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I D # 14951

SUBJECT =ADVANCE STRUCTURAL ANALYSIS

ANSWER SHEET

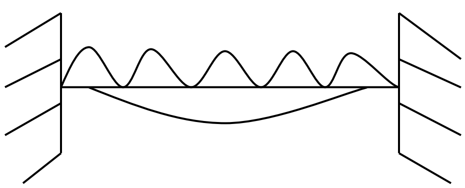
Q.NO (01)

a) Explain description of flexibility method procedure.

ANSWER:

DESCRIPTION OF FLEXIBILTY METHOD PROCEDURE:

1. Determine the degree of S.I.A number of releases equal to the degree of S.I are applied to the strc, each released beam made by the removal of interval or external force.The release strc is referred to as primary strc.the release strc must be choosen such that the remaining strc is geometrically stable and S.Determinate..In some cases the no. of releases can be less than the degree of indeterminacy, provided that the remaining strc can be readly analyzed.



K.I= O°

= 2°, 3°

→ In all cases, At smcPT

The redundant forces should be carefully choosen so that primary strc are easily analyzed.

2. The releases introduce displacement inconsistency into the strc and as 2nd step these inconsistencies are errors in the primary strc are determine.in other words,we calculate the mag.of errors in the displacements corresponding to the R.forces.these displacements may be due to external applied load,Temp variation,settlement at support etc are calculated using the method of virtual forces.
3. The 3rd step consists of determination of displacements in primary strc due to unit value of reduntants.(methods of virtual forces).these displacements are required at some location and in the same direction as the displacements errors determine in step 2.

4. Values of the redundant forces necessary to eliminate the errors in the displacement are now determined.this require the writing of super position equations, in which the effects of separate reduntants are added to the displacements.
5. The superposition at displacements results in a set of simultaneous linear equations.(n=No. of releases) that expresses the fact that there is zero relative displacements at each release. These compatibility equations gurantee a final displace shape.

(b) Differentiate between flexibility and stiffness method.

ANSWER :

FLEXIBILTY METHOD :

1.Determine the degree of S.I (degree of redundancy), n

2. Choose the redundants.

3. Assign Coordinates 1,2,…,n to the redundants.

4. Remove all the deduced once to obtain the release structure.

5. Determine [ΔL], the displacements at the coordinates due to the applied loads acting on the released structure.[ΔL] ΔRL.

6. Determine [ΔR], the displacements at the coordinates.due to the redundants acting on the released strc.

7.Compute the net displacement at the coordinates.

$[\Delta] = [\Delta L] + [\Delta R]$

$[\Delta] = [\Delta L] + [F][R]$

$[\Delta RS] = [\Delta RL] + [F][AR]$

$[AR] = [F]^{-1}\ [\Delta RS-\Delta RL]$

8. Use the compatibility of displacement to compute the redundance.

9. Knowing the redundants, compute the internal member forces by using equations of statics.

STIFFNESS METHOD:

1. Determine the degree of K.I (degree of freedom), n.

2. Identify the independent displacement components.

3. Assign Coordinates 1 to n to the independent displacement components.

4. Prevent all the displacement component to restrain strc.

5. Determine [ΔL], the actions at the coordinates in the restrained strc due to the loads other than those acting at the coordinates.

6. Determine the forces required at the coordinates in the unrestrained strc to cause the independent displacement components, Δ . AB.

7. Compute the net forces at the coordinates.

$[A] = [AL] + [A\Delta]\,[S]\,[\Delta]$

8. Use the conditions of equations to compute the displacements.

$[\Delta] = [S]^{-1}\,[A-AL]$

9. Knowing the displacements, compute the internal member forces by using slope deflection equations.

Q.NO (02)

Analyse the frames as shown in figures by using flexibility method.

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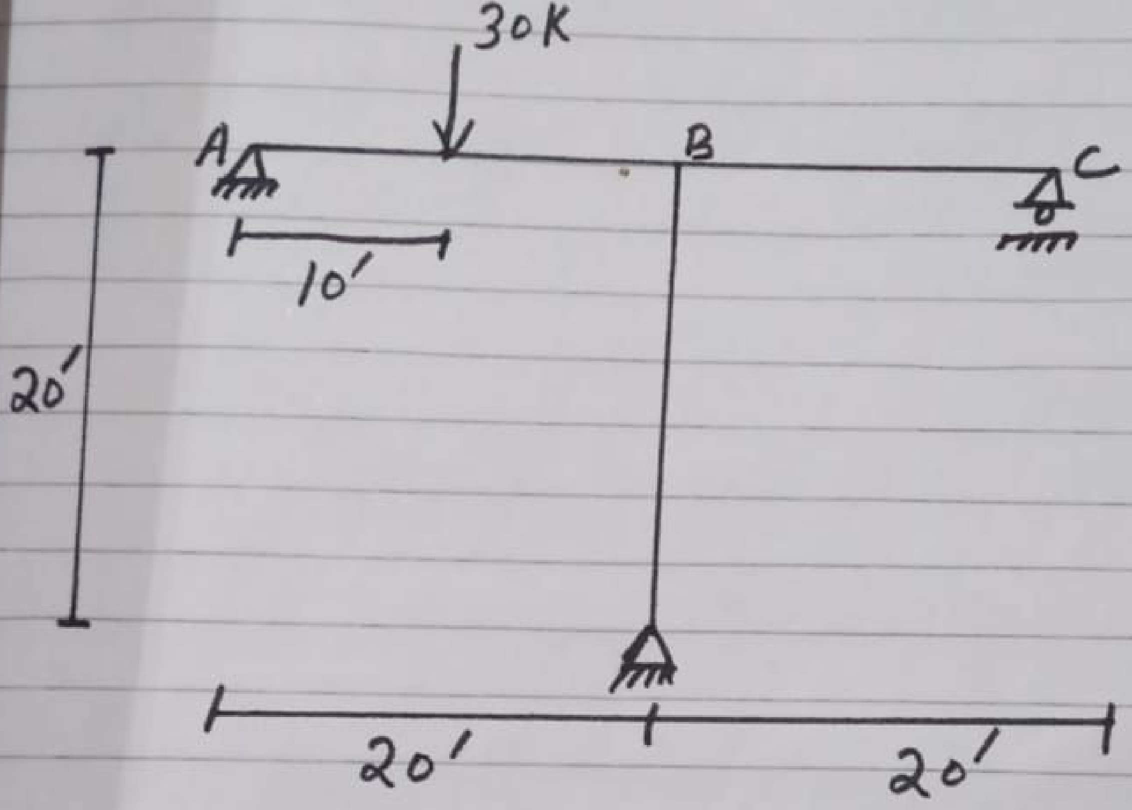
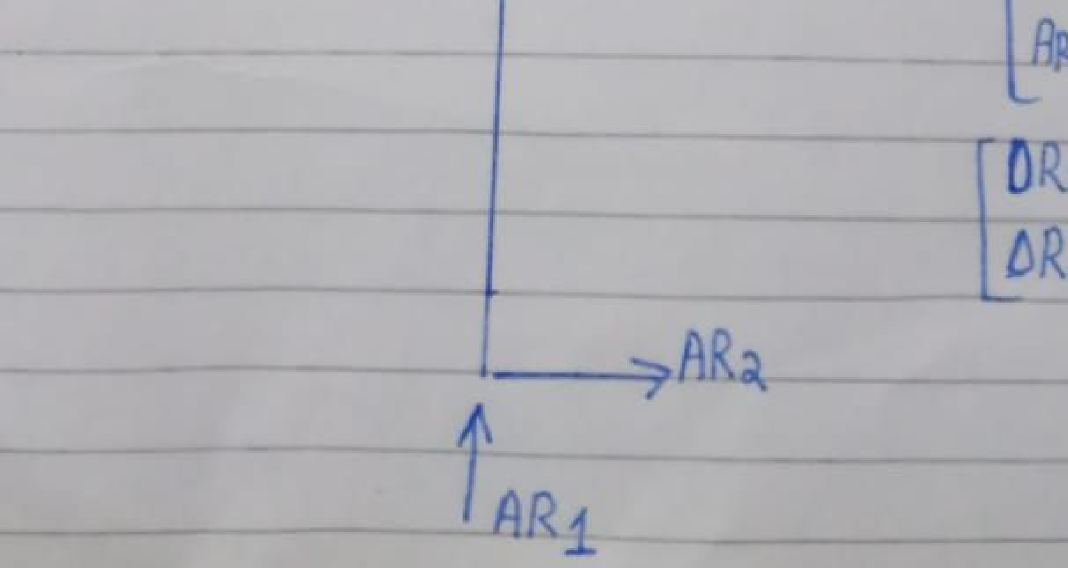
Q·No (02)

(a)



SOLUTION:-



$$\begin{bmatrix} AR_1 \\ AR_2 \end{bmatrix} = \begin{bmatrix} ? \\ ? \end{bmatrix}$$

$$\begin{bmatrix} \Delta Rs_1 \\ \Delta Rs_2 \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \end{bmatrix}$$

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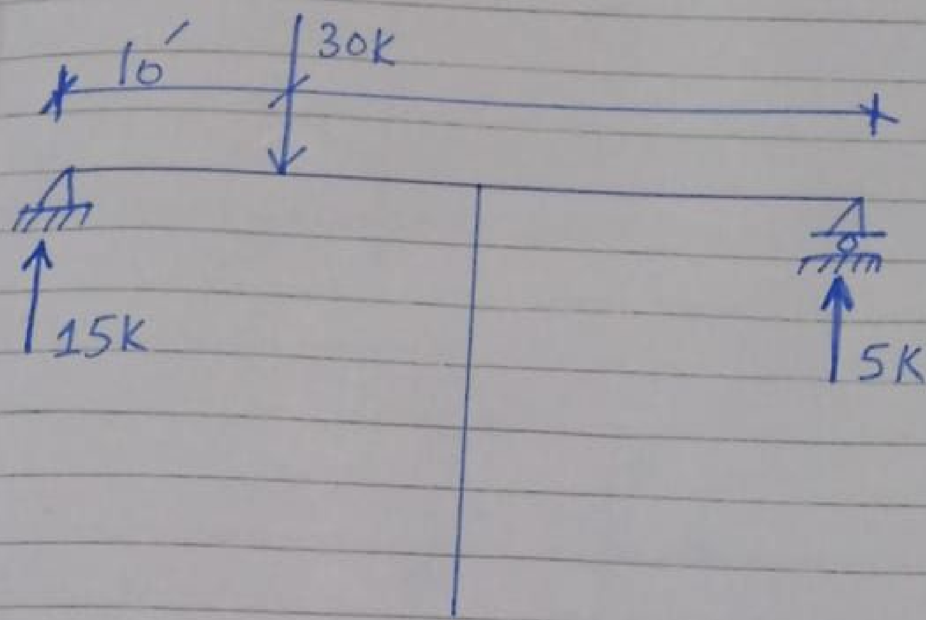
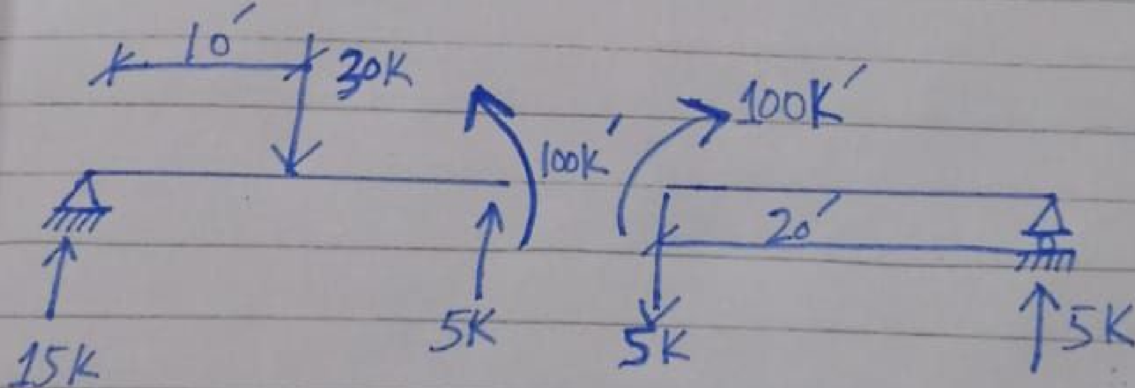
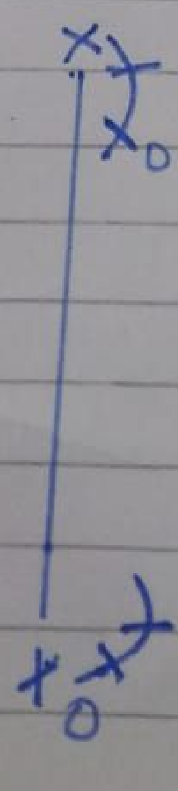
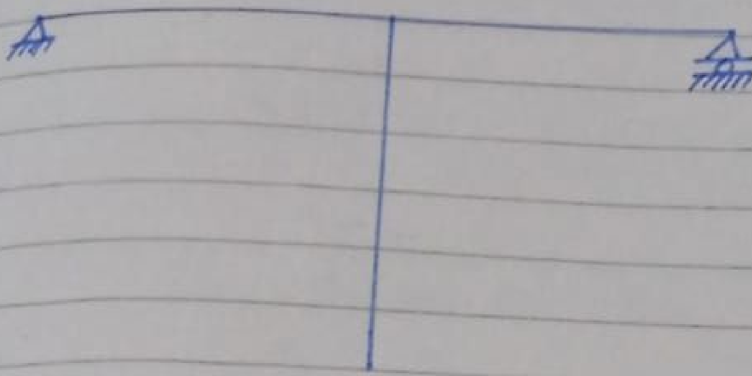
[ΔRL] and [F]

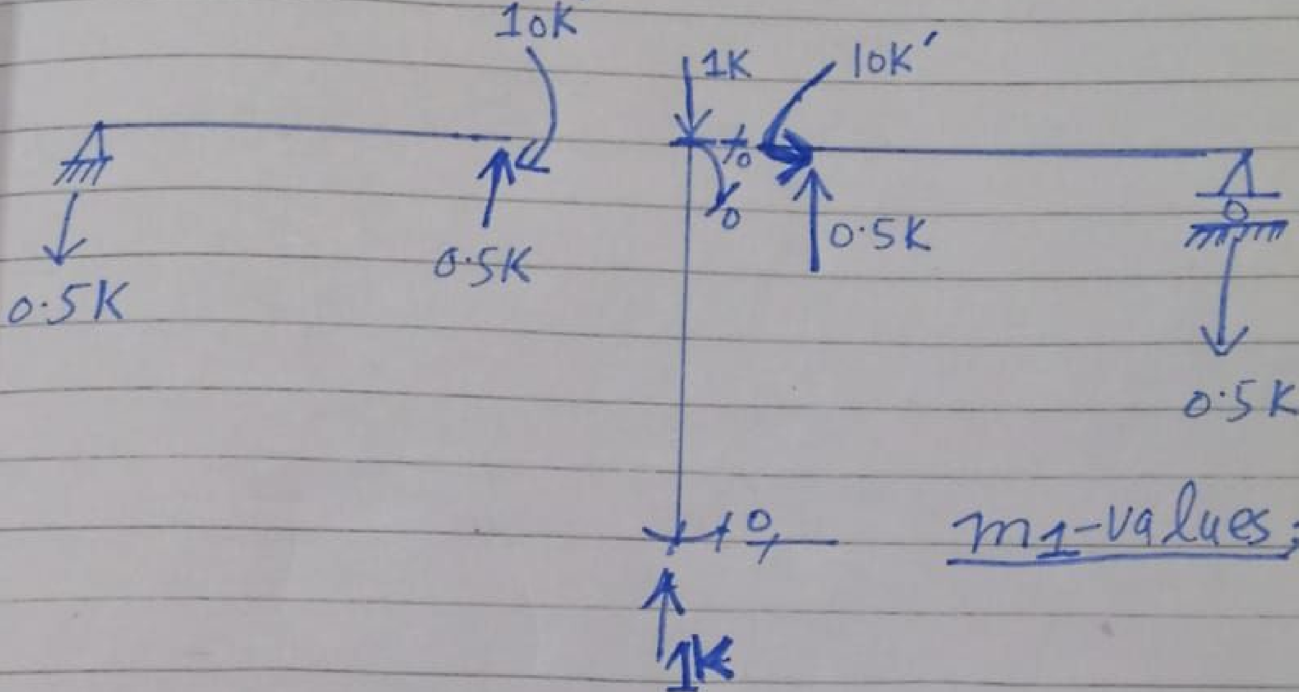




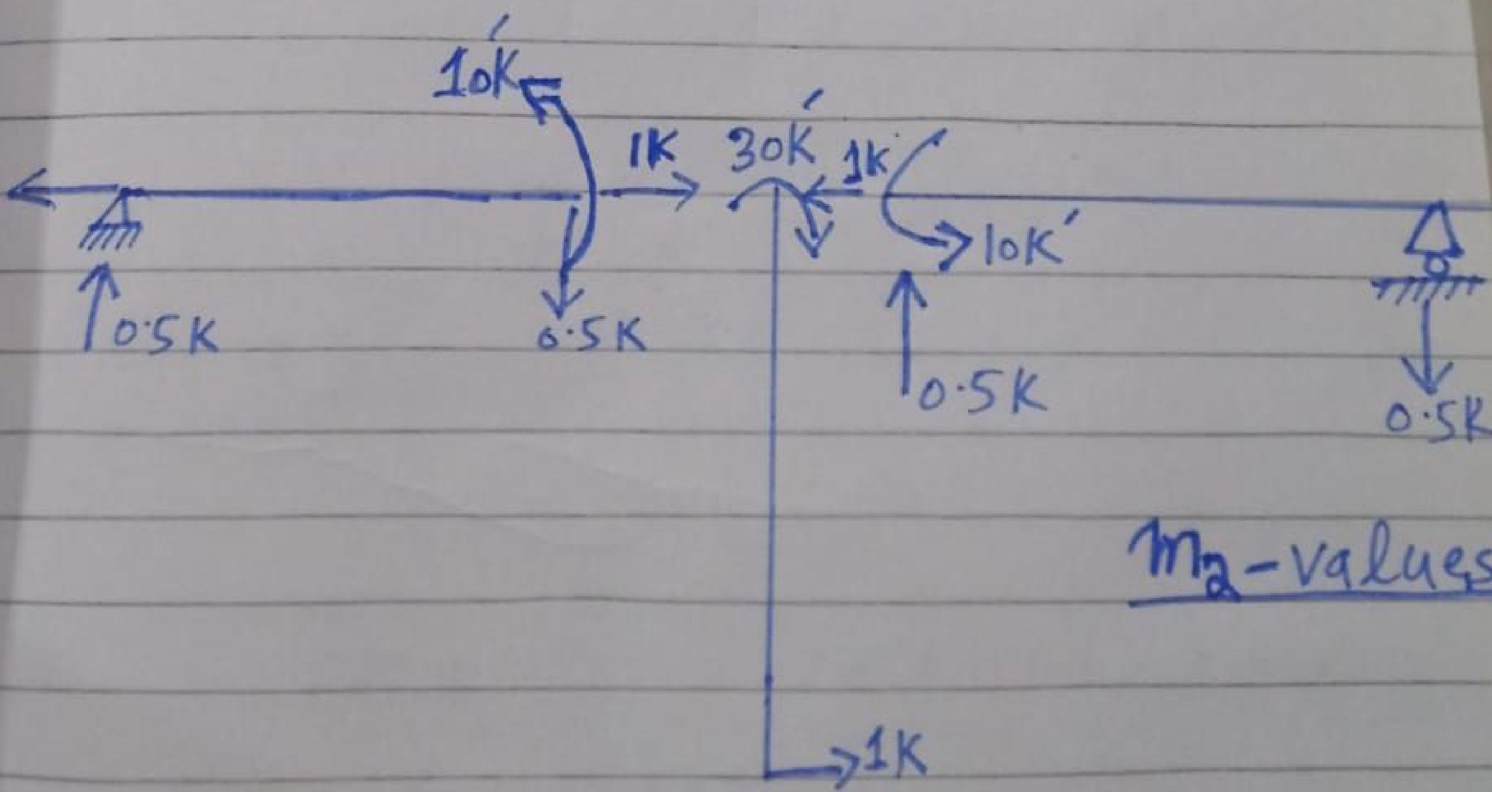


M-Values;





m1-values;



m2-values;

(4)

Member	AB		BC	BD
Origin	A	A	C	D
Limits	0→10	10→20	0 → 20	0 → 20
I	I	I	I	I
M	$15x$	$15x-20(x-10)$ $=-5x+200$	$5x$	0
m_1	$-0.5x$	$-0.5x$	$-0.5x$	0
m_2	$0.5x$	$0.5x$	$-0.5x$	x

$$\Delta RL_1 = \int_0^L \frac{M_i m_1 i}{EI} dx = \frac{1}{EI}\left[\int_0^{10} (15x)(-0.5x) + \int_{10}^{20} (-5x+200)(-0.5x) + \int_0^{20} (5x)(-0.5x) + 0\right]$$

$$= -18333.33 / EI$$

$$\Delta RL_2 = \sum_{i=1}^{m} \int_0^L \frac{M_i m_2 i}{EI} dx = 5000 / EI$$

$$= F_{11} = \sum_{i=1}^{m} \int_0^L \frac{m_1^2 i}{EI} dx = 1333.33 / EI$$

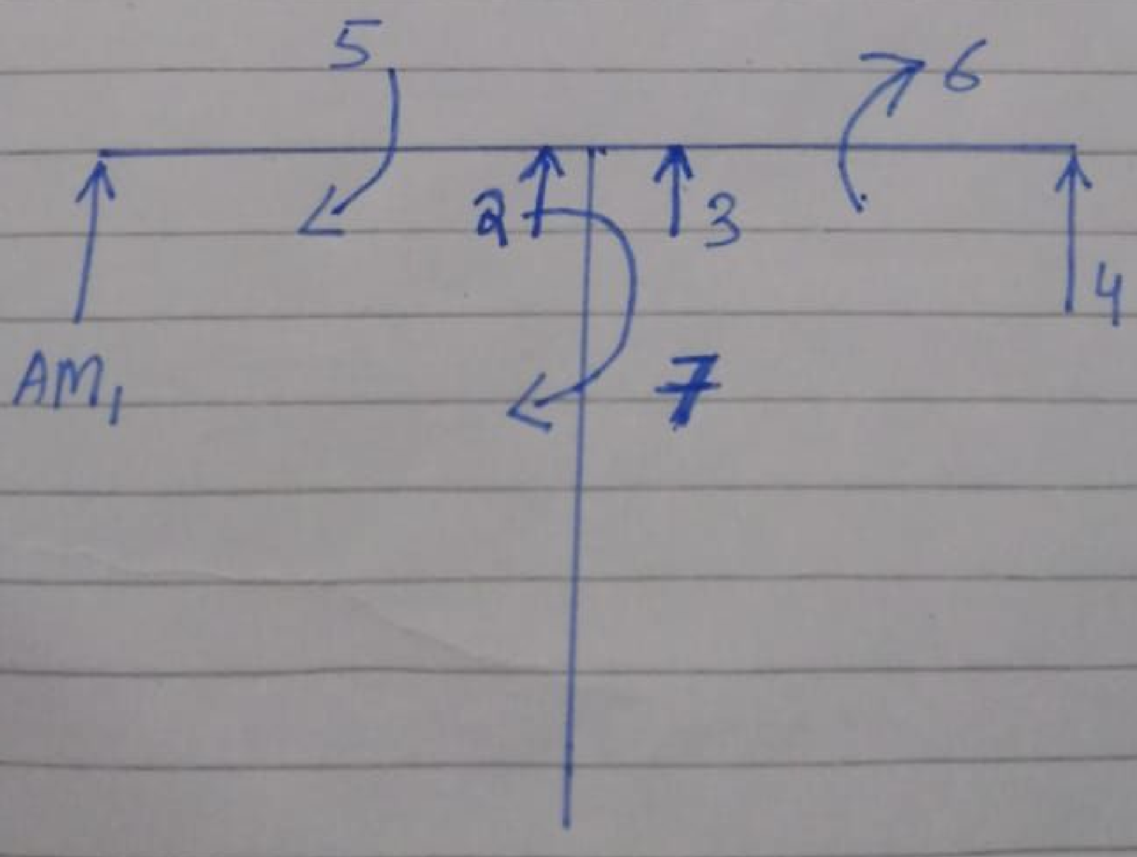
(5)

$$F_{22} = \sum_{i=1}^{m} \int_0^L \frac{m_2^2 i}{EI} dx = 4000/EI$$

$$F_{12} = F_{21} = \sum_{i=1}^{m} \int_0^L \frac{m_1 i + m_2 i}{EI} dx = 0$$

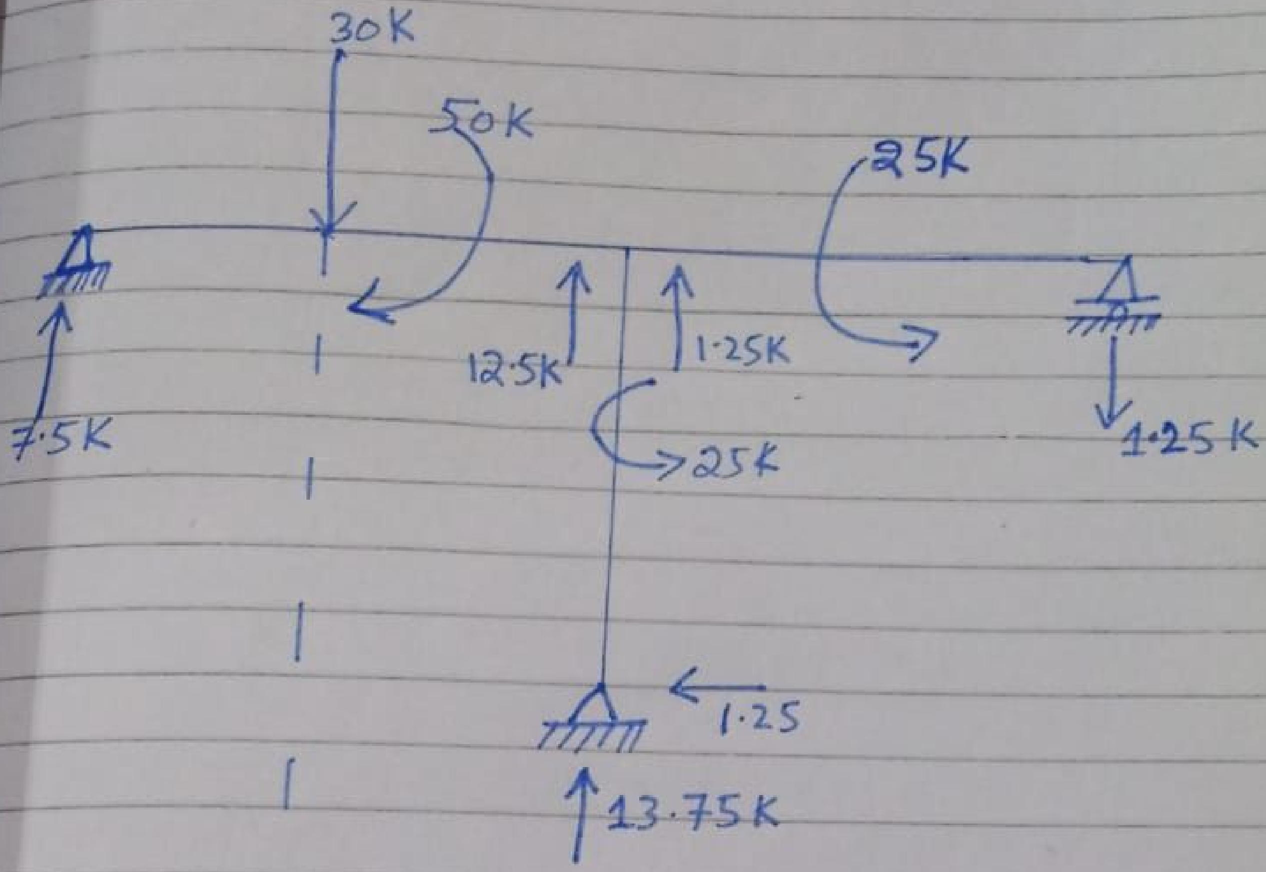
$$\begin{bmatrix} AR_1 \\ AR_2 \end{bmatrix} = \cancel{EI} \begin{bmatrix} 1333.33 & 0 \\ 0 & 4000 \end{bmatrix}^{-1} \times \begin{bmatrix} +18333.33 \\ -5000 \end{bmatrix} \frac{1}{\cancel{EI}}$$

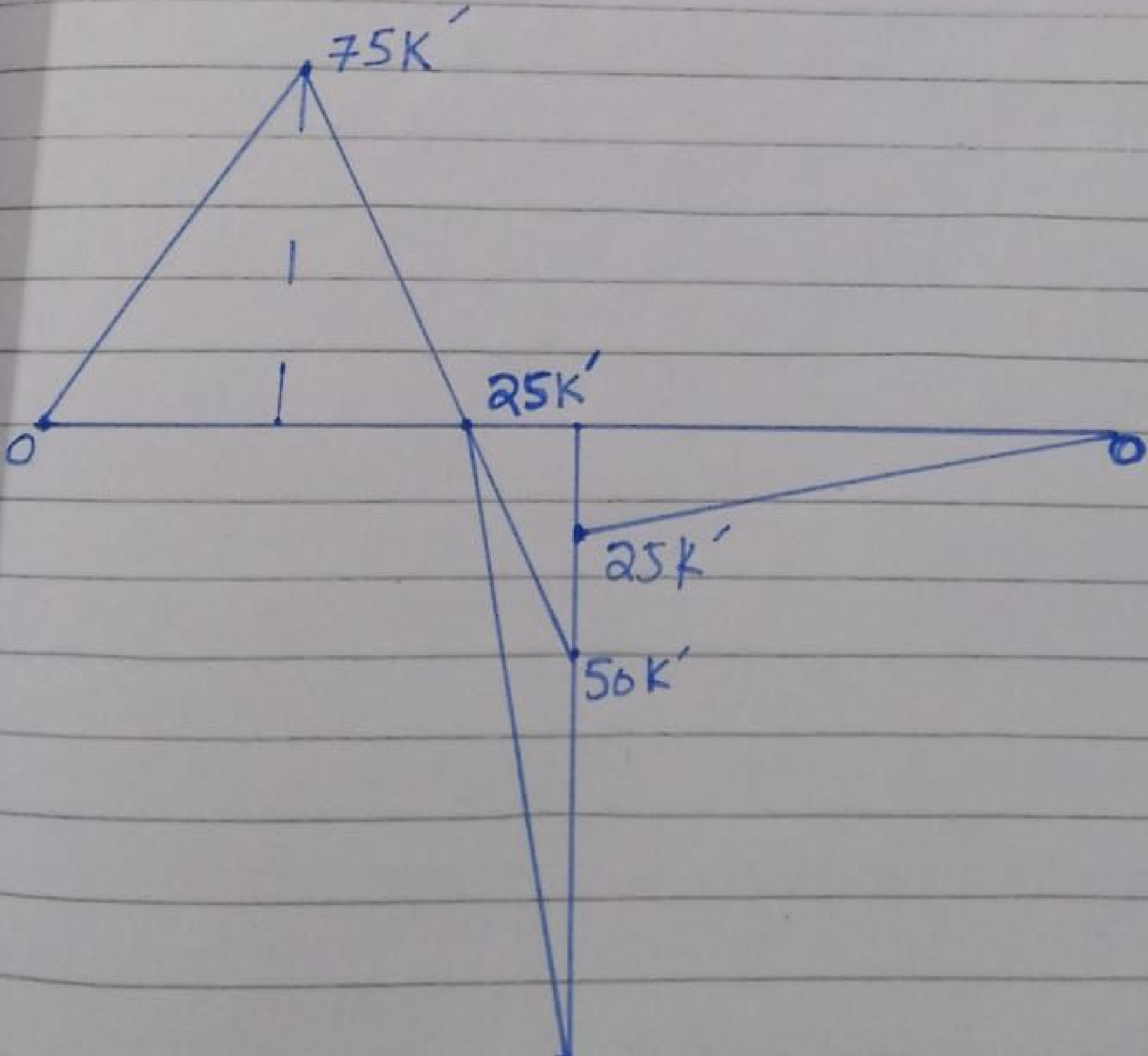
$$= \begin{bmatrix} 13.75k \\ +1.25k \end{bmatrix}$$



(6)

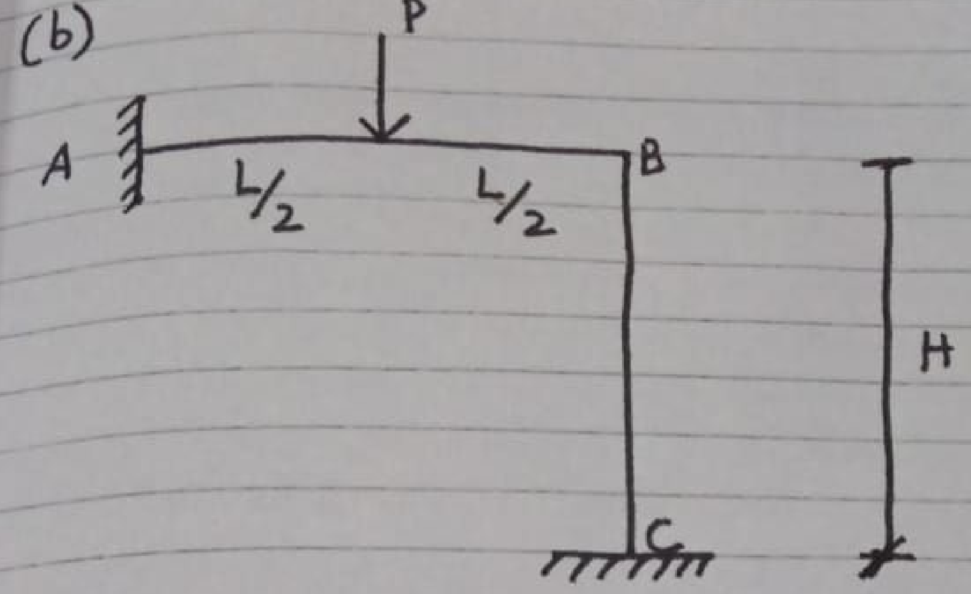
$$\begin{bmatrix} AM_1 \\ 2 \\ 3 \\ 4 \\ 5 \\ 6 \\ 7 \end{bmatrix} = \begin{bmatrix} 15 \\ 5 \\ -5 \\ 5 \\ -100 \\ 100 \\ 0 \end{bmatrix} + \begin{bmatrix} -0.5 & 0.5 \\ 0.5 & -0.5 \\ 0.5 & 0.5 \\ -0.5 & -0.5 \\ 10 & -10 \\ -10 & -10 \\ 0 & 20 \end{bmatrix} \times \begin{bmatrix} 13.75 \\ -1.25 \end{bmatrix} = \begin{bmatrix} 7.37K \\ 12.5K \\ 1.25K \\ -1.25K \\ 50K' \\ -25K' \\ -25K' \end{bmatrix}$$


30K
50K
25K
12.5K
1.25K
7.5K
25K
1.25K
1.25
13.75K

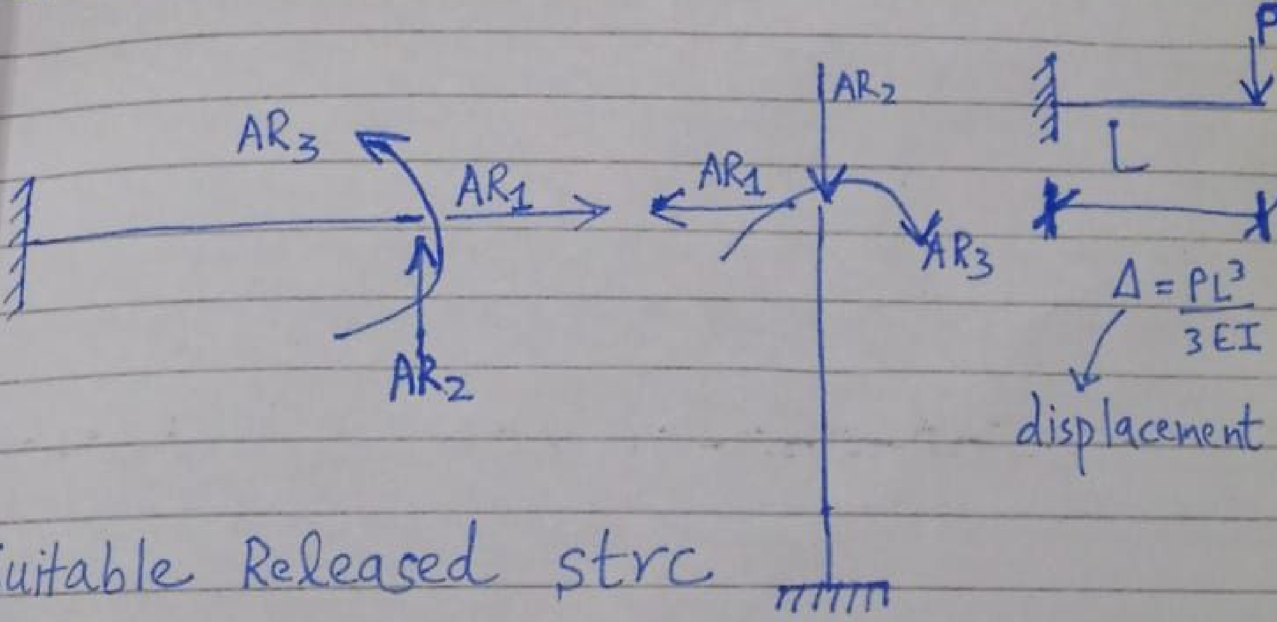

75K'
25K'
0
0
25K'
50K'

Q. No (02)

(b)

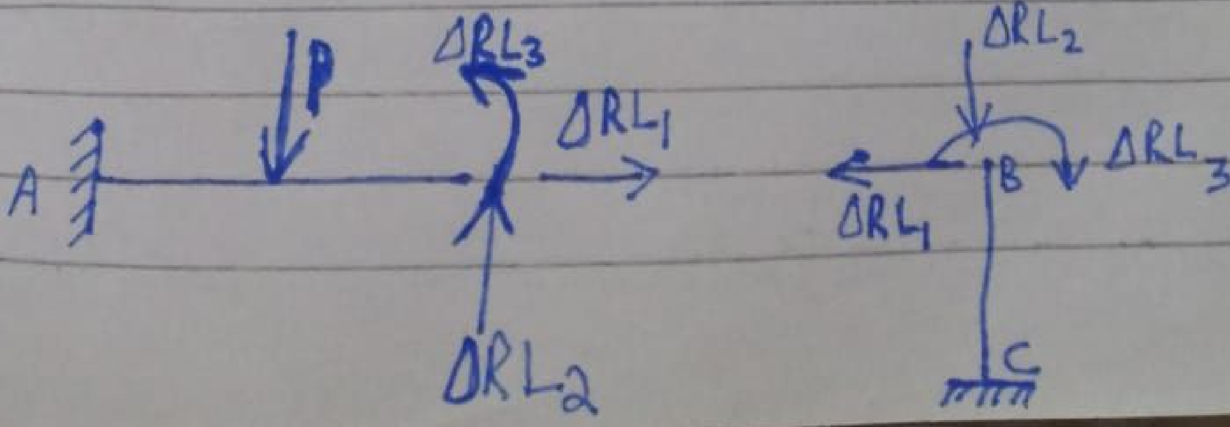


<u>Solution:</u>



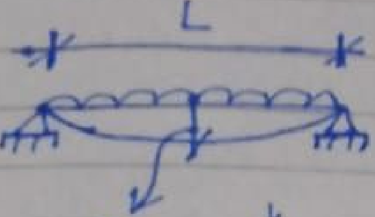
Suitable Released strc

Displacements in released strc. caused by the loads.

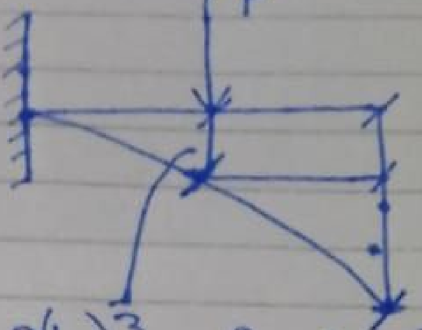


(9)

$\Delta RL_1)\ AB = 0$, $\Delta RL_2)\ AB = 5PL^3/48EI$



$\frac{5}{384}\frac{wL^4}{EI}$



$\frac{P\left(\frac{L}{2}\right)^3}{3EI}$ $\quad \theta = \frac{P\left(\frac{L}{2}\right)^2}{2EI}$

$\Delta = \Delta_1 + \Delta_2$

$= \frac{PL^3}{24EI} + \frac{PL^3}{16EI}$ $\qquad \frac{PL^3}{24EI} = \frac{PL^2}{8EI}$

$= \frac{PL^3}{EI}\left(\frac{2+3}{48}\right)$ $\qquad \Delta_2 = \frac{PL^2}{8EI} \times \frac{L}{2} = \frac{PL^3}{16EI}$

$= 5PL^3/48EI$

$\Delta RL_3)\ AB = -\frac{PL^2}{8EI}$

$\Delta RL_3)\ BC = \Delta RL_2)\ BC = \Delta RL_3)\ BC = 0$

b/c there is no load on BC

$\Delta RL_1 = 0 + 0 = 0$

$$\Delta RL_2 = \frac{-5PL^3}{48EI} + 0 = \frac{-5PL^3}{48EI}$$

$$\Delta RL_3 = \frac{-PL^2}{8EI} + 0 = \frac{-PL^2}{8EI} \qquad EI = 26458.33$$

$$[\Delta RL] = \begin{bmatrix} 0 \\ -5/48 \; PL^3/EI \\ -PL^2/8EI \end{bmatrix} \qquad \begin{matrix} -6400/EI - 0.242 \\ -480/EI - 0.018 \end{matrix}$$

Flexibility matrix:

a)- Apply $AR_1 = 1$ and obtain F_{11}, F_{21} & F_{31}

The displacement at end B at member AB

$$F_{11})\, AB = \frac{L}{EA} , \quad F_{21})\, AB = 0$$

$$F_{31})\, AB = 0$$

The displacement at end B at member BC

$$F_{11})\, BC = \frac{H^3}{3EI} , \quad F_{21})\, BC = 0$$

$$F_{31})\, BC = \frac{-H^2}{2EI}$$

(11)

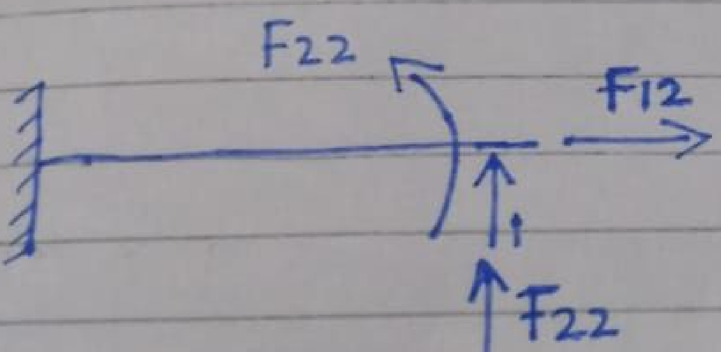
The Final value at the flexibility Co-efficients are:

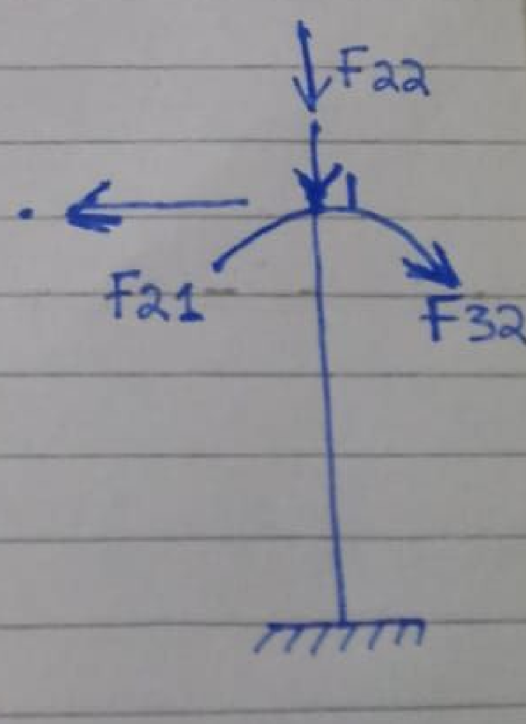
$$F_{11} = \frac{L}{EA} + \frac{H^3}{3EI} \qquad F_{21} = 0 + 0 = 0$$

$$F_{31} = 0 - H^2/_{2EI} = \frac{-H^2}{2EI}$$

$$[F] = \begin{bmatrix} \frac{L}{EA} + \frac{H^3}{3EI} & 0 & -H^2/_{2EI} \\ 0 & L^3/_{3EI} + H/_{EA} & L^2/_{2EI} \\ -H^2/_{2EI} & L^2/_{2EI} & L/_{EI} \ \frac{+H}{EI} \end{bmatrix}$$

Apply $AR_2 = 1$ and obtain F_{12}, F_{22}, F_{32}

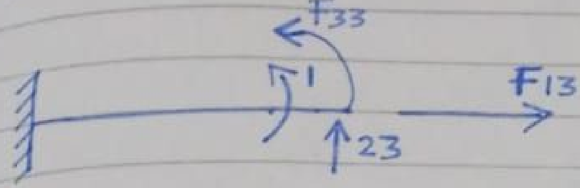


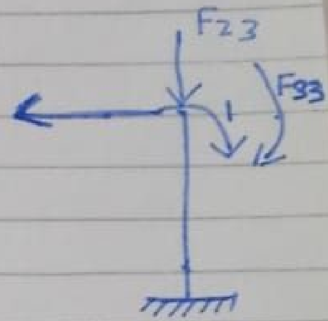


$$F_{12} = 0_1 + F_{22} = L^3/_{3EI} + \frac{H}{EA}$$

$$F_{32} = L^3/_{2EI}$$

c) $AR_3 = 1$





$F_{13} = -H^2/2EI$

$F_{23} = L^2/2EI$

$F_{33} = \frac{L}{EI} + \frac{H}{EI}$

$$\begin{bmatrix} \Delta R S_1 \\ 2 \\ 3 \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \\ 0 \end{bmatrix}$$

$$AR_1 = \frac{-3P}{32} \left[\frac{1 - 12r}{(1 + 3r)(1 + 12r)} \right]$$

$$AR_2 = \frac{13P}{32} \left[\frac{1 + 84r/13}{(1 + 3r)(1 + 12r)} \right]$$

where $r = \frac{1}{Al^2}$

$$AR_3 = \frac{-PL}{16} \left[\frac{1 - 12r}{1 + 12r} \right]$$

For typical plane frame the magnitude of "γ" is of the order 10^{-3}. So the factor $1-12\gamma$ .... etc are approx 1.0. If we ignore axial determination the values obtained are sufficiently accurate for most practical purposes.

If axial determination are ignored:

$$Q_1 = -3P/32 \qquad -2.50, 6.25, -16.76$$

$$Q_2 = 13P/32 \quad , \quad Q_3 = -PL/16$$

$$\begin{bmatrix} 0.0127 & 0 & -0.0019 \\ 0 & 0.0516 & 0.0048 \\ -0.0019 & 0.0048 & 0.0010 \end{bmatrix}$$

$$AR_1 = -2.50, \; AR_2 = 6.25, \; AR_3 = -16.76$$