# FINAL TERM

Name: Syed Najeeb

ID: 7855

Semester: 6th

Section: B

Subject: Structure Analysis - II

Instructor: Engr

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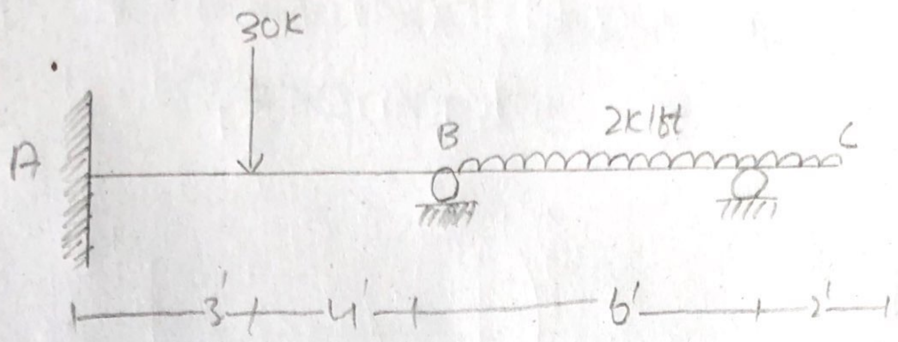
01 7855 Question # 01

Q#01



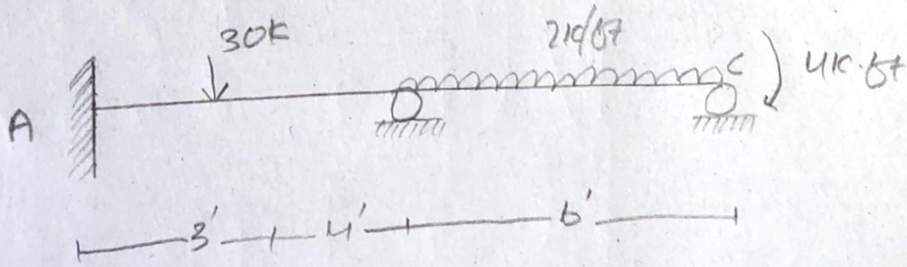

Solution:

Step #01

Determining Kinematic Indeterminancy

$K.I = 5^\circ$

So we have to reduce the extended portion



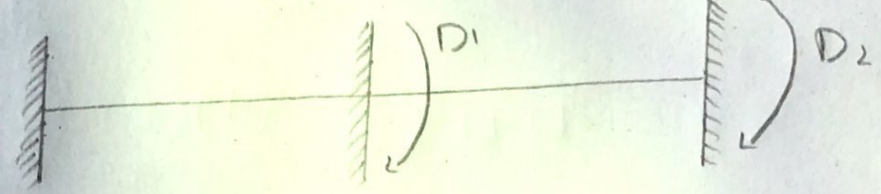

$\Rightarrow \frac{2(2)}{1} = 4K.ft$

now $K.I = 2^\circ$

02

## Step#02

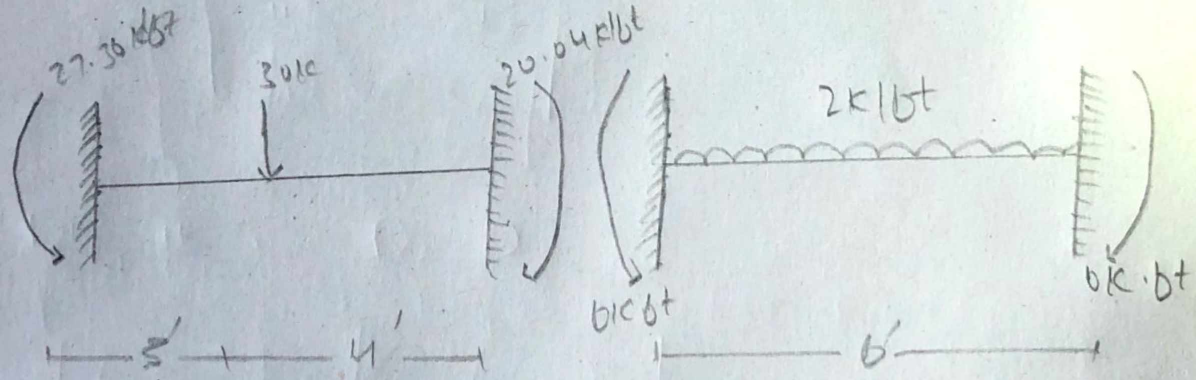
Determine unknown joint displacement




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

## Step #03

Compute [ADL] matrix




=> For pointed load (not at mid)

=> For left end :-

$$= \frac{Pab^2}{l^2} = \frac{(30)(3)^2(4)}{(7)^2} = 27.38 \text{ k.ft}$$

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For right end:-

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

For UDL:

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

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

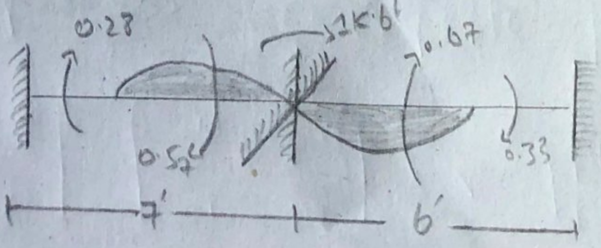
$ADL_2 = 6$k.ft

Step # 04

compute [S] matrix

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

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




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

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

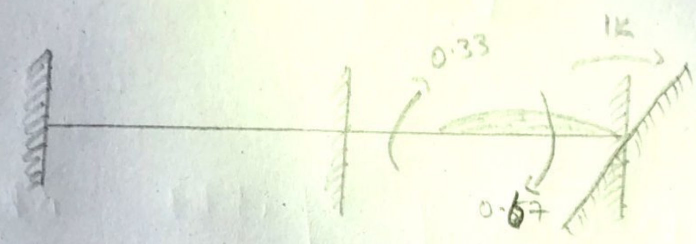
04

$S_{11} = 0.57 + 0.67$

$= 1.24 EA$

$S_{21} = 0.33 EA$

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 compute [D] Matrix

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

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

$\boxed{05}$

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

$= 0.8308 - 0.1089$

$|S| = 0.7219$

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

now

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

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

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

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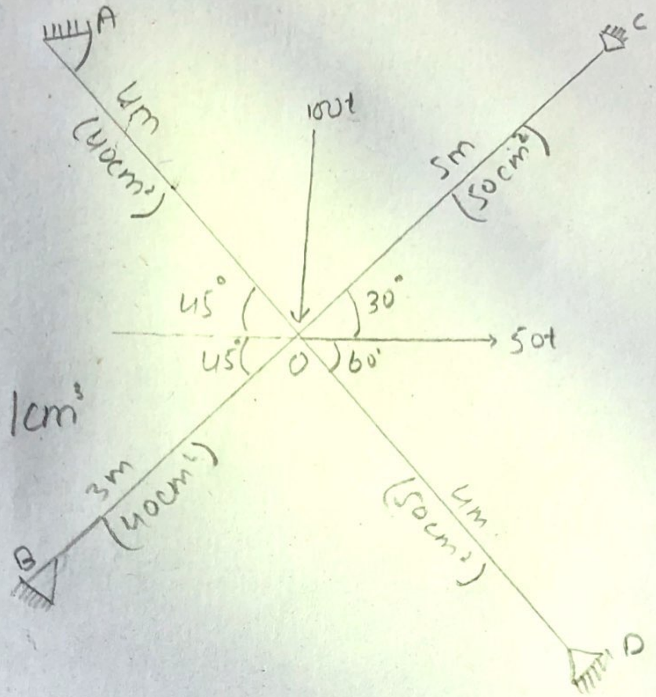
Q#02




Solution: <u>For A:</u>

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

$$\Rightarrow P = 2.828m$$

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

$$\Rightarrow b = 2.828m$$

<u>For B:</u>

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

$$\Rightarrow P = 2.12m$$

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

$$\Rightarrow b = 2.12m$$

For C:

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

$\Rightarrow P \Rightarrow 2.5\,m$

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

$\Rightarrow b = 4.33m$

now

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

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

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

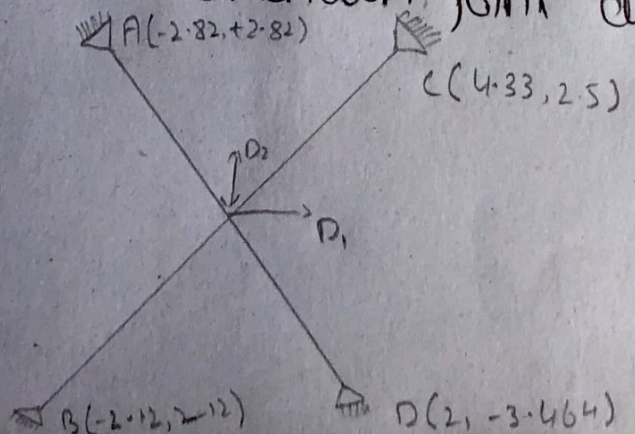
$EA(D) = 2000 \times 50 = 100{,}000t$

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

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

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

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

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

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

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

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

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

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$$+ \frac{1000,000}{(400)^3} \times (-200)^2$$

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

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

$$S_{12} = S_{21} = \sum_{l=1}^{m} \frac{EA}{l^3} \times (x_k - x_i)(y_k - y_i)$$

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

$$+ \frac{100,000}{(500)^3} \times (-433)(0-250) + \frac{1000,000}{(400)^3} \times (-200)(0+346)$$

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

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

$$AMD = \frac{EA}{l^2} (y_k - y_i)$$

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

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

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

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

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

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

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

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

Step#04

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

$$\begin{bmatrix} D_1 \\ D_2 \end{bmatrix} = \begin{bmatrix} 455.003 & 12.237 \\ 12.237 & 469.628 \end{bmatrix}^{-1} \times \begin{bmatrix} 50 \\ -100 \end{bmatrix}$$

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

Step #6 [AM]

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

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

$$\begin{bmatrix} AM_1 \\ Am_2 \\ AM_3 \\ AM_4 \end{bmatrix} = \begin{bmatrix} 16.68 + 30.46 \\ 22.29 - 40.70 \\ -20.49 + 21.6 \\ -14.79 - 46.71 \end{bmatrix}$$

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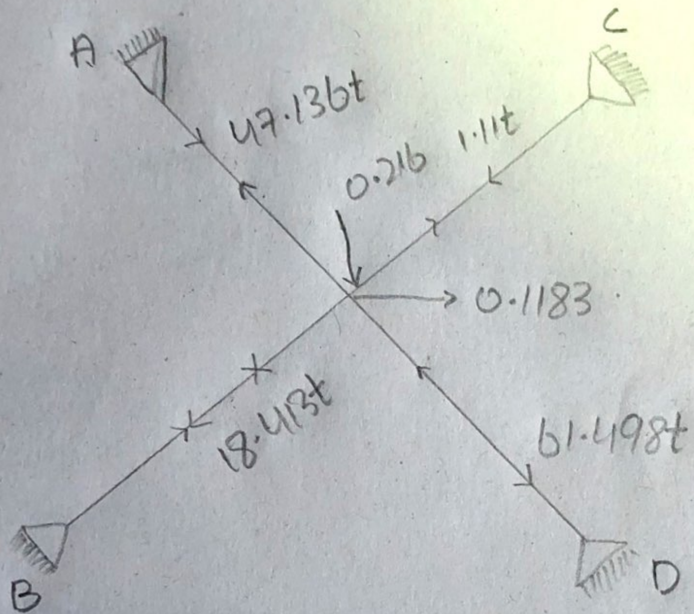
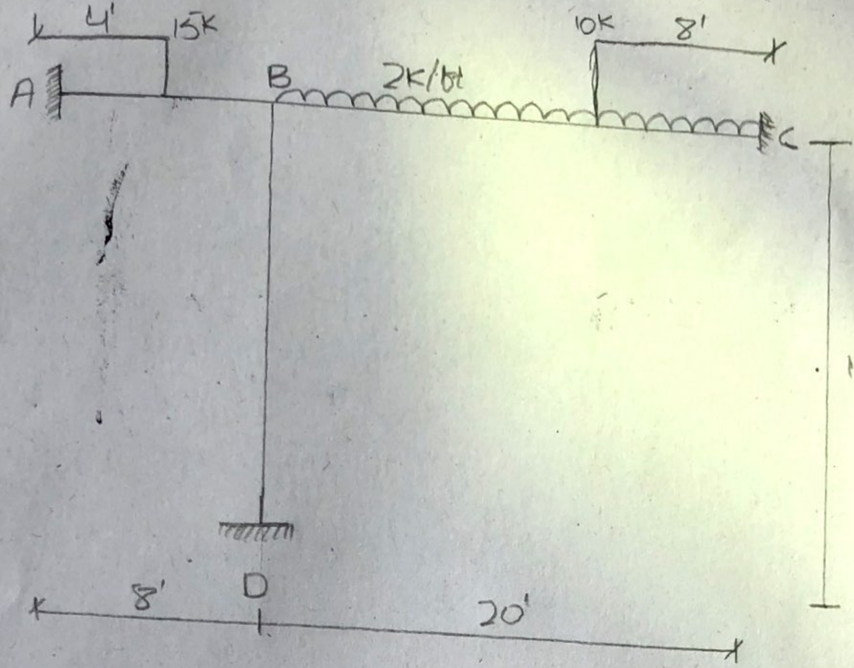
$$\begin{bmatrix} AM_1 \\ AM_2 \\ AM_3 \\ AM_4 \end{bmatrix} = \begin{bmatrix} 47.136t \\ -18.413t \\ 1.11t \\ -61.498t \end{bmatrix}$$



13 7855 Question # 03

Q#03




## Solution:

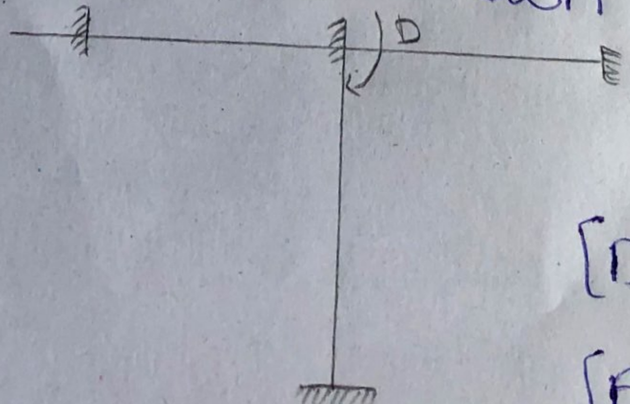
### Step # 01

Determine kinematic Indeterminancy

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

### Step # 02

Determine unknown joint displacement

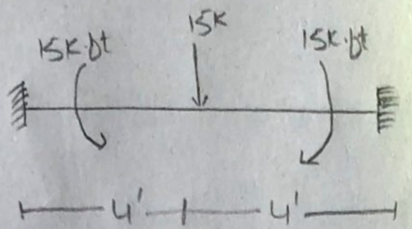


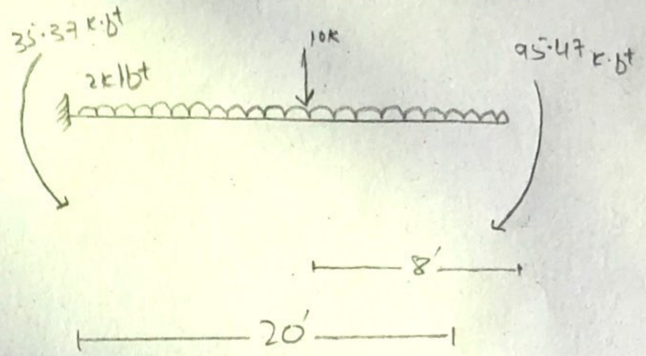

$[D] = [?]$

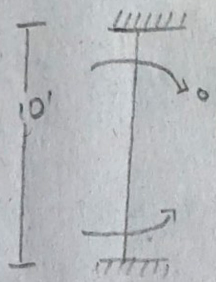
$[AD] = [0]$

## Step # 03

### Compute [ADL] Matrix




=> Point load at center :-

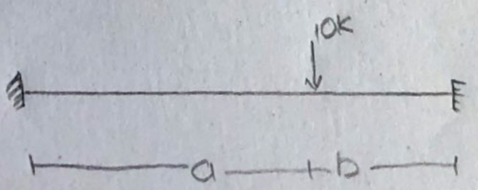
$$\frac{PL}{8} \Rightarrow \frac{(15)(8)}{8} = 15 \text{ kip}\cdot\text{ft}$$

=> Uniformly distributed load:

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

=> Point load (not at mid) :-

suppose :



For left End:-

$$\frac{Pab^2}{L^2} = \frac{(10)(12)(8)^2}{(20)^2} = 28.87 \text{ k.ft}$$

so total moment at left end.

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

Similarly at right end:

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

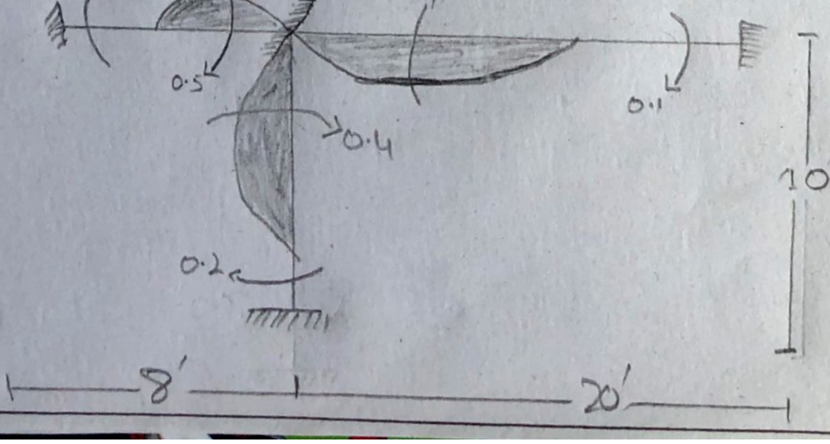
so $[ADL] = -85.87 + 15 = -70.87$ k.ft

Step #04

Determine [S] matrix

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

now



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

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

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

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

$= 1.1\, EI$

$[S] = 1.1EI$

Step #05

Comput [D] matrix

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

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

$= \frac{70.87}{1.1}$

$[D] = [64.42]\ ^{1}/_{EI}$