Day. M T W T F S   Date: __/__/__

Subject : Structure II

Instructor : Engr Adeed Khan

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ID #7759

Summer : semister.

Date : 21/8/2020

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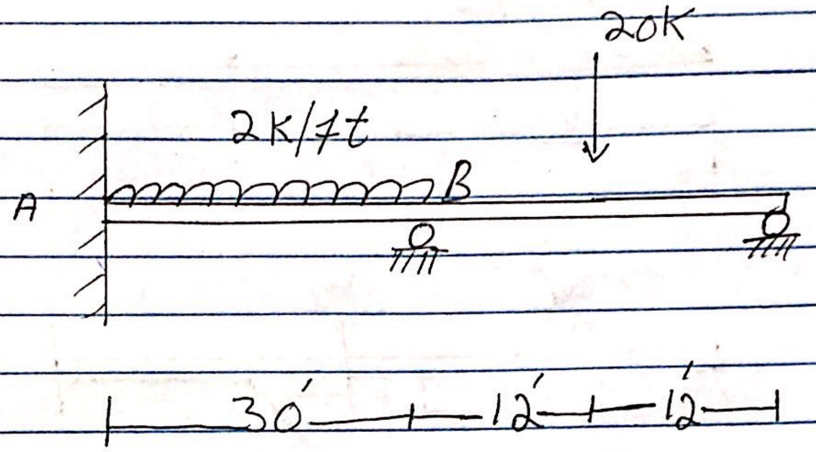
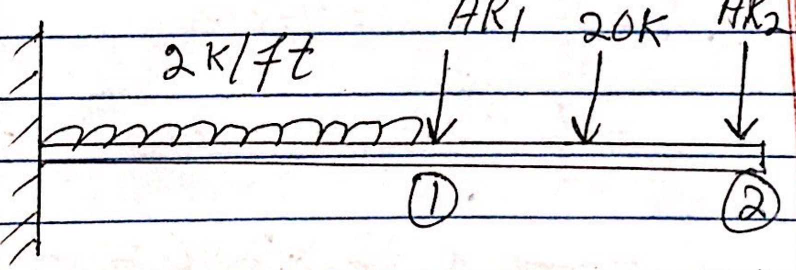
Question NO. (01)



Solution:

Structural Indeterminacy = 2°

Step # 01: Select Redundant Actions



$$\begin{bmatrix} DRS_1 \\ DRS_2 \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \end{bmatrix}, \quad \begin{bmatrix} AR_1 \\ AR_2 \end{bmatrix} = \begin{bmatrix} ? \\ ? \end{bmatrix}$$

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

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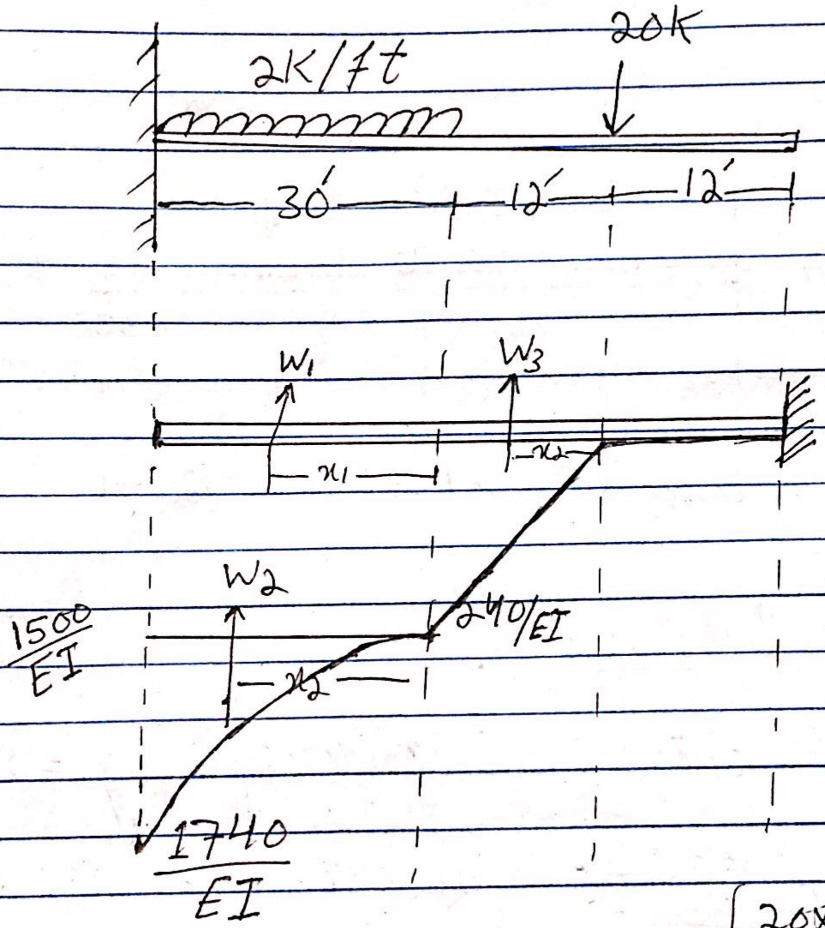
Step #2 compute the value of [DRL]



$W_1 = 1500 \times 30 = 45000$

$W_2 = \frac{1}{3} \times 30 \times 240 = 2400$

$W_3 = \frac{1}{2} \times 12 \times 240 = 1440$

$20 \times 12 = 240$

$20 \times (12 + 30) + 2 \times 30 \times 15 = 1740$

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

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

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

Now finding DRL :-

$DRL_2 = W_1 \times (x_1 + 24) + W_2 \times (x_2 + 24)$
$+ W_3 \times (x_3 + 12)$

$= 45000\,(15+24) + 2400\,(22.5+24)$
$+ 1440\,(8+12)$

$= 1755000 + 111600 + 28800$

$DRL_2 = 1895400/EI$

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

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

$= 675000 + 54000$

$= 729000$

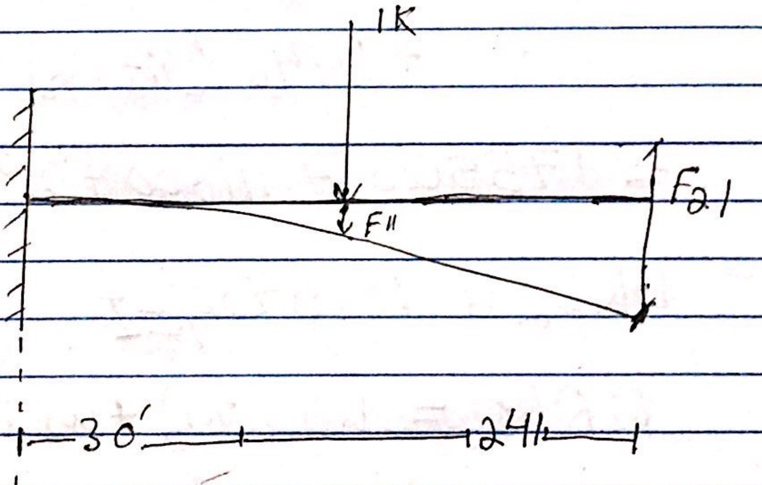
So,

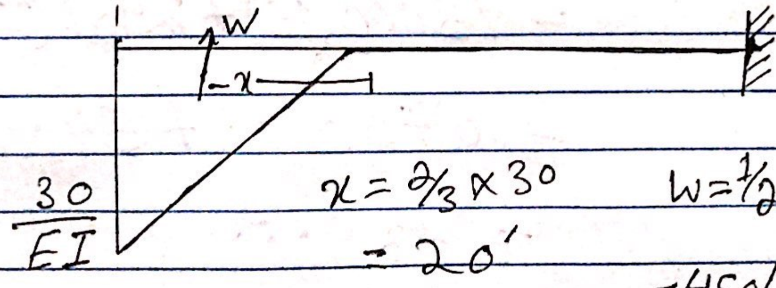
$$DRL = \frac{1}{EI}\begin{bmatrix} 729000 \\ 1895400 \end{bmatrix}$$

Step #03: Flexibility matrix

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

a) Applying Unit Load on AR1





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

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

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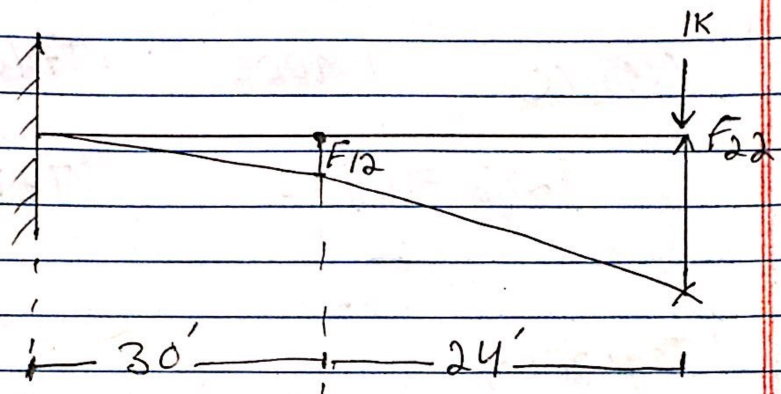
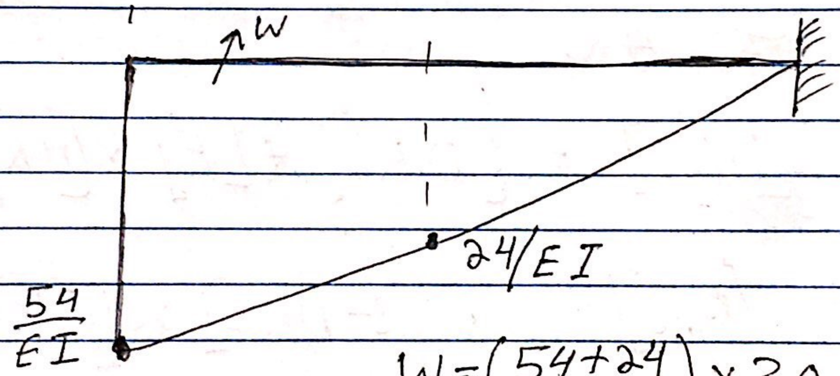
So,

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

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

Now Apply unit load on R_2:





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

$$= 1170/EI$$

Now the distance

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

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

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

$$\Rightarrow F_{22} = \frac{1170}{EI} \times (16.92+24) = \frac{47876.4}{EI}$$

Hence

$$F_{2\times2} = \begin{bmatrix} 9000 & 19796.4 \\ 19800 & 47876.4 \end{bmatrix} \frac{1}{EI}$$

Step #04 Compute the value of AR.

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

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

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

$$= \frac{1}{\begin{vmatrix} 9000 & 19796.4 \\ 19800 & 47876.4 \end{vmatrix}} \times Adj \begin{bmatrix} 9000 & 19796.4 \\ 19800 & 47876.4 \end{bmatrix}$$

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$= |F| = (9000 \times 47876.4 - 19796.4 \times 19800)$

$(430887600 - 391968720)$

$\Rightarrow |F| \; 38918880$

$$\Rightarrow Adj\ F = \begin{bmatrix} 47876.4 & -19796.4 \\ -19800 & 9000 \end{bmatrix}$$

$$= \begin{bmatrix} AR_1 \\ AR_2 \end{bmatrix} = \begin{bmatrix} 0 - 729000 \\ 0 - 1895400 \end{bmatrix} \frac{1}{ET} \times \frac{1}{38918880} \begin{bmatrix} 47876.4 & -19796.4 \\ -19800 & 9000 \end{bmatrix}$$

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

$$\begin{bmatrix} AR_1 \\ AR_2 \end{bmatrix} = \begin{bmatrix} 66.193 \\ -67.505 \end{bmatrix}$$

Answer

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Question No (02)

Differentiate between Forced method and displacement method.

FORCE METHOD	DISPLACEMENT METHOD
→ Ds < DK	Ds > DK
→ Forces are Redundent or unknowns	Displacements are redundent or unknowns.
→ Starts with equilibrium of Forces.	Starts with compatible deformations.
→ Force found by compatibility eqns of displacements	Displacements found by equilibrium eqns of forces.
→ No. of redundants = Ds	No. of redundants = DK
→ Not suitable for compute.	Not suitable for trusses.

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Q No (02): Suggest which method is more suitable For Structure analysis of matrix approach.

Answer: Stiffness method which is also called Displacement method is more suitable for structure analysis matrix approach, as it is a primary method used in matrix analysis. The main advantage of this method over Flexibility method is that is conductive to computer programming. once the analytical model of the structure has been defined. No further engineering decision are required in Stiffness method in order to carry out analysis.

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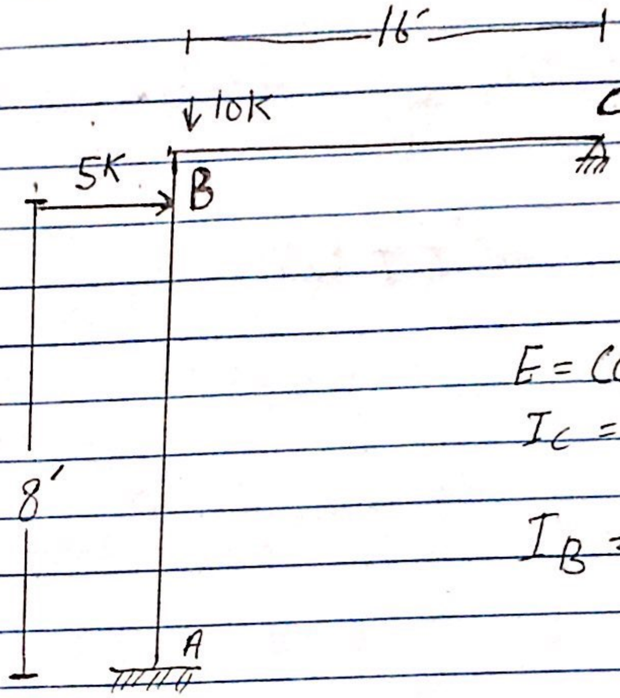
Question No # (03)



$E = \text{constant}$

$I_C = I$

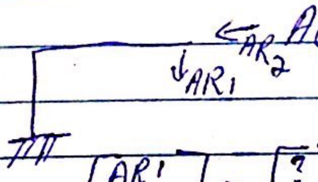
$I_B = 2I$

Solution:

Total statical indeterminacy

$\Rightarrow R - 3 = 5 - 3 = 2^\circ$

Step # 01: Identify Redundant Actions.



$$\begin{bmatrix} AR_1 \\ AR_2 \end{bmatrix} = \begin{bmatrix} ? \\ ? \end{bmatrix} \qquad \begin{bmatrix} DRS_1 \\ DRS_2 \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \end{bmatrix}$$

Step # 2:

compute value of [DRL]

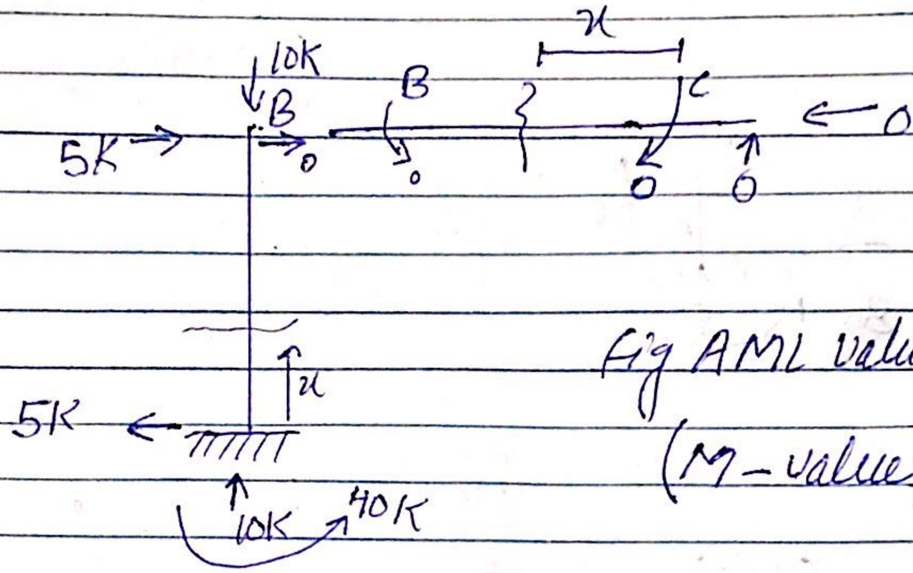


Fig AML values (M-values)

---x---

Step # 03

[F] or [AMr]

(a)

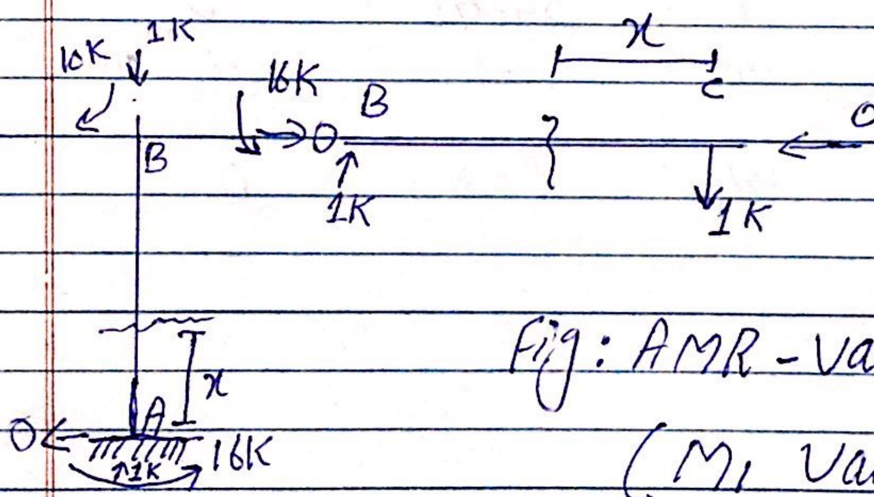


Fig: AMR-values (M_1 value)

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b)

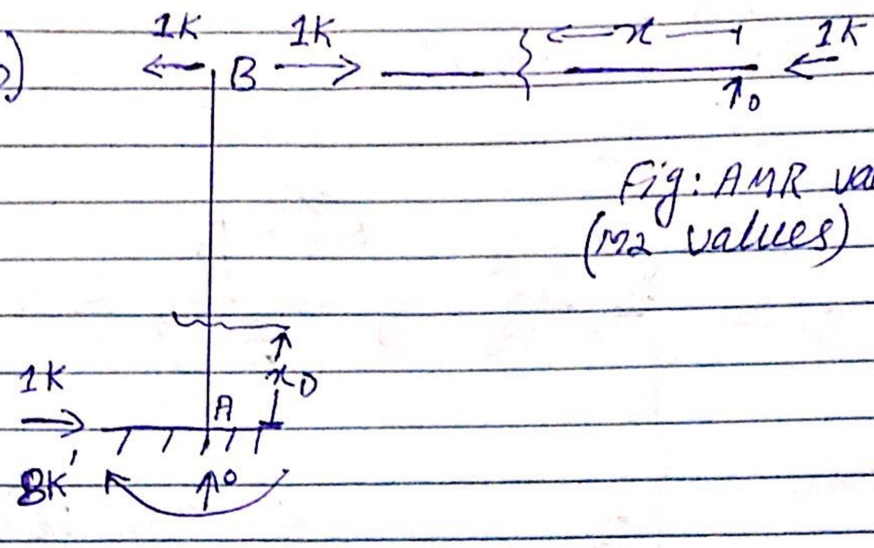

Fig: AMR values (m2 values)

Member	AB	BC
Origin	A	C
Limits	0-8	0-16
I	I	2I
M	$5x-40$	0
m1	-16	$x \rightarrow$ Take x section on M2 fig
m_2	$8-x$	0

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For finding values of DRL:

$$DRL_1 = \int_0^8 \frac{M_{AB} \cdot M_1(AB)}{EI} + \int_0^{16} \frac{M_{BC} \cdot M_2(BC)}{EI}$$

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

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

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

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

⇒ Compute Flexibility Matrix:

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

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

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

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

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

$$F_{12} = F_{21} = \frac{-512}{EI}$$

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

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

$$F_{22} = 170.67$$

As we know that

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

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

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

$$= \begin{bmatrix} 2730.67 & -512 \\ -512 & 170.67 \end{bmatrix}^{-1} \times \begin{bmatrix} 0 - 2560 \\ 0 + 853.33 \end{bmatrix}$$

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