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Subject = Structural Anylasis

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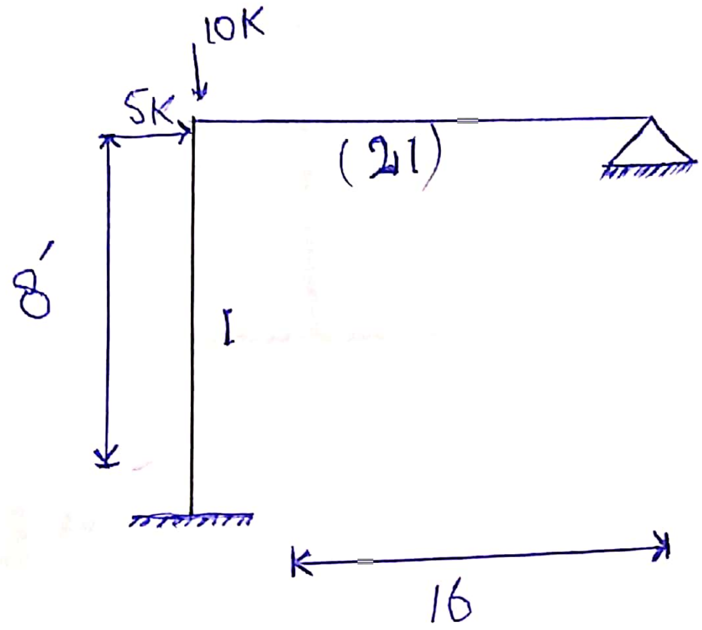
# Ans: 03




$EI =$ Constant

"flexibility Method"

**Sol**

1) "Degree of Static Indeterminacy"

$D_{si} = R - 3 = 5 - 3 = 2^{\circ}$

2) "flexure rigidity"

$EI =$ Constant

3) Redundant Actions;

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

$$\begin{bmatrix} DRS_1 \\ DRS_2 \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \end{bmatrix}$$

③

② **Step 2 :→** Compute value of [DRL] (2)

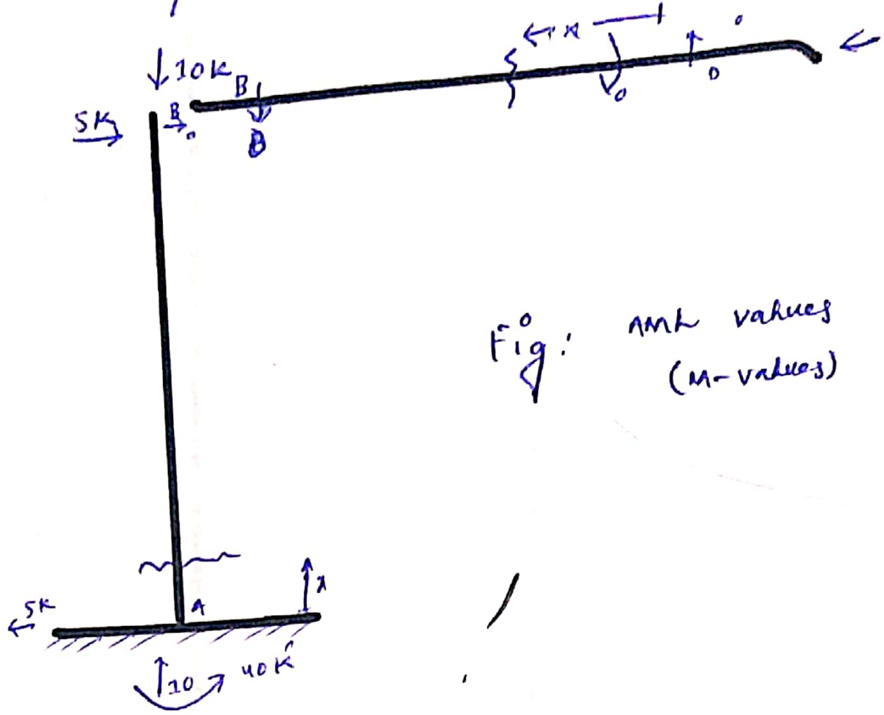



Fig: AML values (M-values)

**Step 3 :→** [F] or [AMR]

ⓐ

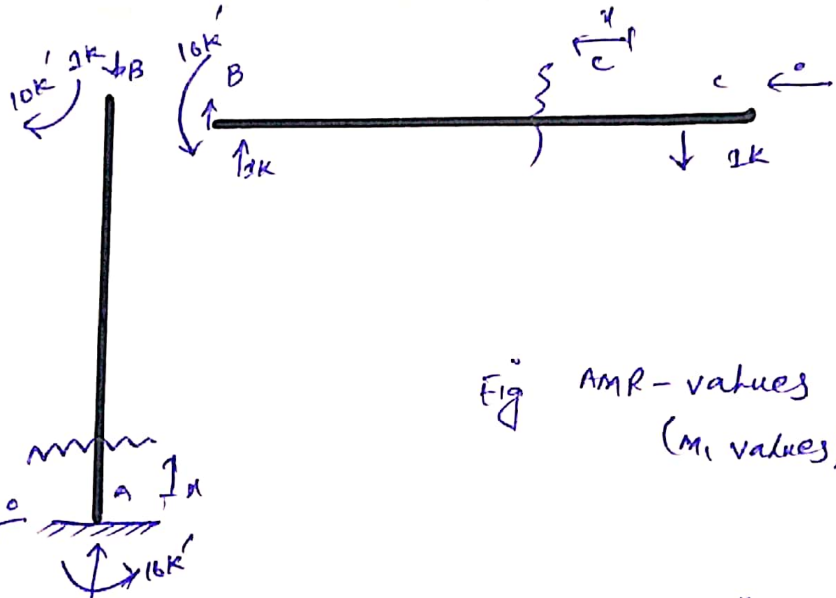



Fig AMR-values (M₁ values).

ⓑ

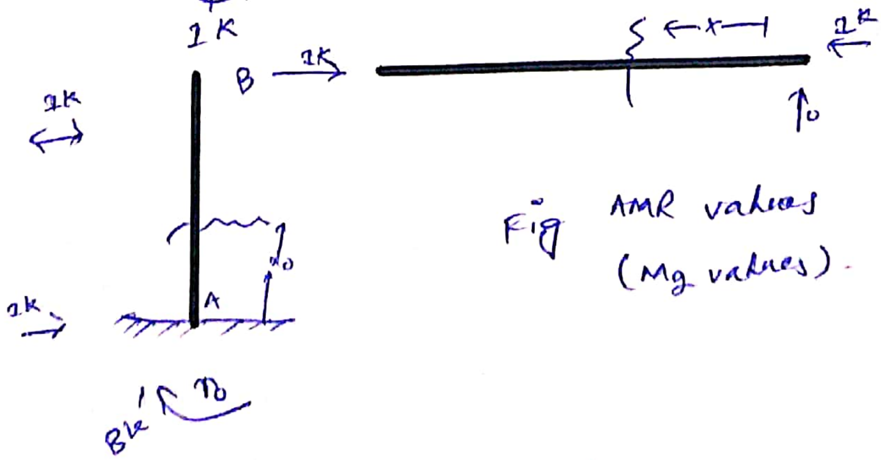



Fig AMR values (Mg values).

Scanned with CamScanner

| Member | AB | BC |
| --- | --- | --- |
| Origin | A | C |
| Limits | 0, B | 0–16 |
| I | I | 2I |
| M | $5x-40$ | 0 |
| $m_1$ | $-16$ | $x$ |
| $m_2$ | $8-x$ | 0 |

select origin (should be select the support)

Take x-section and Fig and & Find moment

Take x section on $m_1$ Fig from the origin.

⇒ **FOR Finding value of DRL :→**

$$DRL_1 = \int_0^B \frac{M_{AB} \cdot M_1 (AB)}{E_I} + \int_0^{16} \frac{M_{BC} \cdot M_1 (BC)}{E_2}$$

$$= \int_0^B \frac{(5x-40)(-16)\,dx}{E_I} + \int_0^{16} \frac{0 \cdot x}{E(2I)}\,dx$$

$$\boxed{DRL_1 = \frac{2560}{EI}}$$

$$DRL_2 = \int_0^B \frac{(5x-40)(8-x)\,dx}{EI} + \int_0^{16} \frac{0 \cdot 0}{E(2I)}\,dx.$$

$$\boxed{DRL_2 = \frac{-853.33}{EI}}$$

⇒ Compute the following.

$$F_{2\times 2} = \begin{bmatrix} F_{11} & F_{12} \\ F_{21} & F_{22} \end{bmatrix}$$

(7)

(4) $\Rightarrow$ $F_{11} = \int_0^8 \frac{m_1^2(AB)}{E_1} + \int_0^{16} \frac{m_2^2(BC)}{EI} = \int_0^8 \frac{(-16)^2 dx}{EI} + \int_0^{16} \frac{x^2}{E_2}$

$$\boxed{F_{11} = \frac{2730.67}{EI}}$$

$\Rightarrow$ $F_{12} = F_{21} = \int_0^8 m_1(AB) \cdot m_2(AB) + \int_0^{16} \frac{m_1(BC)}{EI}$

$= \int_0^8 \frac{(-16)^2(8-x)}{EI} dx + \int_0^{16} \frac{(x)^3(0)}{2 E(I)}$

$$\boxed{F_{12} = F_{21} = \frac{-512}{B}}$$

$F_{22} = \int_0^8 (m_2)^2_{AB} dx + \int_0^{16} (m_2)^2_{BC} dx$

$= \int_0^8 \frac{(8-x)^2}{EI} dx + \int_0^{16} \frac{0^2}{2E_1} dx$

$$\boxed{F_{22} = 170.67}$$

As we know

$[DRS] = [DRL] + [AR] \times [F]$

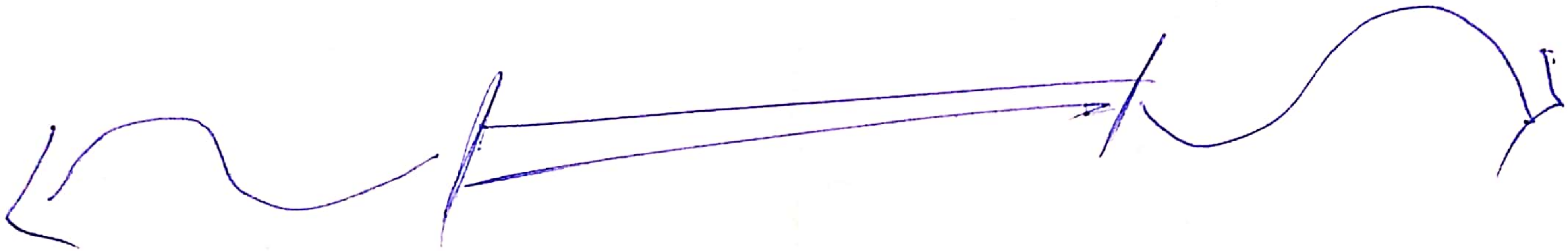
$\Rightarrow [AR] = \frac{[DRS] - [DRL]}{[F]}$

$\Rightarrow [AR] = [F]^{-1} \times [DRS] - [DRL]$

(5)

$$= \begin{bmatrix} 2730.67 & -512 \\ -512 & 170.67 \end{bmatrix}^{-1} \times \begin{bmatrix} 0 - 2560 \\ 0 + 853.53 \end{bmatrix}$$

$$\begin{bmatrix} AR_1 \\ AR_2 \end{bmatrix} = \begin{bmatrix} -0.00005 \\ 4.997 \end{bmatrix} = \begin{bmatrix} 0 \\ 5 \end{bmatrix}$$



(1)

Q#2:

Ans:

| Force Method | Displacement Method |
| --- | --- |
| * $D_s < D_k$ | * $D_s > D_k$ |
| * Forces are redundant or unknowns | * Assumed Displacement as unknown |
| * Prefirable when structure has less static Indeterminate | * Porfirable when structure have less kinematics Indetorminty |
| * starts with equillbrium of forces | * starts with compatible Deformation. |
| No of redudunts = DS | * No of redudants = $D_k$ |
| * Knowns flexibility * method e.g consistent * Method of detormation | Known as stifness method e.g: Slope displacement method |
| Forces found by compabillity eqs of displacement | * Displacement found by equillbrium of forces. |

"PART 2" (2)

(i) Force Method

(ii) Displacement Method

SUITABLE

①: In force method, we assume forces and moments as unknown and solve for them Then we calculate displacement and rotations from forces and moments.

This is better than displacement method if and only if static Indeterminacy is less than kin-matic indeterminacy.

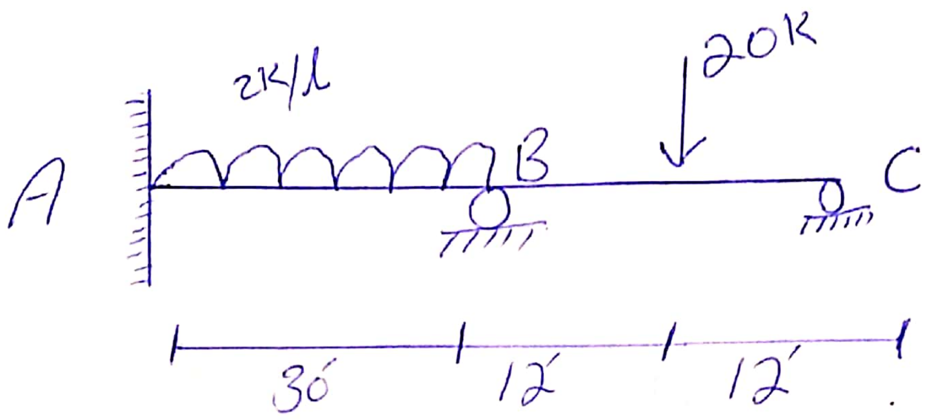
②: stifness method also called displacement method is more suitable for structure analysis, matrix approach, The main advantage of this method over flexibility method is that it is conductive to computer programing. once the analytical model of the structure has been defined, NO further engineering decisions are required to carry out analysis.

(1)

(1)

"Q# 01,,

"Ans:, Given Beam,,




$EI = \text{constant}$

"Flexibility method:.

Sol:- (1) "Degree of static indeterminacy;

$$Dsi = R-3 = 5-3 \boxed{= 2}$$

(2) "Flexure rigidity;

$$EI = \text{Constant}$$

(3),

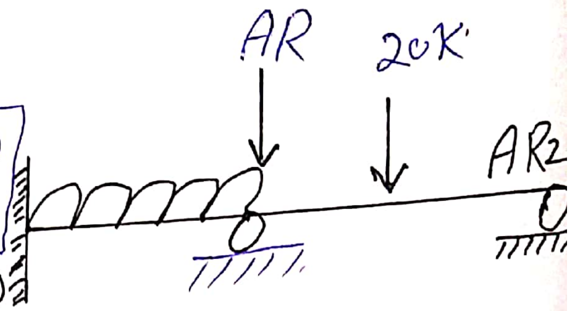
(2)

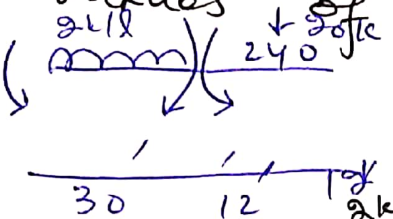
(3); Redundant Actions;

$$\begin{bmatrix} DRS_1 \\ DRS_2 \end{bmatrix} = \begin{bmatrix} ? \\ ? \end{bmatrix}, \begin{bmatrix} AR_1 \\ AR_2 \end{bmatrix} = \begin{bmatrix} ? \\ ? \end{bmatrix}$$

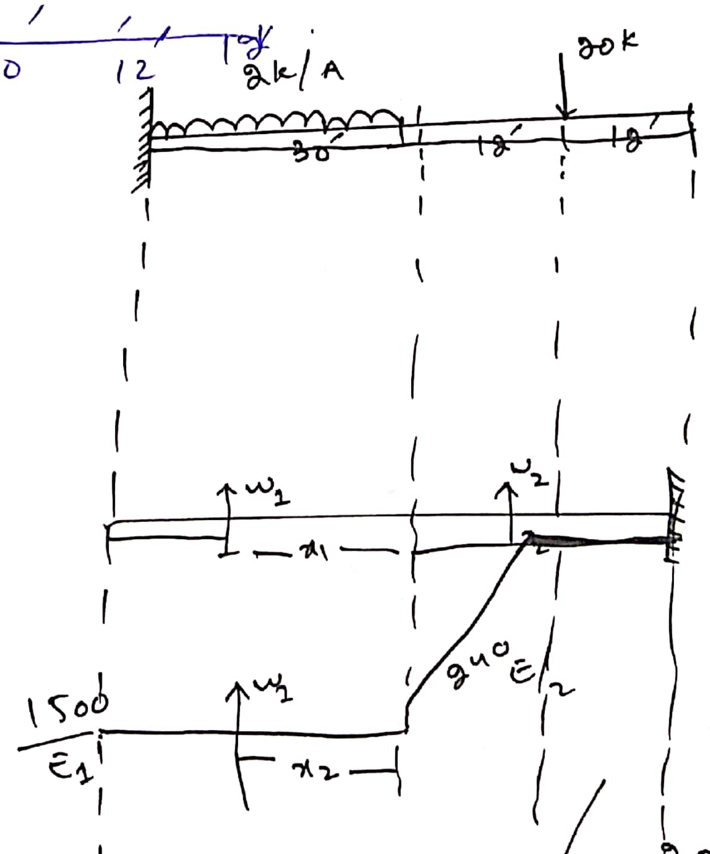
$$[DRS] = [DRL] + [F][AR]$$

(compute values of DRL)




STEP 4:




$w_1 = 1500 \times 30 = 45000$

$w_2 = \frac{1}{2} \times 30 \times 240 = 2400$

$w_3 = \frac{1}{2} \times 12 \times 240 = 1440$

$20 \times 2 = 240$

$20(12 \times 30) + 2 \times 30 \times 15$

$= 1740$

(3)

# (3)

Now = $x_1 = b/2 = 30/2 = 15'$

$x_2 = \frac{3}{n+2} \times L = \frac{3}{2+2} \times 30 = 22.5'$

$x_3 = 2/3 \times L = 2/3 \times 12 = 8'$

Now DRL = ?

$DRL_1 = W_1 (x_1) + W_2 (x_2)$

$= 45000 (15) + 2400 (22.5)$

$= 675000 + 54000$

$= 729000$

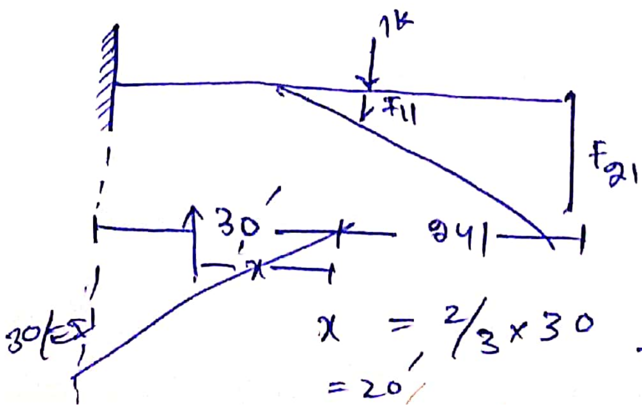
So,

$$DRL = \frac{1}{EI} \begin{bmatrix} 729000 \\ 1895400 \end{bmatrix}$$

Step 3: Flexibility Matrix

$$[F]_{2\times2} = \begin{bmatrix} F_{11} & F_{12} \\ F_{21} & F_{22} \end{bmatrix}$$

a) Applying Unit Load on $AR_1$



$w = 1/2 \left(\frac{30}{EI} \times 30\right) = 450/EI$

$x = 2/3 \times 30 = 20'$

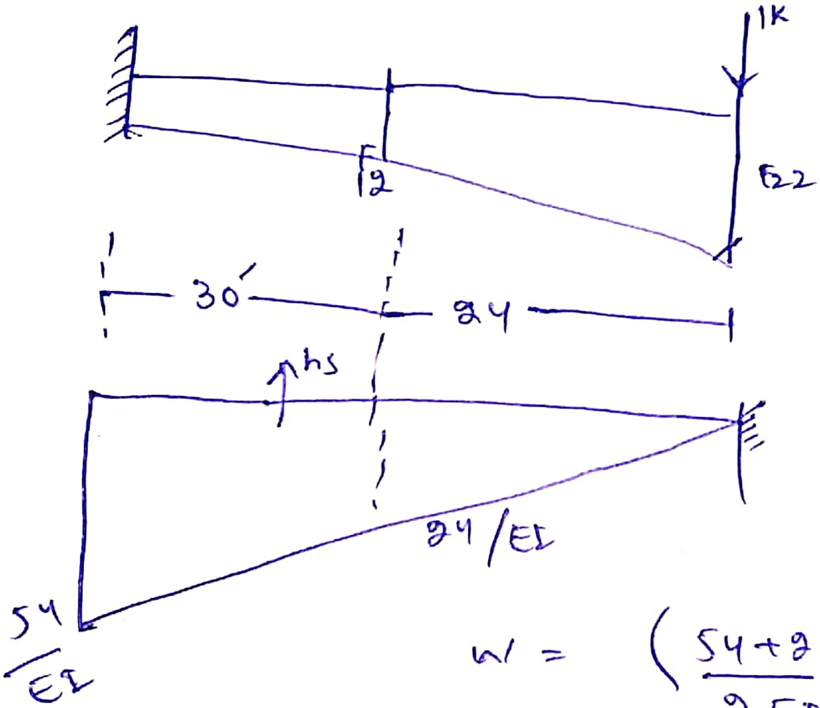
(4)

(4)

$$F_{11} = \frac{450}{EI}(20) = 9000/EI$$

$$F_{21} = \frac{450}{EI}(20+24) = 19800/EI$$

Now Apply Unit load on $Al_2$




$$w = \left(\frac{54+24}{2EI}\right) \times 30$$

$$= 1170/EI$$

(5)

$$x = \frac{L}{3}\left[\frac{b+2(a)}{a+b}\right]$$

$$= \frac{30}{3}\left[\frac{24+2(54)}{54+24}\right] \doteq 16.92$$

$$\Rightarrow \quad F_{12} = \frac{1170}{EI} \times 16.92 = \frac{19796.4}{EI}$$

$$\Rightarrow \quad F_{22} = \frac{1170}{EI} \times (16.92 + 24)$$

$$= \frac{47876.4}{EI}$$

Hence

$$F_{2\times 2} \begin{bmatrix} 9000 & 19796.4 \\ 198000 & 47876.4 \end{bmatrix} \frac{1}{EI}$$

(Step 4): compute the values of AR

$$[DRS] = [DRL] + [F] \times [AR]$$

$$[AR] = [DRS - DRL] \times [F]^{-1}$$

$$[F]^{-1} = \frac{1}{|F|} \times Adj\ F$$

$$= \frac{1}{\begin{vmatrix} 9000 & 19796.4 \\ 198000 & 47876.4 \end{vmatrix}} \times Adj \begin{bmatrix} 9000 & 1979\,6.4 \\ 198000 & 478\,6.4 \end{bmatrix}$$

(6)

8

$$|F| = (9000 \times 47876.4 - 19796.4 \times 198000)$$

$$(430887600 - 391968720)$$

$$|F| = 38918880$$

$$\Rightarrow \quad Adj\ A = \begin{bmatrix} 47876.4 & -19796.4 \\ -198000 & 9000 \end{bmatrix}$$

$$\begin{bmatrix} AR1 \\ AR2 \end{bmatrix} = \begin{bmatrix} 0 - 729000 \\ 0 - 1895400 \end{bmatrix} \frac{1}{EI} \times \frac{1}{38918880} \begin{bmatrix} 47876.4 & -19796.4 \\ -198000 & 9000 \end{bmatrix}$$

$$= \begin{bmatrix} -729000 \\ -1895400 \end{bmatrix} \frac{1}{EI} \times \frac{\begin{bmatrix} 47876.4 & -19796.4 \\ -19800 & 9000 \end{bmatrix}}{38918880}$$

$$\begin{bmatrix} AR1 \\ AR2 \end{bmatrix} = \begin{bmatrix} 66.193 \\ -67.505 \end{bmatrix}$$