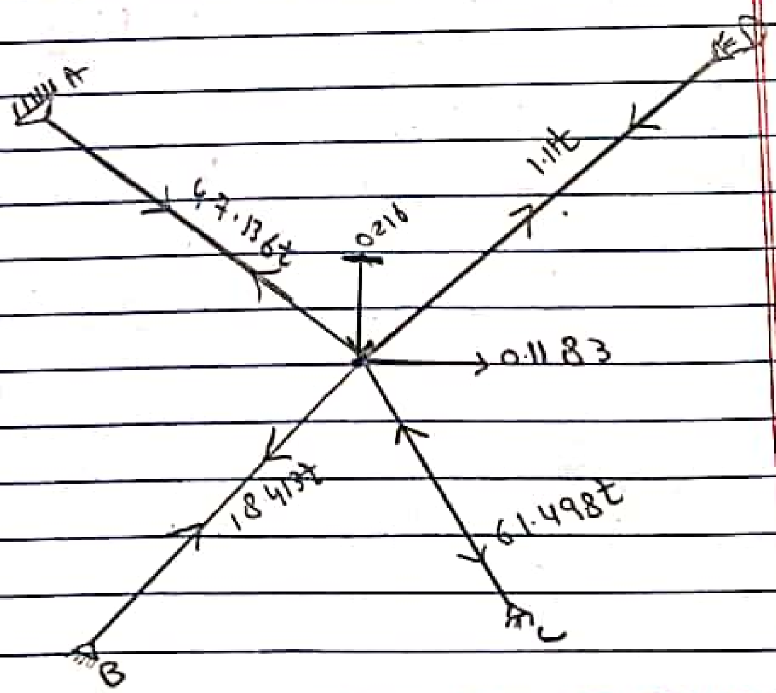
[AM]

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

$$= \begin{bmatrix} 141 \times 0.1183 + (-141) \times (0.216) \\ 188.44 \times 0.1183 + (188.44) \times (-0.216) \\ -173.2 \times 0.1183 + (-100)(-0.216) \\ -125 \times 0.1183 + 216.25 \times (0.1216) \end{bmatrix}$$

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

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



Q#3

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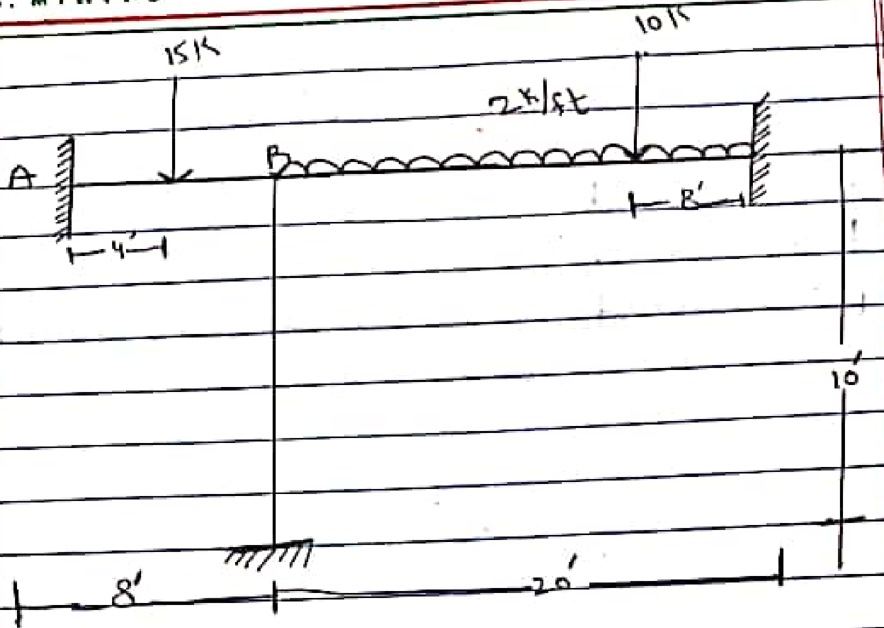
Q/3



Solution!

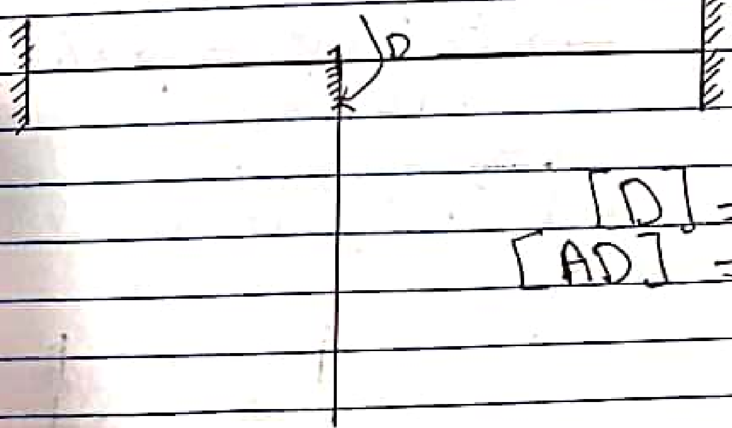
Step #1

Kinematic indeterminacy

K.I = 1°

Step#2

Determine unknown Joint displacement



$[D] = [?]$

$[AD] = [0]$

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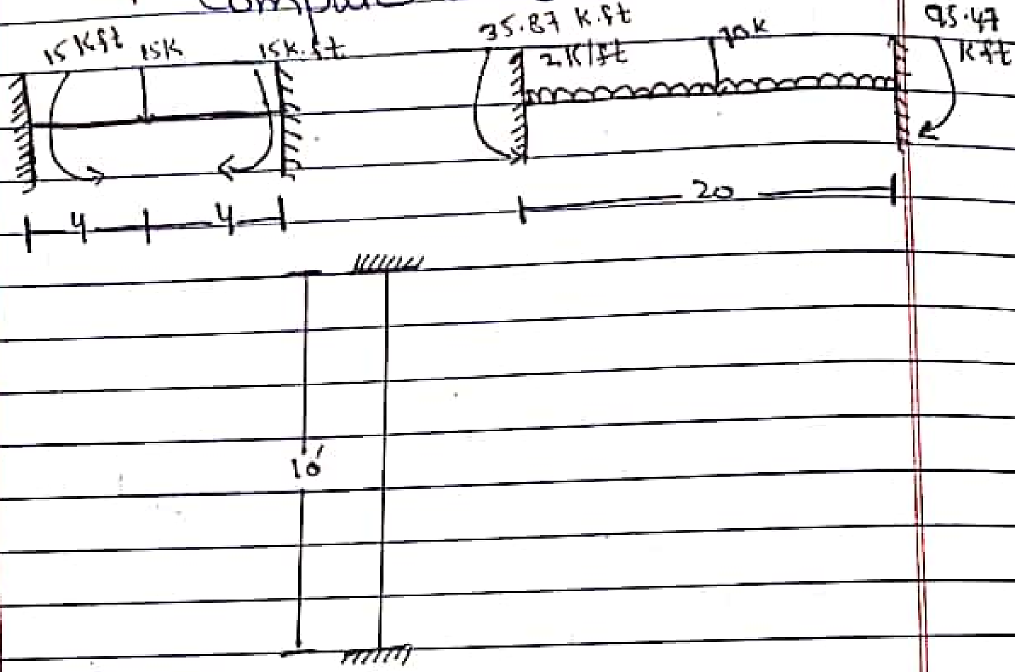
Step#3

Compute [ADL] Matrix



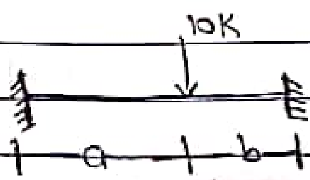
* point load at centre:

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

* uniformly distrubted load:

$$\frac{wl^2}{12} \rightarrow \frac{(2)(20)^2}{12} = \boxed{66.67 \text{ K.ft}}$$

* point load (not at mid):



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★ for left end:

$$\frac{Pab^2}{L^2} \Rightarrow \frac{(10)(12)(8)^2}{(20)^2} = \boxed{19.2\ K.ft.}$$

★ for right end

$$\frac{Pa^2b}{L^2} = \frac{(10)(12)^2(8)}{(20)^2} = \boxed{28.8\ K.ft.}$$

So the total moment at left end:

$$19.2 + 66.67 = \boxed{85.87\ K.ft}$$

⇒ Similarly at right end

$$28.8 + 66.67 = \boxed{95.47\ K.ft}$$

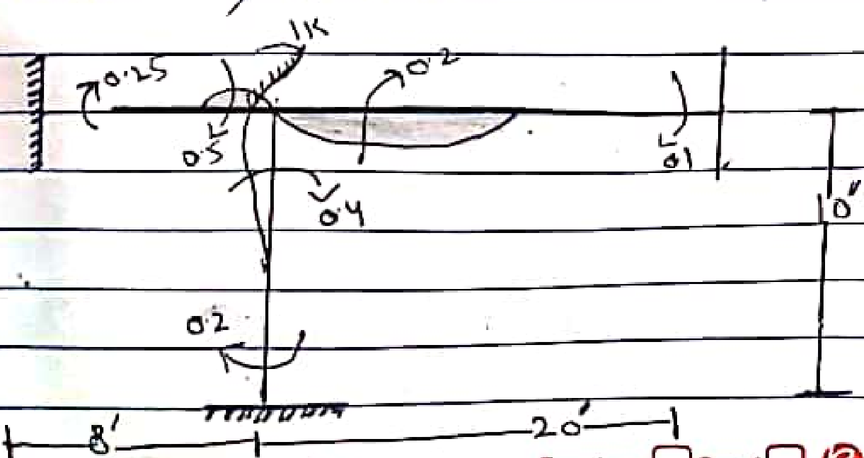
$$So\ [ADL] = -85.87 + 15 = \boxed{-70.87\ K.ft}$$

Step #4

Determine [S] matrix

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

Now, D = 1K.



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

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

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

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

$= 1.1 EI$

$[S] = 1.1 EI$

Step#5

Compute [D] matrix

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

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

$= \frac{70.87}{1.1}$

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

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