14.6.26 (Sunday)

Ref Book: Structural analysis (Aslam Kassimal)

EWCE-411 (Lec Zihad). (Pre year ques. আসে)

Syllabus:

① Direct stiffness method

② Moment distribution

③ IL for indeterminate structures → Noor Sir

DoSI & DoKI:

~~Diff~~

Degree of static indeterminacy

→ External static indeterminacy

→ Internal

Degree of Kinematic indeterminacy.

2° indeterminacy → If we can solve other eq. এখান যে 2 টা eq আসি solve পাবি → ~~Redundant~~ Redundant

DoSI :

$I_s = I_{se} + I_{sI}$ (External, Internal)

DoSI = Num of external ① = (External reaction − 3) + (3m − 3J + 3 − R_{rc}) ②

(num of member, num of joint)

R = External reaction

R_{rc} = Released reaction

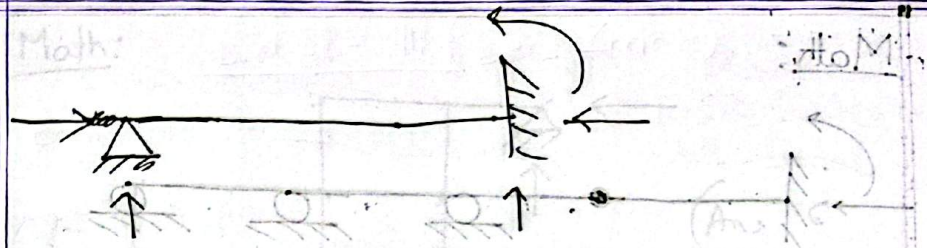
$= (R - 3) + (3m - 3J + 3 + R_{rc})$

$\Rightarrow I_s = (R + 3m) - (3J + R_{rc})$ [For 2D] → Beam, Frame

* Reaction থাকার সময় যতটি joint বাড়বে...

* Hinge support এ moment 0 move করতে পারে।
∴ moment = 0 → $R_{rc} = 1$

* Roller support → $R_{rc} = 2$



$I_s = (R + 3m) - (3J + R_{rc})$

$= (5 + 3\times1) - (3\times2 + 10) = 2$

For 3D structure,

$I_s = (R + 6m) - (6J + R_{rc})$

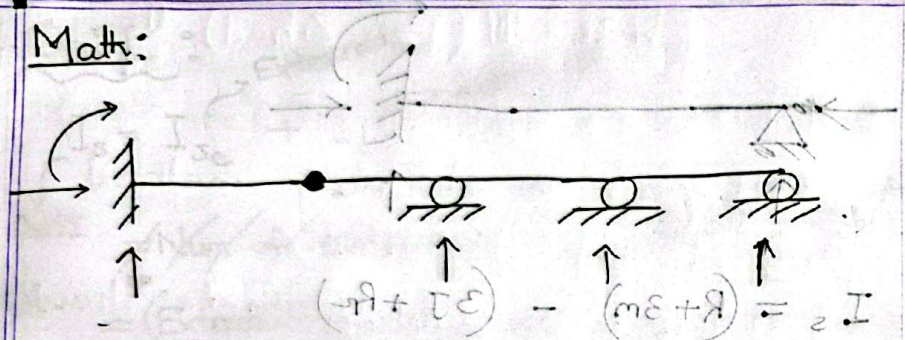
Truss = $m + R - 2J$

DoSI = 0 → [Stable, determinate]

> 0 → [" , Indeterminate]

< 0 → [Unstable, Determinate]

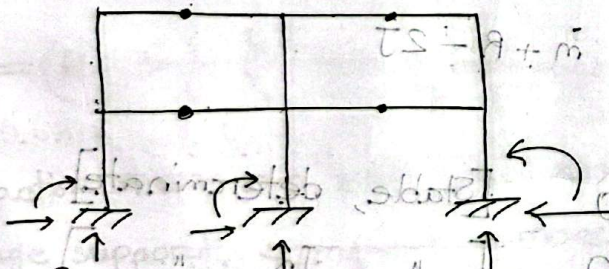
Math:



$I_s = (6 + 3\times 9) - (3\times 5 + 1)$

$= 2^\circ$

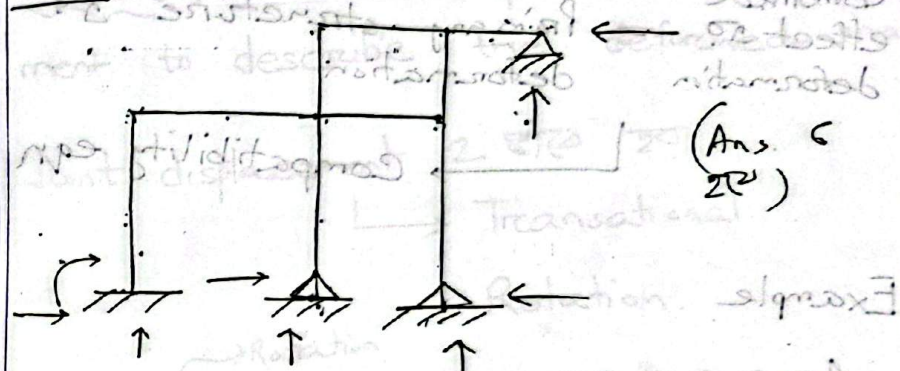
Math:



$I_s = (9 + 3\times 19) - (3\times 13 + 4)$

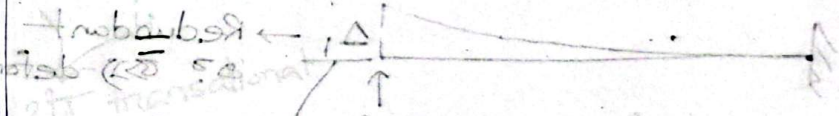
$= 8$

Math:



(Ans, 6 2°)

$I_s = (9 + 3\times 9) - (3\times 9) + 0)$



~~Comparatively eqn~~

Compatibility eqn:



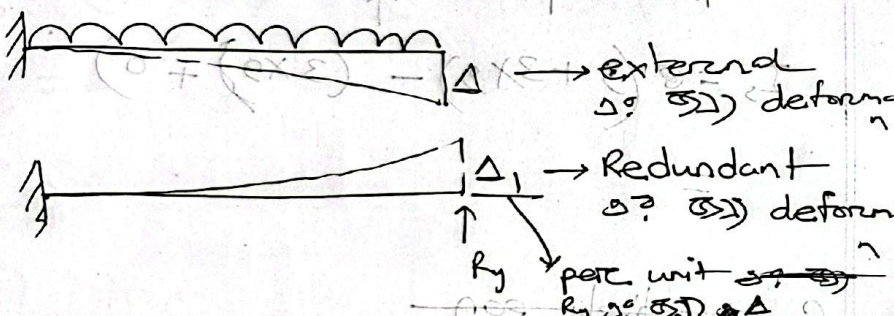
Combined effect → external loading deformation + Redundant deformation

Summation of deformation & Combined effect

Combined effect of deformation = Primary structure deformation

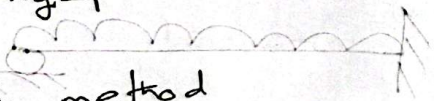
↳ Compatibility eqn

Example



Main structure of deformation = 0

$\therefore 0 = \Delta + R_y \Delta_1$



Flexibility method

~~DoSI value for 0~~

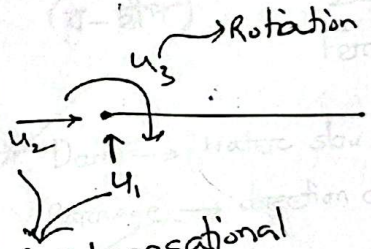
DoSI of system compatibility eqn

DoKI: Num of independent joint displacement to describe the deformed shape

Joint displacement 2 प्रकार के

↳ Transational

∴ ∴ Rotation.



2 transational

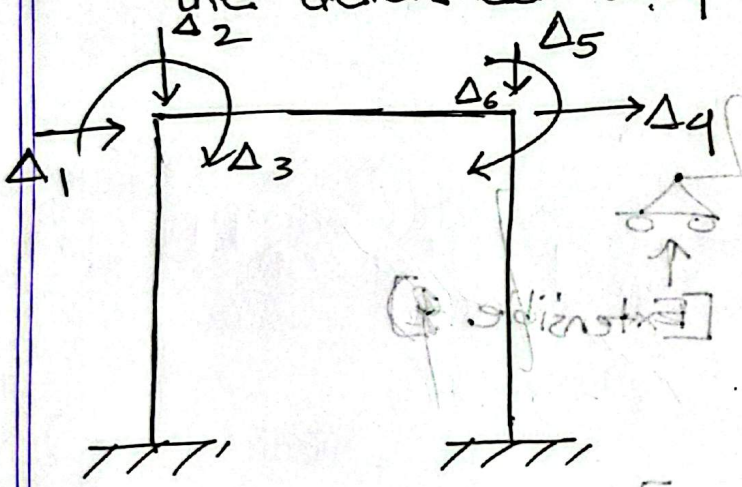
21.6.26 (Sunday)

EWCE-411 (Ziad sir)

Degree of kinetic indeterminacy (DOKI)

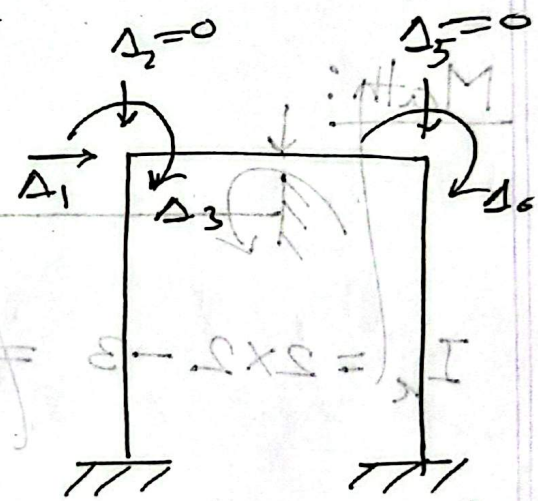
Degree of freedom (DOF)

- Num of independent joint displacement (translational & rotation) to describe the deformed shape



If member is extensible

DOF = 6



If member is inextensible

$\Delta_2 = \Delta_5 = 0$

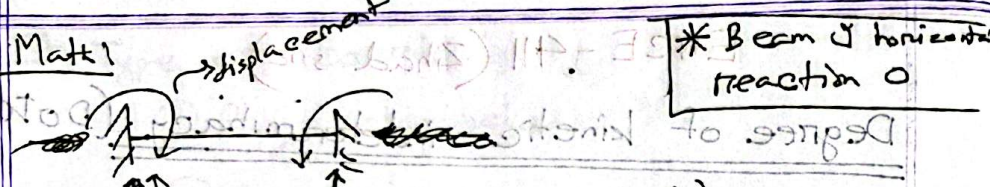
$\Delta_1 = \Delta_4$ [inextensible হলে, মধ্যের joint গুলো একই সমান]

এবং 0 বার of member সমান।

(DOF = 3)

DOKI → Displacement method
DOSI → Forced method

Math:



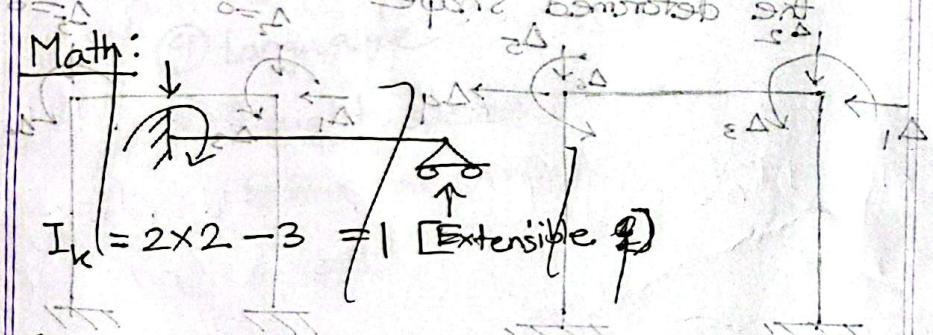
* Beam ⇒ horizontal reaction 0

DOF = 0 (as Fixed support)

DOSI = 3 [3 eqn needed to solve this]

$I_k = 2J - k = 2\times2 - 4 = 0$

Math:



$I_k = 2\times2 - 3 = 1$ [Extensible]

$I_k = 2J - k$ [Beam]

$I_k = 3J - k$ [Plane frames, 2D]

$I_k = 6J - k$ [Space ⊎, 3D]

J = Num of joint

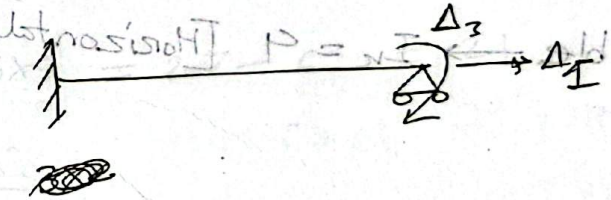
k = constraints give by support

~~$I_j = 3J - (k+3)$~~

$I_k = 3J - (k+m)$

compatible eqn

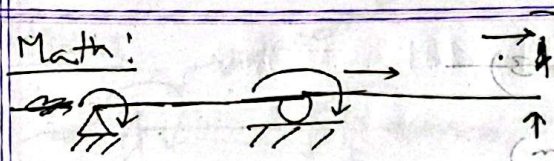
Math



$I_{jk} = 3\times2 - 4$
$= 2$
(Extensible)

Intextensible
of rotation 2 type
$I_k = 1$

Math:



Extensible → $I_k = 3J - (k+m)$

$= 3 \times 2 - (3+0)$

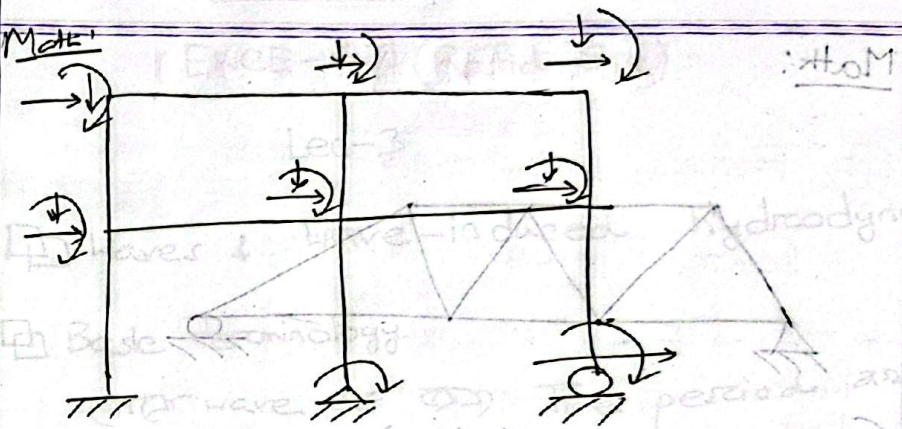
$= 3$

Inexte

Extensible → $I_k = 6$

Inextensible → $I_k = 4$ [Horizontal

Math:

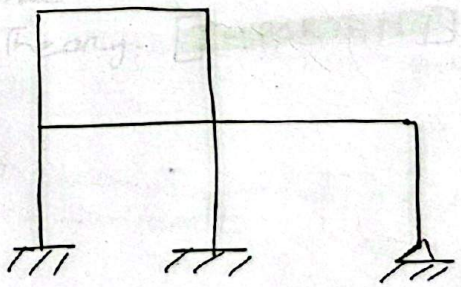


Extensible member

$I_k = 21$

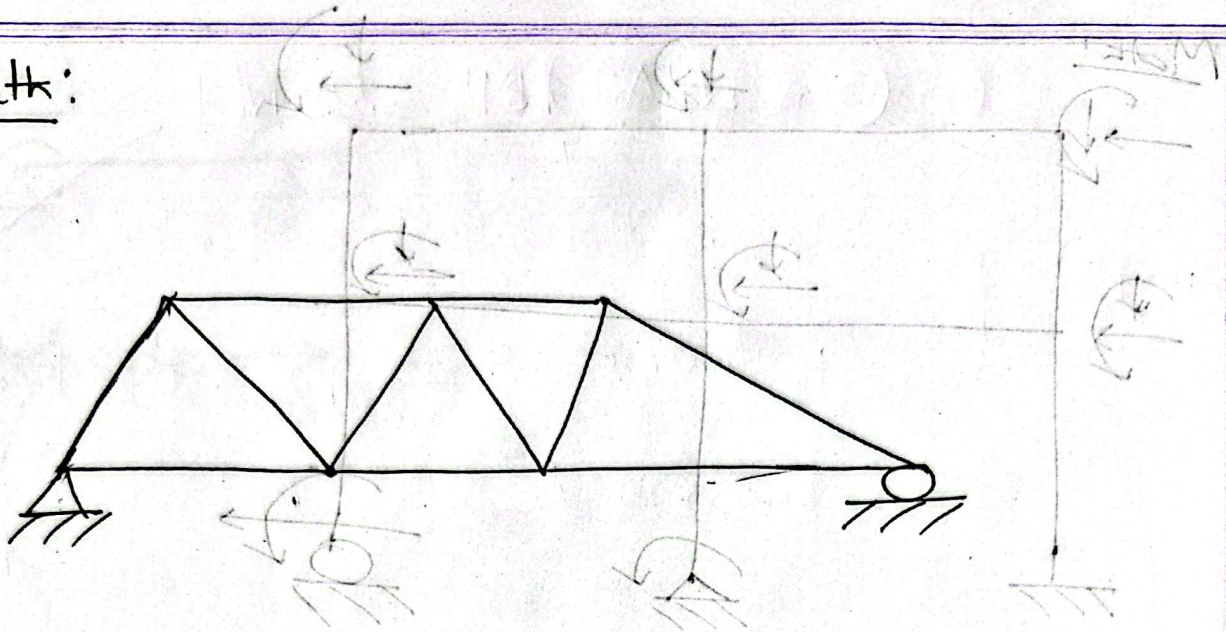
$3 \times 9 = 27 - 6 = 21$

Math:



extensible & inextensible

Matk:

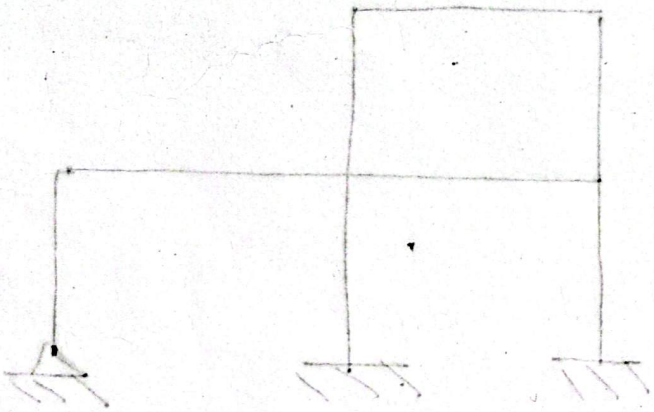


(Truss & no rotation)

$$2J - k = 2 \times 7 - 3 = 11$$

Simply supported. DOSI = 0

DOKI = 3



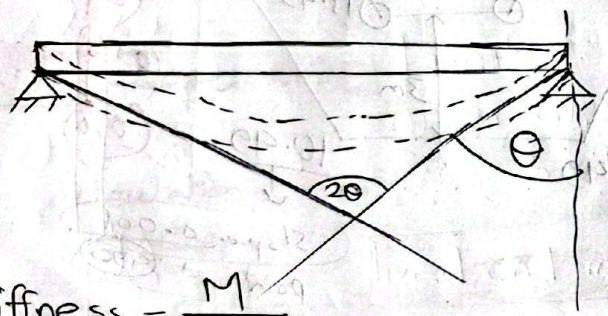
28.6.26 (Sunday)

~~EWCE~~

~~GEEM-1/445~~

EWCE-411 (Zihad sir)

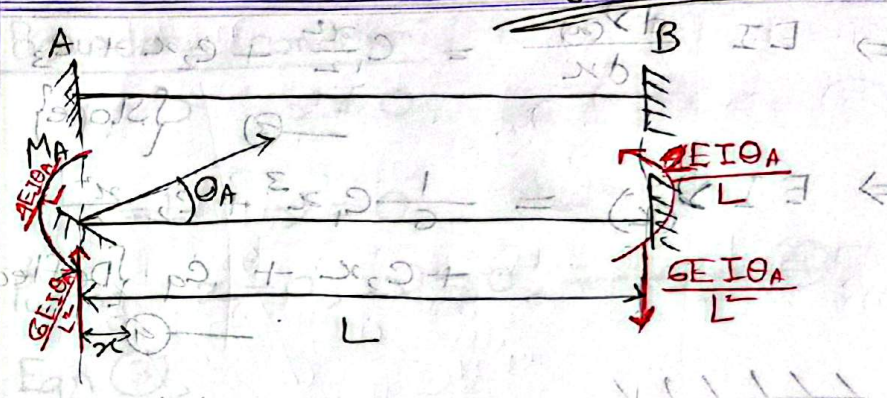
Stiffness:



$$\text{Stiffness} = \frac{M}{\theta}$$

Derivation → ~~outside~~ ~~area~~

By rotation



~~$EI \frac{d^4y}{dx^4}$~~ → load

$$EI \frac{d^4y_{(x)}}{dx^4} = P$$

As no external loading, $P = 0$

$$EI \frac{d^4y_{(x)}}{dx^4} = 0$$

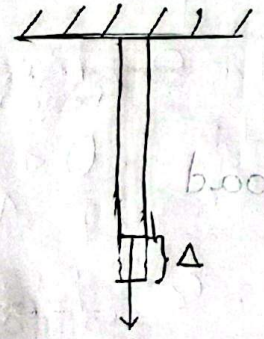
$$\Rightarrow EI \frac{d^3y_{(x)}}{dx^3} = C_1 \quad \{\text{Shear}\} \quad \text{——(1)}$$

$$\Rightarrow EI \frac{d^2y_{(x)}}{dx^2} = C_1 x + C_2 \quad \{\text{Moment}\} \quad \text{——(2)}$$

$y \rightarrow$ Deflection (y)

$$\Rightarrow EI \frac{dy_{(x)}}{dx} = C_1 \frac{x^2}{2} + C_2 x + C_3 \quad \text{—③} \quad \{\text{Slope}\}$$

$$\Rightarrow EI\, y_{(x)} = \frac{1}{6} C_1 x^3 + C_2 \frac{x^2}{2} + C_3 x + C_4 \quad \text{—④} \quad \{\text{Deflection}\}$$



1 unit rotation এর জন্য যে পরিমাণ moment লাগবে → Stiffness

fixed end moment (FEM)

$$\Delta = \frac{PL}{AE}$$

$$\Rightarrow \left(\frac{P}{\Delta}\right) = \frac{AE}{L}$$

Stiffness

Boundary condition:

$x = 0 \quad y = 0 \quad \theta_x = \theta_A$

$x = L \quad y = 0 \quad \theta_L = 0$

Putting $x = 0$, $y = 0$, in eqn ④

Eqn ③,

$$EI\,\theta_A = 0 + C_3$$

$$\Rightarrow \theta_A = \frac{C_3}{EI}$$

$$\therefore EI\theta_x = C_1 \frac{x^2}{2} + C_2 x + EI\theta_A \quad \text{—⑤}$$

From ④,

$$EI\, y_x = \frac{C_1 x^3}{6} + C_2 \frac{x^2}{2} + EI\theta_A x$$

$x = 0, y = 0$

$0 = 0$

$x = L, \quad y = 0$

(5) $\Rightarrow EI\theta_x = \frac{C_1 L^2}{2} + C_2 L + EI\theta_A$

(6) $\Rightarrow 0 = \frac{C_1 L^3}{6} + C_2 \frac{L^2}{2} + EI\theta_A L$

$x = L, \quad \theta = 0,$

(5) $\Rightarrow 0 = \frac{C_1 L^2}{2} + C_2 L + EI\theta_A$ ——— (7)

$x = L, \quad y = 0,$

(6) $\Rightarrow 0 = \frac{C_1 L^3}{6} + C_2 \frac{L^2}{2} + EI\theta_A L$ ——— (8)

(7) $\times L$ − (8),

$\frac{C_1 L^3}{2} + C_2 L^2 + EI\theta_A L = 0$

$\frac{C_1 L^3}{6} + C_2 \frac{L^2}{2} + EI\theta_A L = 0$

(−)

$\frac{1}{3} C_1 L^3 + \frac{1}{2} C_2 L^2 = 0$

$\Rightarrow C_2 = -\frac{2}{3} C_1 L$

(7) $\Rightarrow 0 = C_1 \frac{L^2}{2} + \frac{2}{3} C_2 L + EI\theta_A$

$\theta = C_1 \frac{L^2}{2} - \frac{2}{2} C_1 L^2 + EI\theta_A$

$\Rightarrow 0 = -\frac{1}{6} C_1 L^2 + EI\theta_A$

$\Rightarrow C_1 = \frac{6EI\theta_A}{L^2}$

$C_2 = -\frac{2}{3} \times \frac{6EI\theta_A}{L^2} L$

$= -\frac{4EI\theta_A}{L}$

From ②,

$x = 0$

C_2 = moment

+ive moment → Beam top → compression
Bottom → tension

-ve moment → Beam top → tension
Bottom → compression

As per drawing -ve moment ∴

$x = L$,

$$EI\frac{d^2y_x}{dx^2} = \frac{6EI\theta_A}{L^2} \times L - \frac{4EI\theta_A}{L}$$

$$= \frac{2EI\theta_A}{L}$$

↳ এই moment generate হচ্ছে A point এ moment দেওয়া হলে, তার MA এবং stiffness আসবে

$$\frac{M}{\theta_A} = \frac{4EI}{L} \rightarrow \text{Stiffness}$$

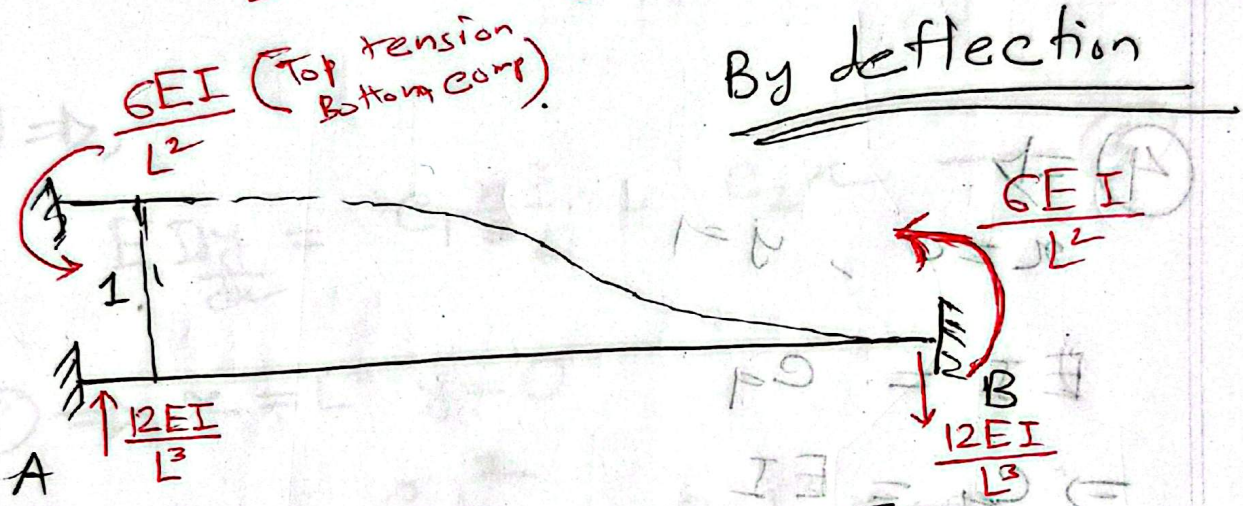
5.7.26 (Sunday)

~~GEEM-4145~~

~~financial proo~~

EWCE-411 [Zihad sir]

By deflection



$$EI\frac{d^4y}{dx^4} = P = 0 \quad \text{(load)} \quad [0 \text{ as no external load}]$$

$$EI\frac{d^3y}{dx^3} = C_1 \quad \text{(Shear)} \quad -(1)$$

$$EI\frac{d^2y}{dx^3} = C_1x + C_2 \quad \text{(moment)} \quad -(2)$$

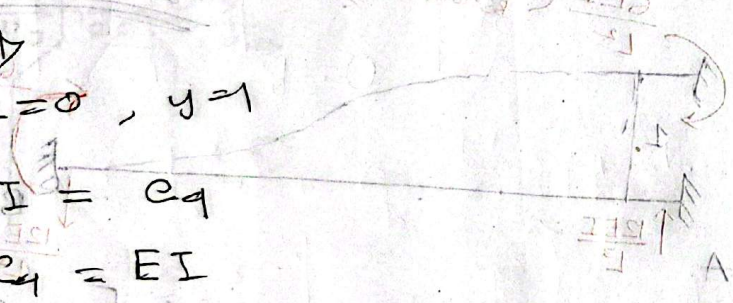
$$EI\frac{dy}{dx} = C_1\frac{x^2}{2} + C_2x + C_3 \quad \text{(Slope)} \quad -(3)$$

$$EIy = C_1\frac{x^3}{6} + C_2\frac{x^2}{2} + C_3x + C_4 \quad \text{(deflection)} \quad -(4)$$

Boundary conditions

$x=0 \Rightarrow y=1 \quad \theta=0^\circ$ → as fixed support

$x=L \Rightarrow y=0 \quad \theta=0^\circ$ → as fixed support



(4) $\Rightarrow$

$x=0, \; y=1$

$EI = C_4$

$\Rightarrow C_4 = EI$

(3) $\Rightarrow x=0, \; \theta=0^\circ$

$\frac{dy}{dx}$ = slope

$0 = C_3 \Rightarrow C_3 = 0$

(4) $\Rightarrow$,

$EIy = C_1\frac{x^3}{6} + C_2\frac{x^2}{2} + EI$ ——— (5)

(3) $\Rightarrow$,

$EI\frac{dy}{dx} = C_1\frac{x^3}{2} + C_2 x$ ——— (5)

(6) $\Rightarrow x=L \quad y=0$

$0 = \frac{C_1 L^3}{6} + C_2\frac{L^2}{2}$ ⟹

(5) $\Rightarrow x=L \quad \theta=0$

$0 = \frac{C_1 L^3}{2} + C_2 L$

$\Rightarrow C_2 = -\frac{C_1 L^2}{2}$

$\therefore \frac{C_1 L^3}{6} + \frac{C_1 L^3}{2} = 0$

⑤ $\Rightarrow x = L \quad \theta = 0$

$$0 = C_1 \frac{L^2}{2} + C_2 L$$

$$\Rightarrow C_2 = -\frac{C_1 L}{2}$$

⑥ $\Rightarrow x = L \quad y = 0$

$$0 = C_1 \frac{L^3}{6} + C_2 \frac{L^2}{2} + EI$$

$$\Rightarrow -C_1 \frac{L^3}{6} = -\frac{C_1 L}{2} \frac{L^2}{2} + EI$$

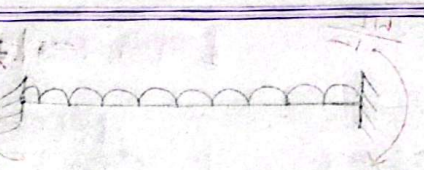
$$\Rightarrow 0 = \frac{C_1 L^3}{6} - \frac{C_1 L^3}{4} + EI$$

$$\Rightarrow \frac{C_1 L^3}{12} = +EI$$

$$\Rightarrow C_1 = +\frac{12EI}{L^3}$$

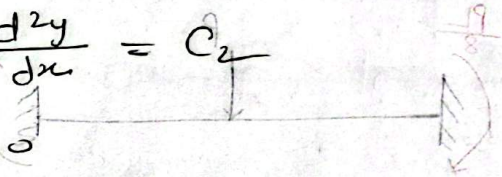
Moment $\frac{6EI\Delta}{L^2}$

$$C_2 = -\frac{6EI}{L^2}$$



② $\Rightarrow x = 0 \cdot y > 0$

$$\therefore EI \frac{d^2y}{dx} = C_2$$



$x = L, \; y = 0$

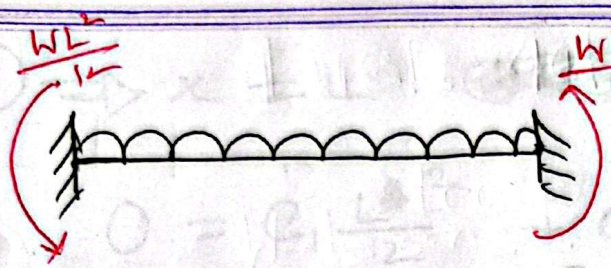
$$EI \frac{d^2y}{dx} = C_1 L + C_2$$

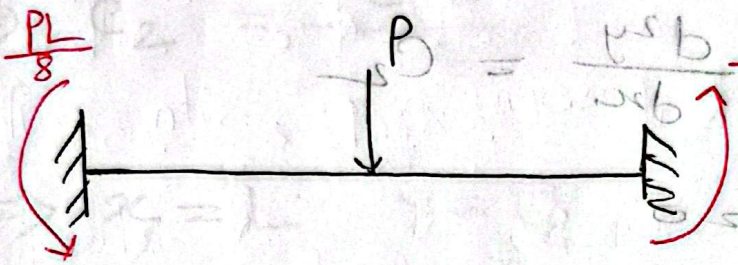
$$= \frac{12EI}{L^2} L - \frac{6EI}{L^2}$$

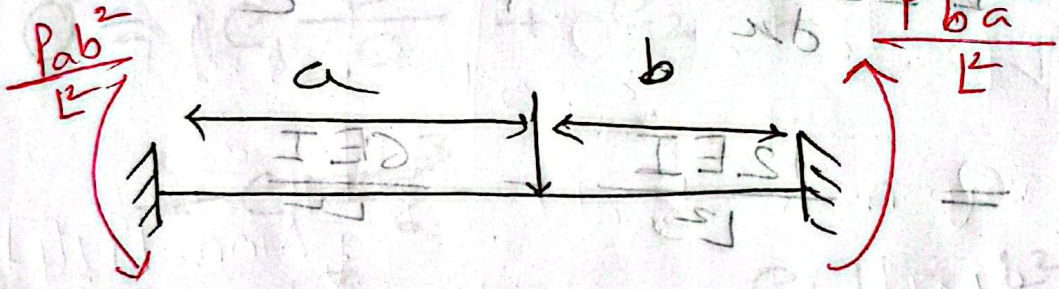
$$= \frac{6EI}{L^2}$$

Stiffness $K = \frac{6EI}{L^2}$

Moment







Ref → Book Last page এ;
আগের page এ

Fixed end moment

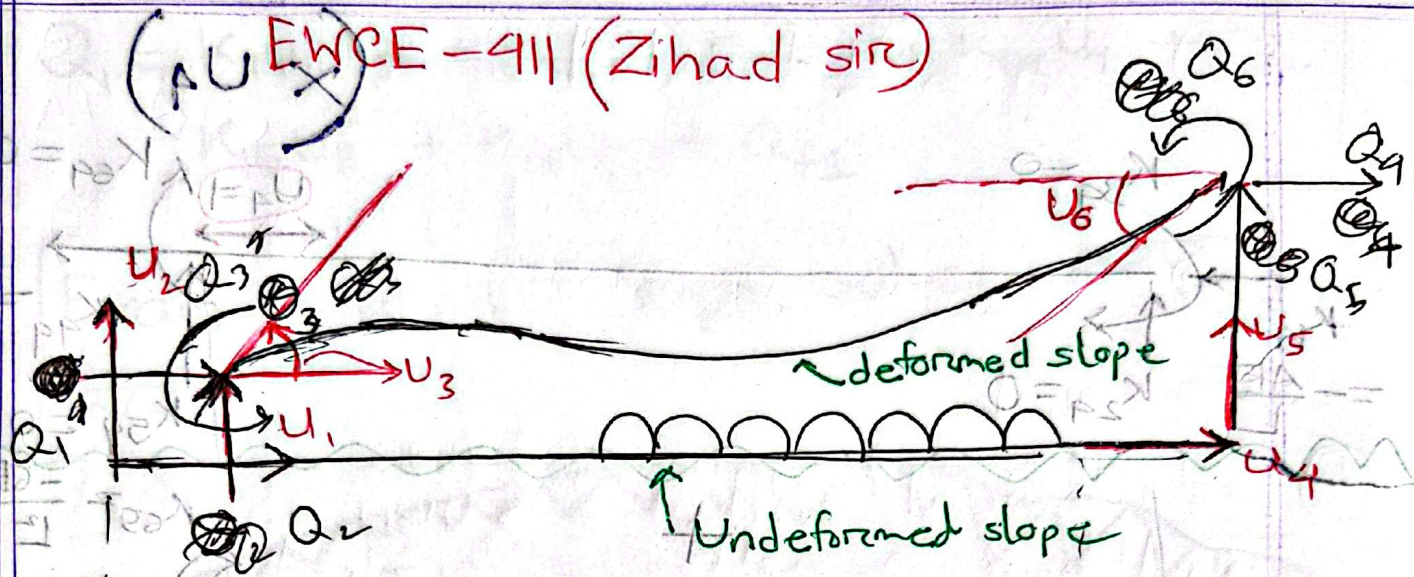
[Memorise]

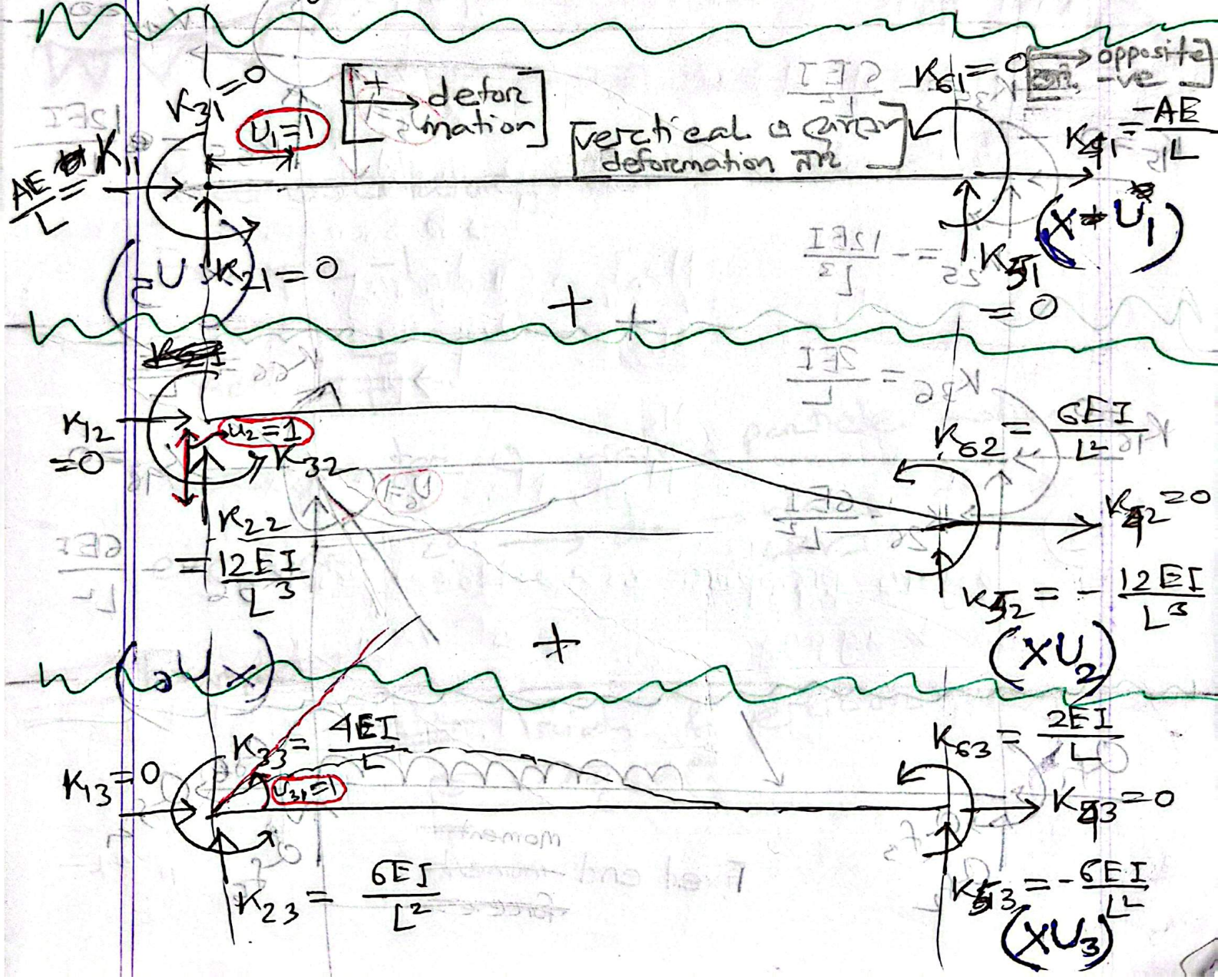
Exam এ দিয়ে দিবে

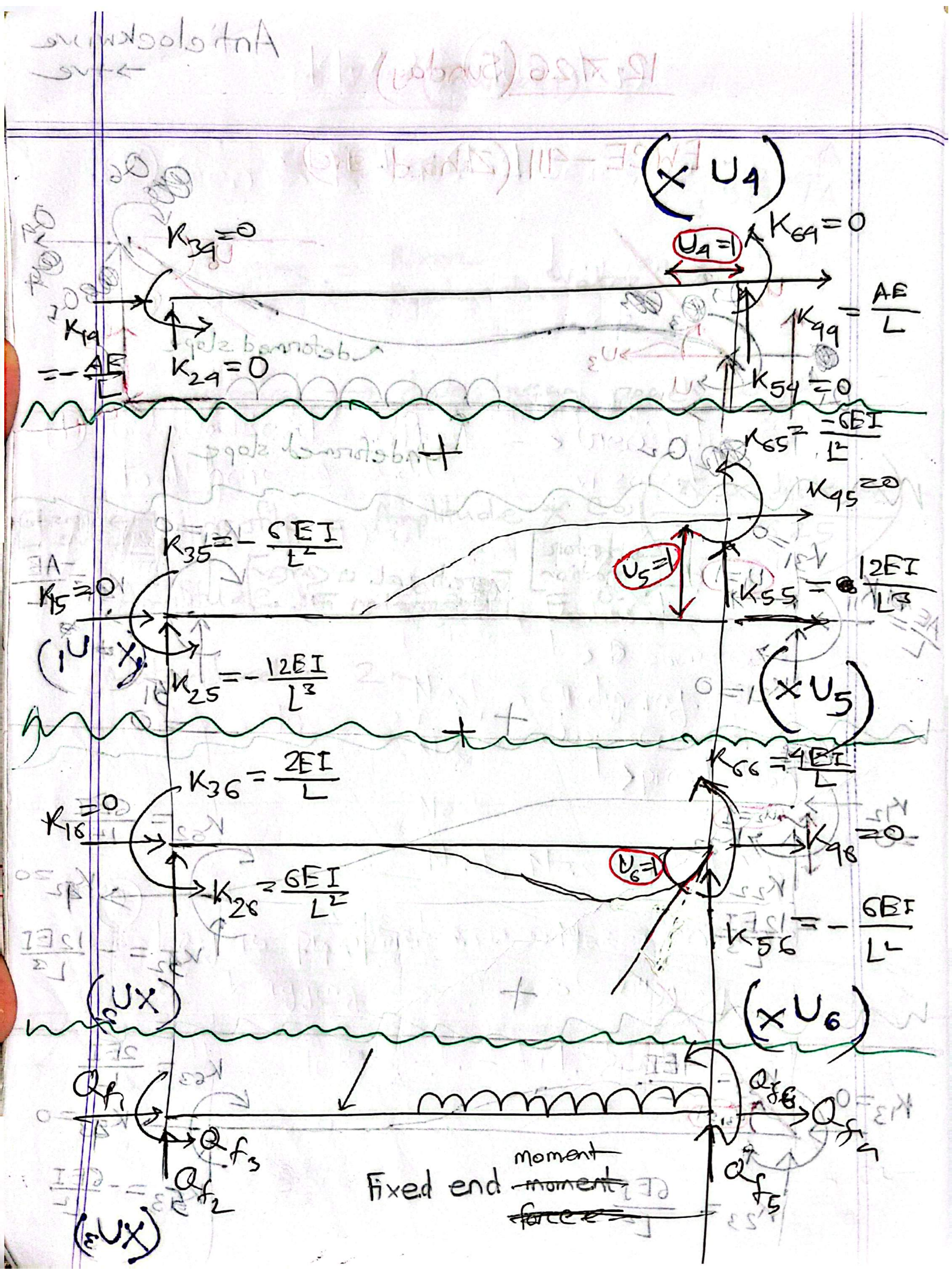
12.7.26 (Sunday)

Anticlockwise → +ve

EWCE-911 (Zihad sir)






(X U4)
U4=1
K34=0
K64=0
K14 = -AE/L
K24=0
K44 = AE/L
K54=0
K65 = -6EI/L²
K45=0
K35 = -6EI/L²
U5=1
K15=0
K55 = 12EI/L³
(X U5)
K25 = -12EI/L³
K36 = 2EI/L
K66 = 4EI/L
K16=0
K46=0
U6=1
K26 = 6EI/L²
K56 = -6EI/L²
(X U6)
Qf1
Qf4
Qf3
Qf2
Qf5
Fixed end moment
force

$$Q_1 = K_{11}U_1 + K_{12}U_2 + K_{13}U_3 + K_{14}U_4 + K_{15}U_5 + K_{16}U_6 + Q_{f1}$$

Exam এ ~~৪~~ 3টার eqn solve করতে দিবে

19.7.26 (Sunday)

FTI

EWCE411 (Zihad sir)

$$Q_1 = K_{11}U_1 + K_{12}U_2 + K_{13}U_3 + K_{14}U_4 + K_{15}U_5 + K_{16}U_6 + Q_{f_1}$$

$$Q_2 = K_{21}U_1 + K_{22}U_2 + K_{23}U_3 + K_{24}U_4 + K_{25}U_5 + K_{26}U_6 + Q_{f_2}$$

$$Q_3 = K_{31}U_1 + K_{32}U_2 + K_{33}U_3 + K_{34}U_4 + K_{35}U_5 + K_{36}U_6 + Q_{f_3}$$

$$Q_4 = K_{41}U_1 + K_{42}U_2 + K_{43}U_3 + K_{44}U_4 + K_{45}U_5 + K_{46}U_6 + Q_{f_4}$$

$$Q_5 = K_{51}U_1 + K_{52}U_2 + K_{53}U_3 + K_{54}U_4 + K_{55}U_5 + K_{56}U_6 + Q_{f_5}$$

$$Q_6 = K_{61}U_1 + K_{62}U_2 + K_{63}U_3 + K_{64}U_4 + K_{65}U_5 + K_{66}U_6 + Q_{f_6}$$

CamScanner

কোনো frame এ internal roller থাকলে → moment থাকে
" " " external (end এ) " " → moment = 0

$$\begin{bmatrix} Q_1 \\ Q_2 \\ Q_3 \\ Q_4 \\ Q_5 \\ Q_6 \end{bmatrix} = \begin{bmatrix} K_{11} & K_{12} & K_{13} & K_{14} & K_{15} & K_{16} \\ K_{21} & K_{22} & K_{23} & K_{24} & K_{25} & K_{26} \\ K_{31} & K_{32} & K_{33} & K_{34} & K_{35} & K_{36} \\ K_{41} & K_{42} & K_{43} & K_{44} & K_{45} & K_{46} \\ K_{51} & K_{52} & K_{53} & K_{54} & K_{55} & K_{56} \\ K_{61} & K_{62} & K_{63} & K_{64} & K_{65} & K_{66} \end{bmatrix} \times \begin{bmatrix} U_1 \\ U_2 \\ U_3 \\ U_4 \\ U_5 \\ U_6 \end{bmatrix} + \begin{bmatrix} Q_{f_1} \\ Q_{f_2} \\ Q_{f_3} \\ Q_{f_4} \\ Q_{f_5} \\ Q_{f_6} \end{bmatrix}$$

U → member displacement (translation & rotation)

$\Rightarrow Q = KU + Q_f$

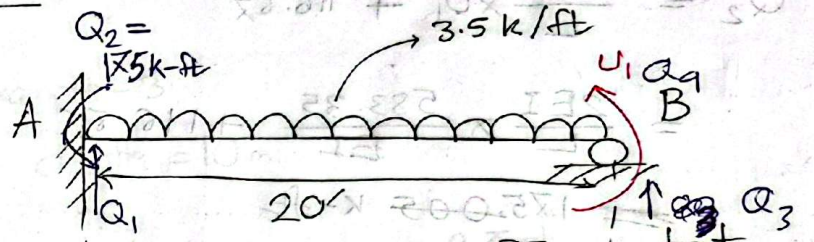
Q → member end forces; K → member stiffness; Q_f → fixed end moment for external loading

$Q = KU + Q_f$

$\Rightarrow 0 = \frac{4EI}{L} \times U_1 - 116.67$ [Anticlockwise positive]

$\Rightarrow U_1 = \frac{583.35}{EI}$

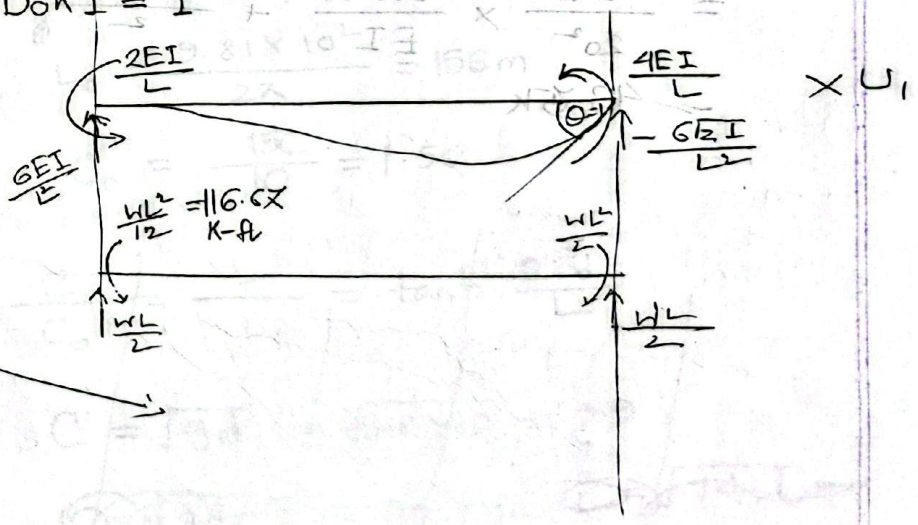
Ex-1



Beam ex inextensible, EI constant

As inextensible ∴ At B just rotation

DoKI = 1



At A,

$$Q_2 = \frac{2EI}{L} \times U_1 + 116.67$$

$$= \frac{2EI}{L} \times \frac{583.35}{EI} + 116.67$$

$$= 175.005 \text{ k-ft}$$

$$Q_1 = \frac{6EI}{L^2} \times U_1 + \frac{WL}{2}$$

$$= \frac{6EI}{20^2} \times \frac{583.35}{EI} + \frac{3.5 \times 20}{2}$$

$$= 43.75 \text{ k}$$

26.7.26 (Sunday)

EwCE - 911 (Zihad Sir)

$$(+\Sigma M_{ext} = (+\Sigma M_{int}$$

At B, $0 = -\frac{35\times14}{8} + \left(\frac{4EI}{14} + \frac{4EI}{10}\right)\times U_1$

$$\Rightarrow U_1 = \frac{89.32}{EI}$$

$$M_A = Q_f + kU = \frac{2EI}{14} \times \frac{89.32}{EI} + \frac{35\times14}{8}$$

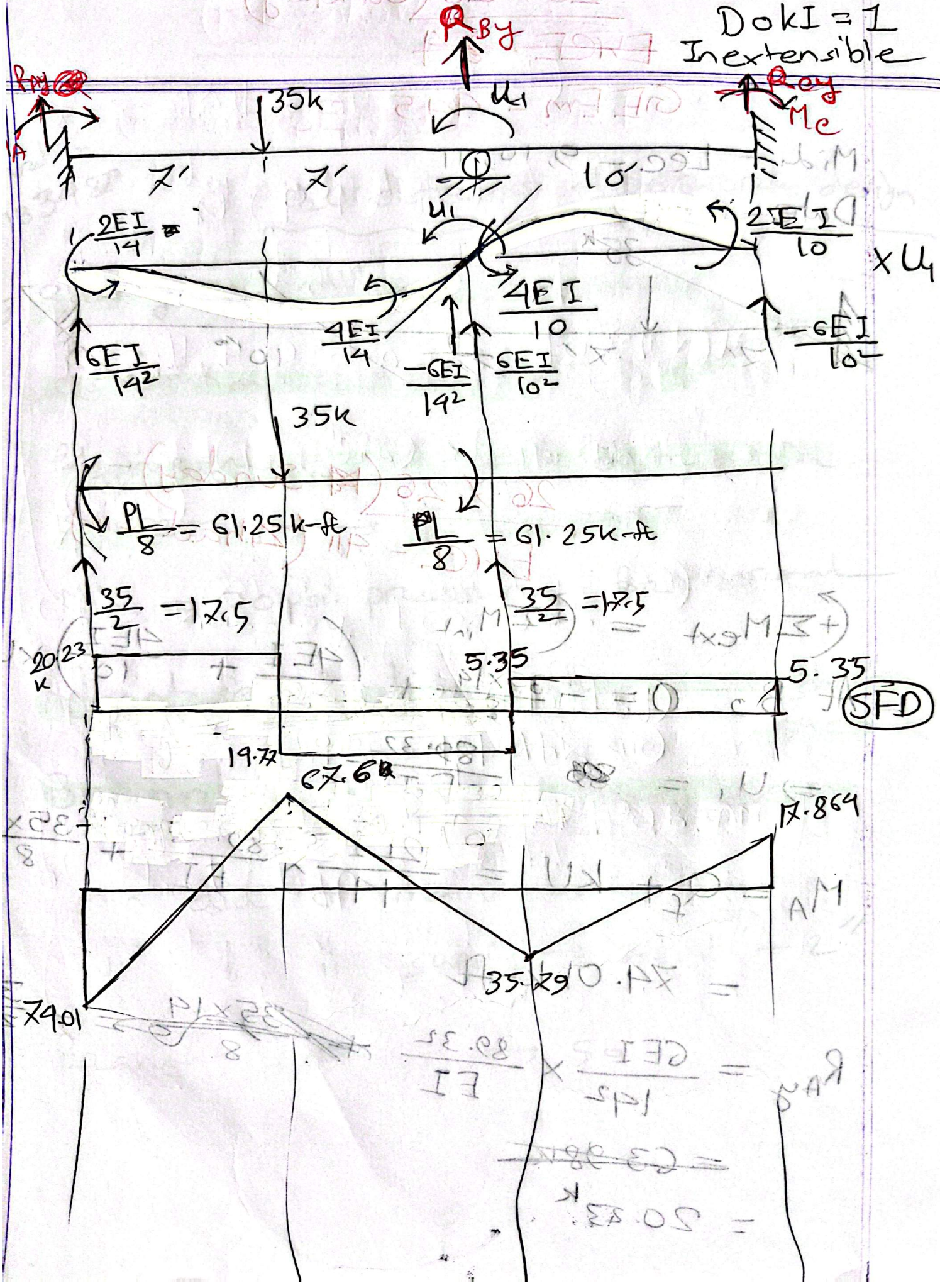
$$= 74.01 \text{ k-ft}$$

$$R_{Ay} = \frac{6EI}{14^2} \times \frac{89.32}{EI} + \frac{35\times14}{8} + \frac{35}{2}$$

~~$= 63.98^k$~~

$$= 20.23^k$$

DoKI = 1
Inextensible



Anti-clockwise

$$R_{cy} = -\frac{6EI}{10^2} \times \frac{89.32}{EI}$$

$$= -5.35\,k$$

$$M_c = +\frac{2EI}{10} \times \frac{89.32}{EI} = -17.864\,k$$

$$R_{By} = \left(-\frac{6EI}{14^2} + \frac{6EI}{10^2}\right) \times \frac{89.32}{EI} + \frac{35}{2}$$

$$= 20.12\,k$$

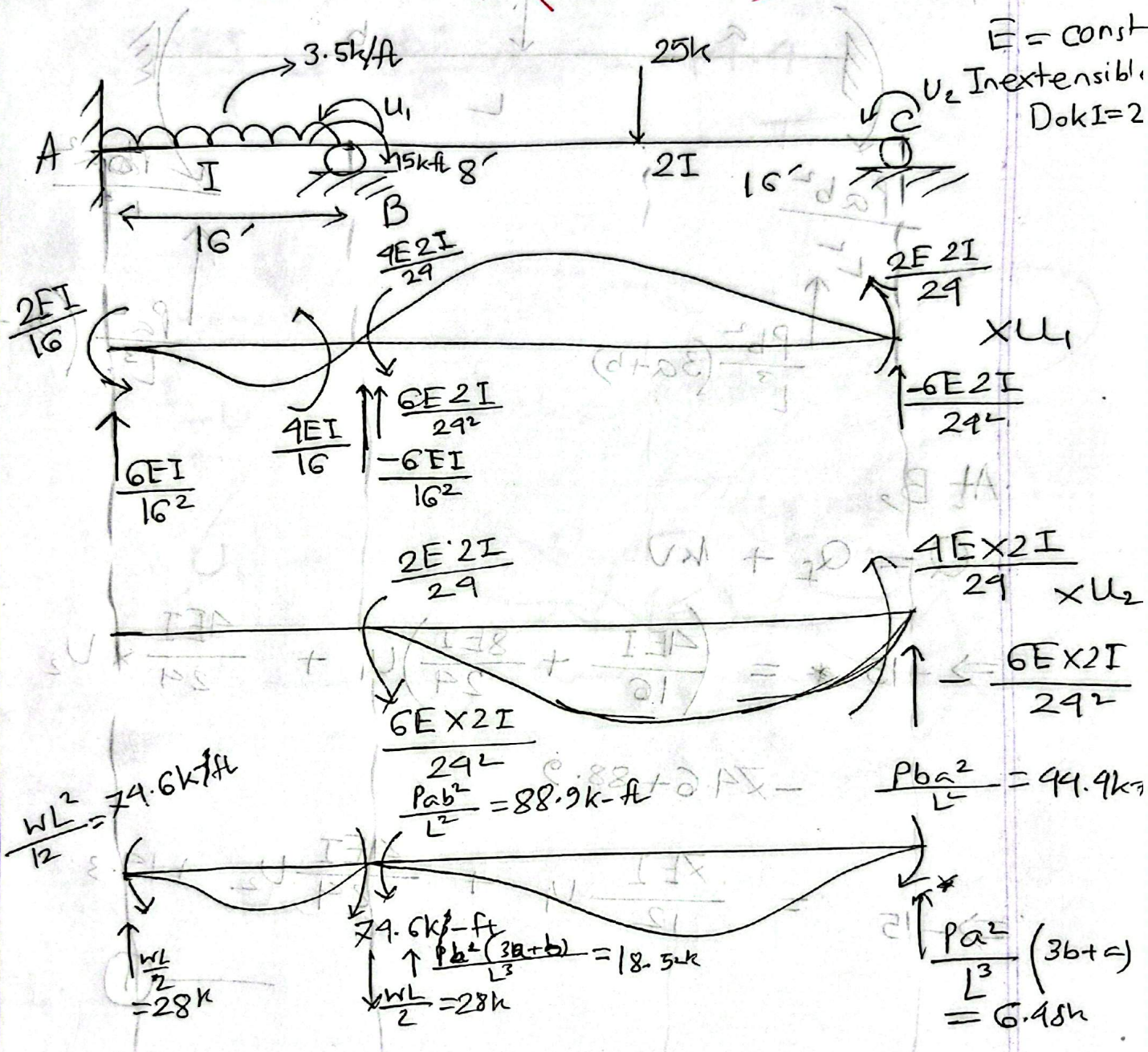
* প্রত্যেক ques এ sfd bmd must থাকতে হবে,

Left
- ↑ → +ve shear
- ↓ → -ve "

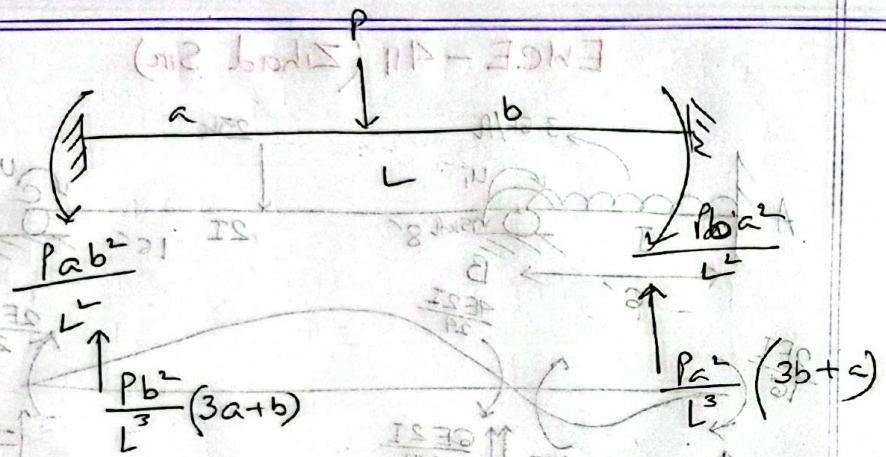
Right
- ↑ → -ve shear
- ↓ → +ve "

9.8.26 (Sunday)

EWCE-411 (Zihad Sir)



*



At B,

$$Q = Q_f + kV$$

$$\Rightarrow -15 * = \left(\frac{4EI}{16} + \frac{8EI}{24}\right)U_1 + \frac{4EI}{24} \times U_2$$

$$-74.6 + 88.9$$

$$\Rightarrow -15 = \frac{7EI}{12}U_1 + \frac{4EI}{24}U_2 + 14.3 \quad \text{——— (1)}$$

At C,

$$0 = \frac{4EI}{24} + \frac{8EI}{24}U_2 - 44.4 \quad \text{——— (2)}$$

(1) × 2 − (2),

$$\frac{14EI}{12}U_1 + \frac{8EI}{24}U_2 + 28.6 = 30$$

$$\frac{4EI}{24}U_1 + \frac{8EI}{24}U_2 - 44.4 = 0$$

$$U_1 = \frac{-102.89}{EI}$$

$$U_2 = \frac{184.7}{EI}$$

$$M_A = \frac{2EI}{16} \times \frac{-102.89}{EI} + 0 \times U_2 + 24.6$$

$$= 61.73 k\text{-}ft$$

$$R_A = \frac{6EI}{16^2} \times \frac{-102.89}{EI} + 0 \times U_2 + 28.$$

$$= 25.5k$$

$$R_B = \left(-\frac{6EI}{16^2} + \frac{6EIx2}{24^2}\right) \times \frac{-102.89}{EI}$$

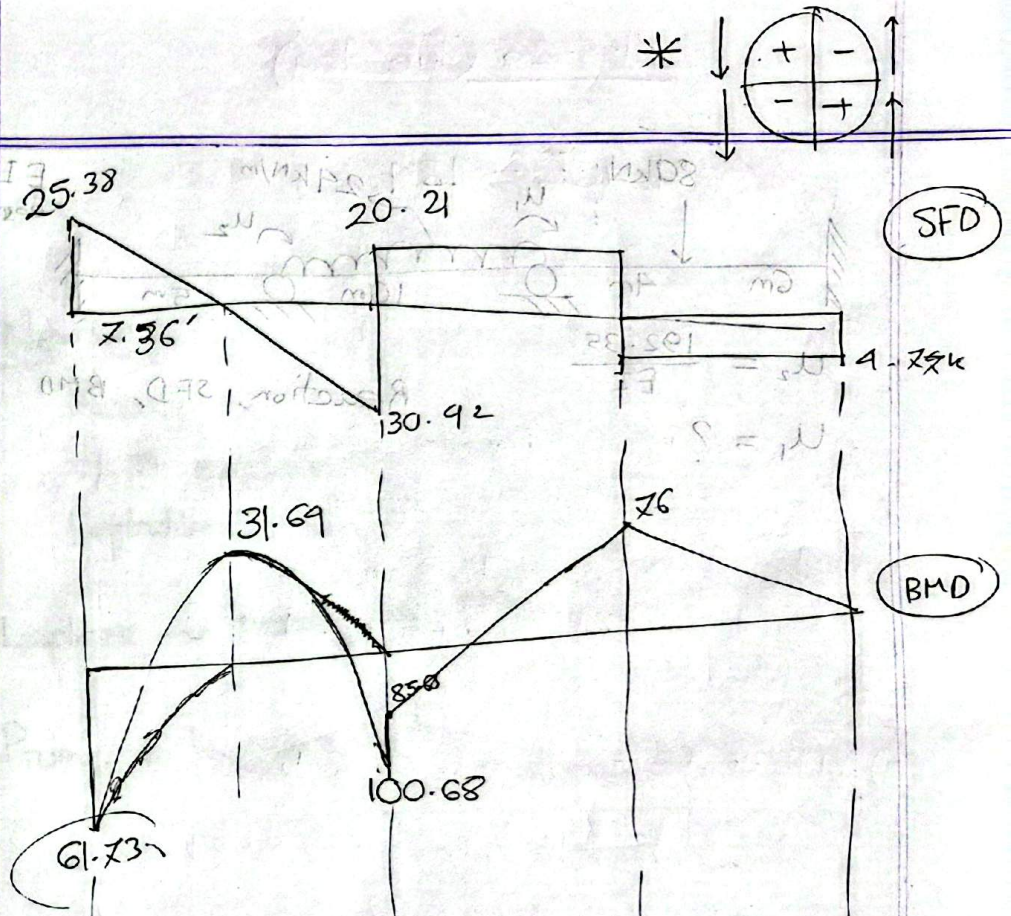
$$+ \frac{6EI}{24^2} \times \frac{184.62}{EI} + 28 + 18.52$$

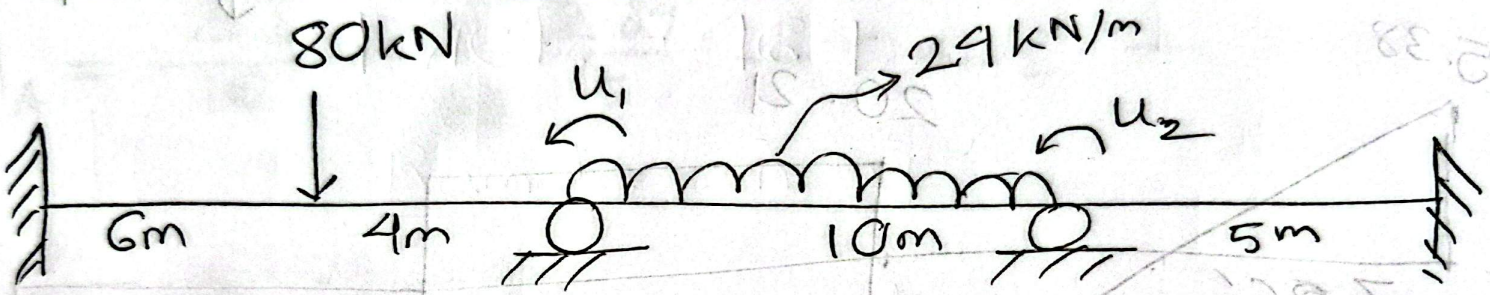
$$= 50.63$$

$$R_C = -\frac{6E \times 2I}{24^2} \times \frac{-102.89}{EI} - \frac{6E \times 2L}{24^2} \times \frac{184.62}{EI}$$

$$+ 6.48$$

$$= 4.77$$

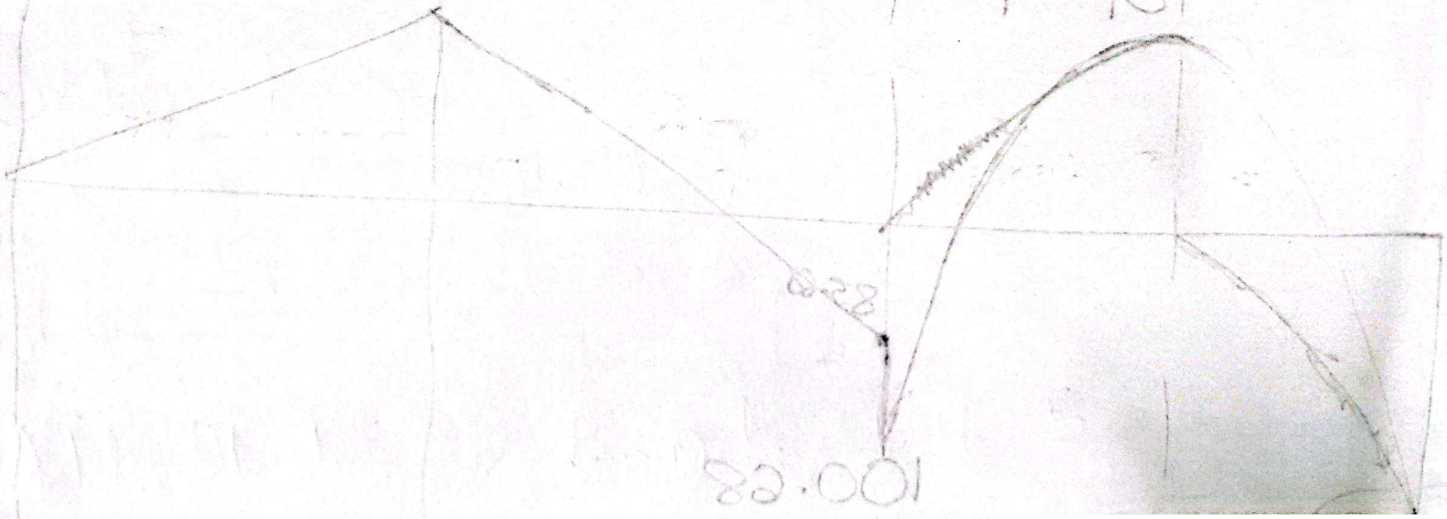




$$u_2 = \frac{192.35}{EI}$$

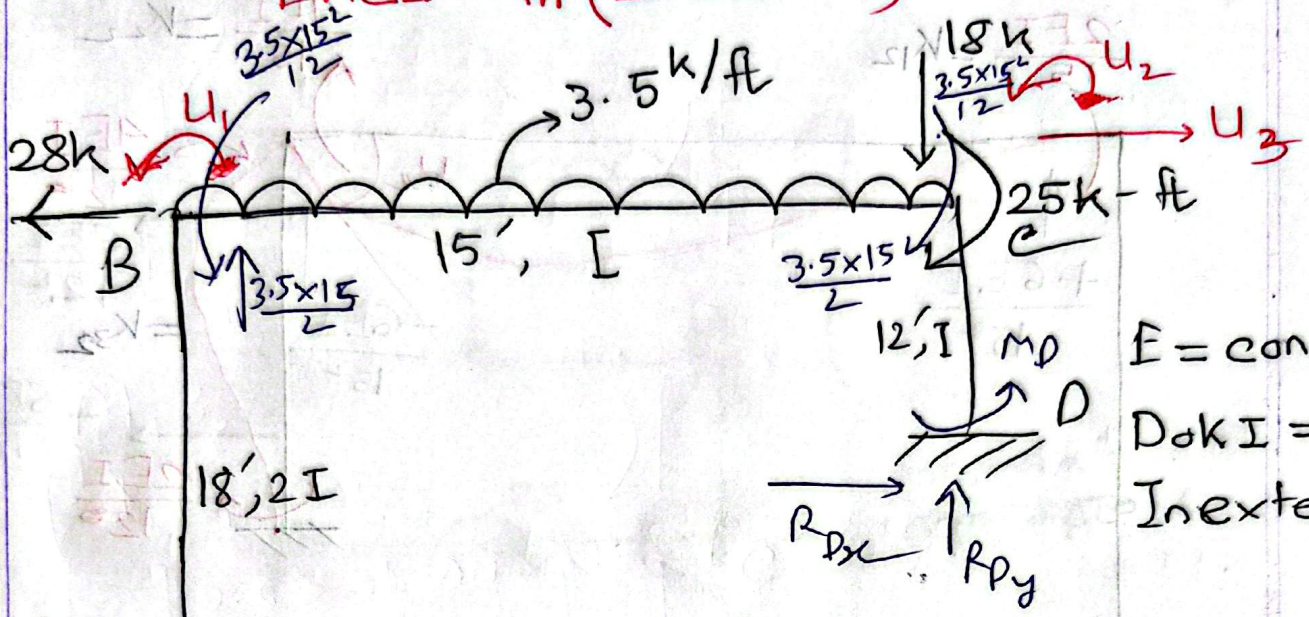
$u_1 = ?$

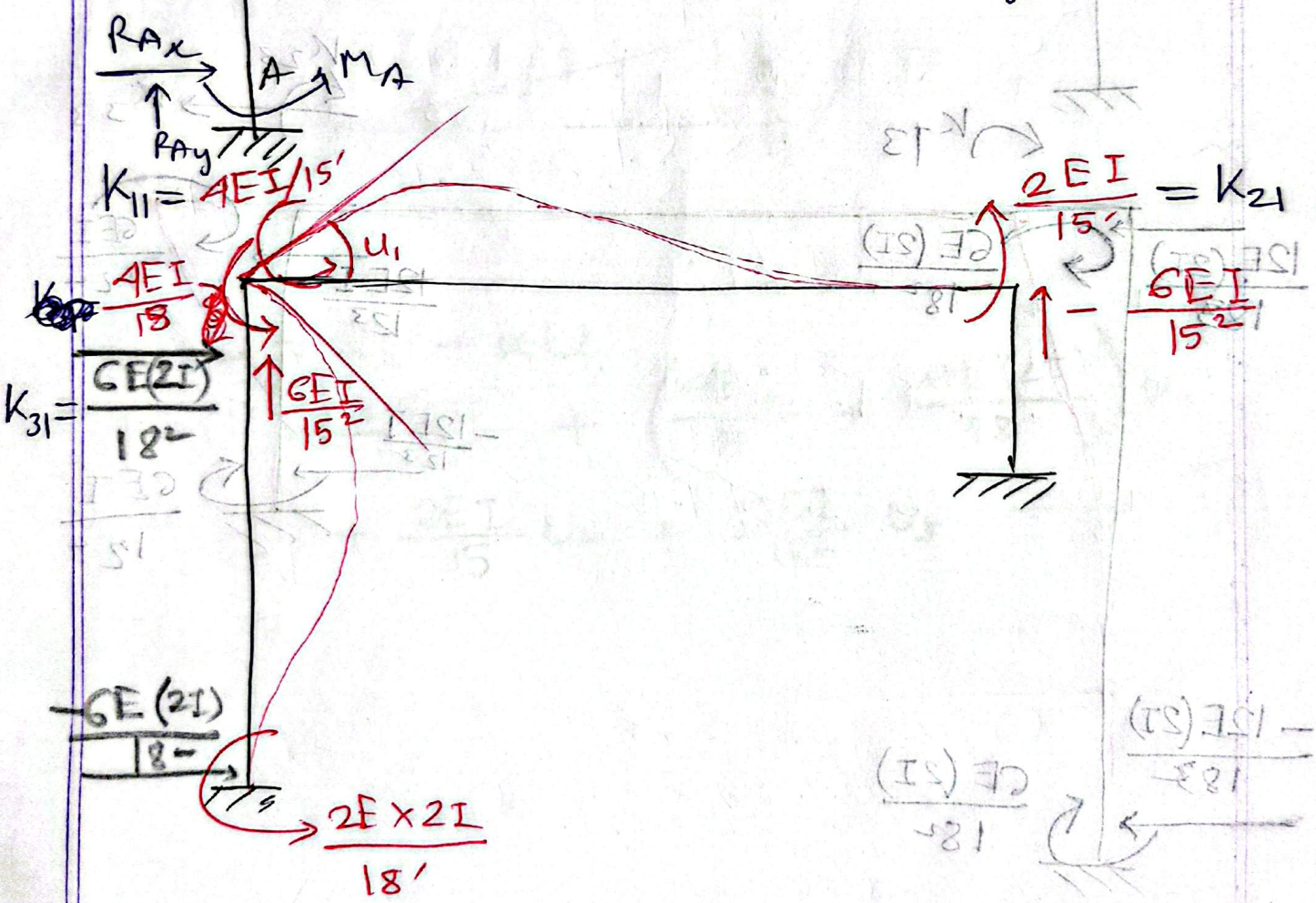
Reaction, SFD, BMD



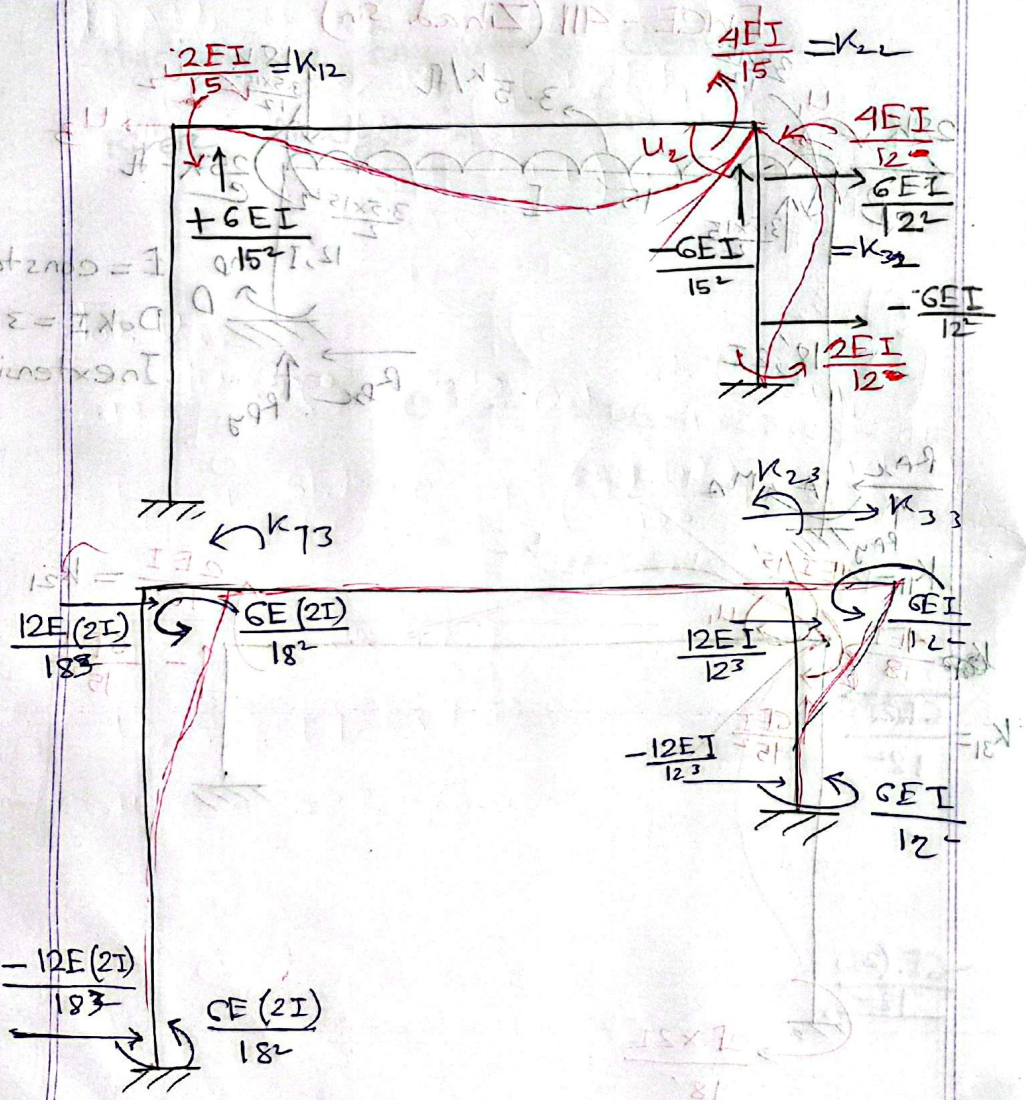
16.8.26 (Sunday)

EWCE - 911 (Zihad sir)

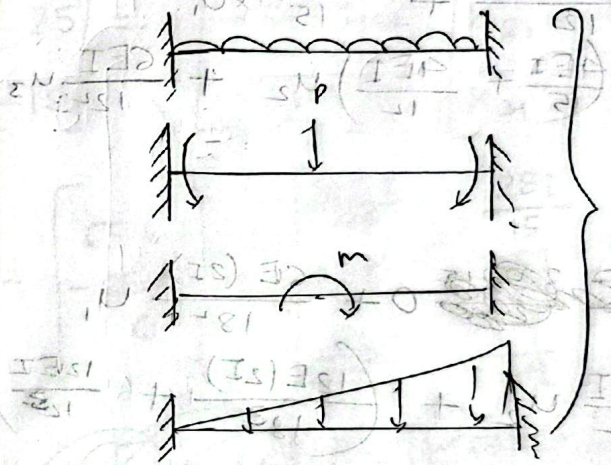




$u_2 = 1$



For exam,



For u_1,

$$Q = Q_f + kU$$

$$\Rightarrow 0 = \frac{3.5 \times 15^2}{12} + \left(\frac{4EI}{15} + \frac{4E(2I)}{18}\right)u_1 + \frac{2EI}{15}u_2 + \frac{12EI}{18^2}u_3 \quad \text{---} \quad (1)$$

For U_2,

$$-25 = -\frac{3.5 \times 15^2}{12} + \frac{2EI}{15} \times U_1 + \left(\frac{4EI}{15} + \frac{4EI}{12}\right) U_2 + \frac{6EI}{12} U_3$$

For U_3,

$$-18 = 0 + \frac{6E(2I)}{18^2} U_1 + \frac{6EI}{12} U_2 + \left(\frac{12E(2I)}{18^3} + \frac{12EI}{18^3}\right) U_3$$

$$U_1 = -6.52/EI$$

$$U_2 = 249.6/EI$$

$$U_3 = -2527.51/EI$$

Or,

$$\begin{bmatrix} 0 \\ -25 \\ -18 \end{bmatrix} = \begin{bmatrix} 65.63 \\ -65.63 \\ 0 \end{bmatrix} + \begin{bmatrix} K_{11} & K_{12} & K_{13} \\ K_{21} & K_{22} & K_{23} \\ K_{31} & K_{32} & K_{33} \end{bmatrix} \times \begin{bmatrix} U_1 \\ U_2 \\ U_3 \end{bmatrix}$$

$$= \begin{bmatrix} 65.63 \\ -65.63 \\ 0 \end{bmatrix} + \begin{bmatrix} \frac{32EI}{45} & \frac{2EI}{15} & \frac{EI}{27} \\ \frac{2EI}{15} & \frac{3EI}{5} & \frac{EI}{24} \\ \frac{EI}{27} & \frac{EI}{24} & \frac{43EI}{3888} \end{bmatrix} \begin{bmatrix} U_1 \\ U_2 \\ U_3 \end{bmatrix}$$

$$\Rightarrow \begin{bmatrix} U_1 \\ U_2 \\ U_3 \end{bmatrix} = \begin{bmatrix} -6.52 \\ 249.60 \\ -2522 \end{bmatrix}$$

At A,

$$R_{Ax} = 0 + \frac{-6EI(2I)}{18^2} \times u_1 \pm 0 - \frac{12EI(2I)}{18^3} \times u_3$$

$$= -10.15$$

$$R_{Ay} = \frac{3.5 \times 15}{2} + \frac{6EI}{15^2} \times u_1 + \frac{6EI}{15^2} u_2 + 0$$

$$= 3$$

$$R_{Ax} = 14.35$$

$$R_{Ay} = 36.49$$

$$M_A = -134.84 \text{ k-ft}$$

$$R_{Dx} = 13.65 \text{ k}$$

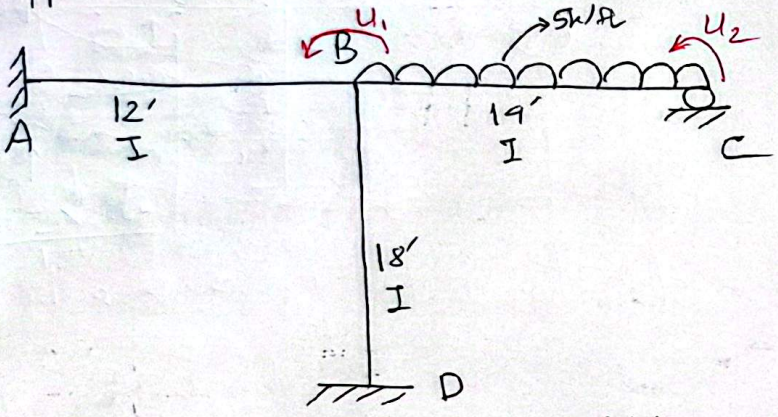
$$R_{Dy} = 39.05 \text{ k}$$

$$M_D = 109.46 \text{ k-ft}$$

23.8.26 (Sunday)

EWCE – 911 (Zihad sir)

Support rotation & settlement



$\theta_A = 0.05$ rad (↻) $\Delta_D = 0.2'$ (↓)

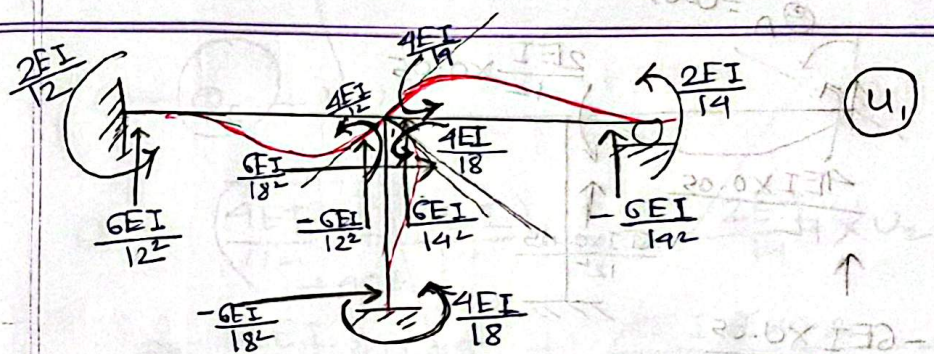
Support A এ rotates clockwise 0.05c

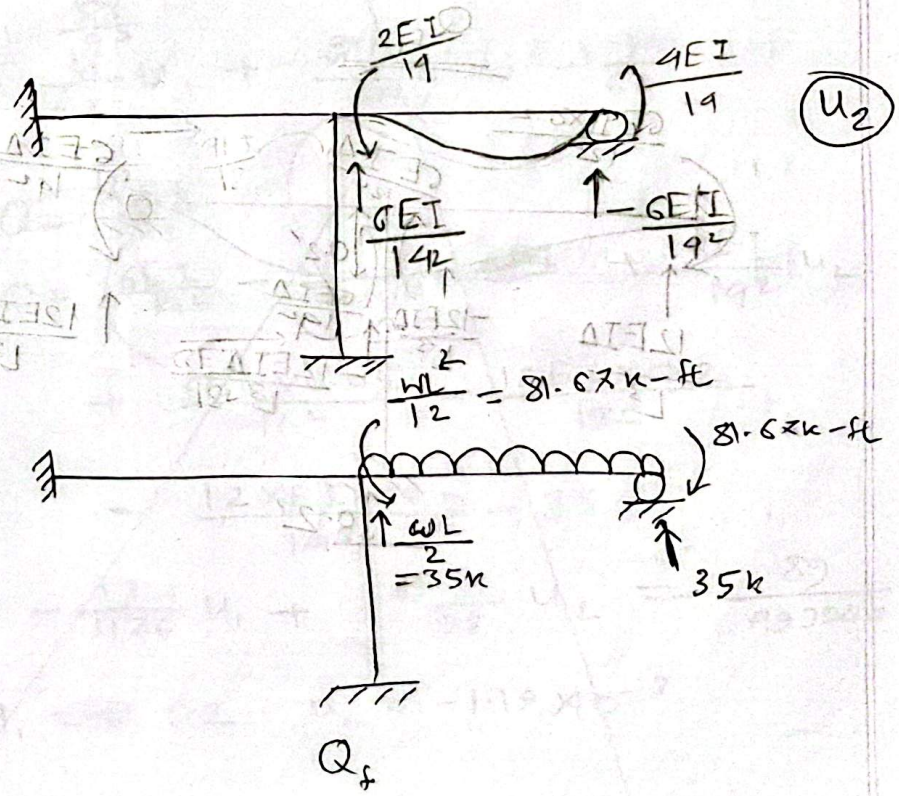
Support B settles downward 0.2′

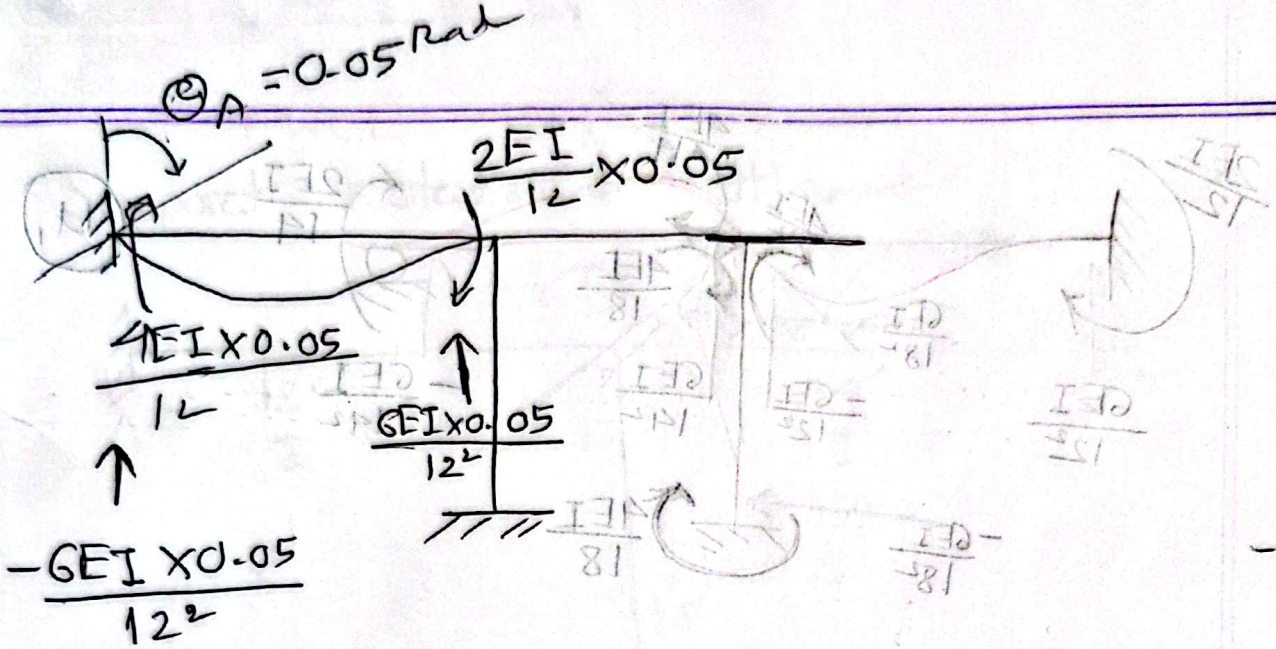
* $Q = Q_f + KU$

Q_f → settlement & rotation এর জন্য external reaction

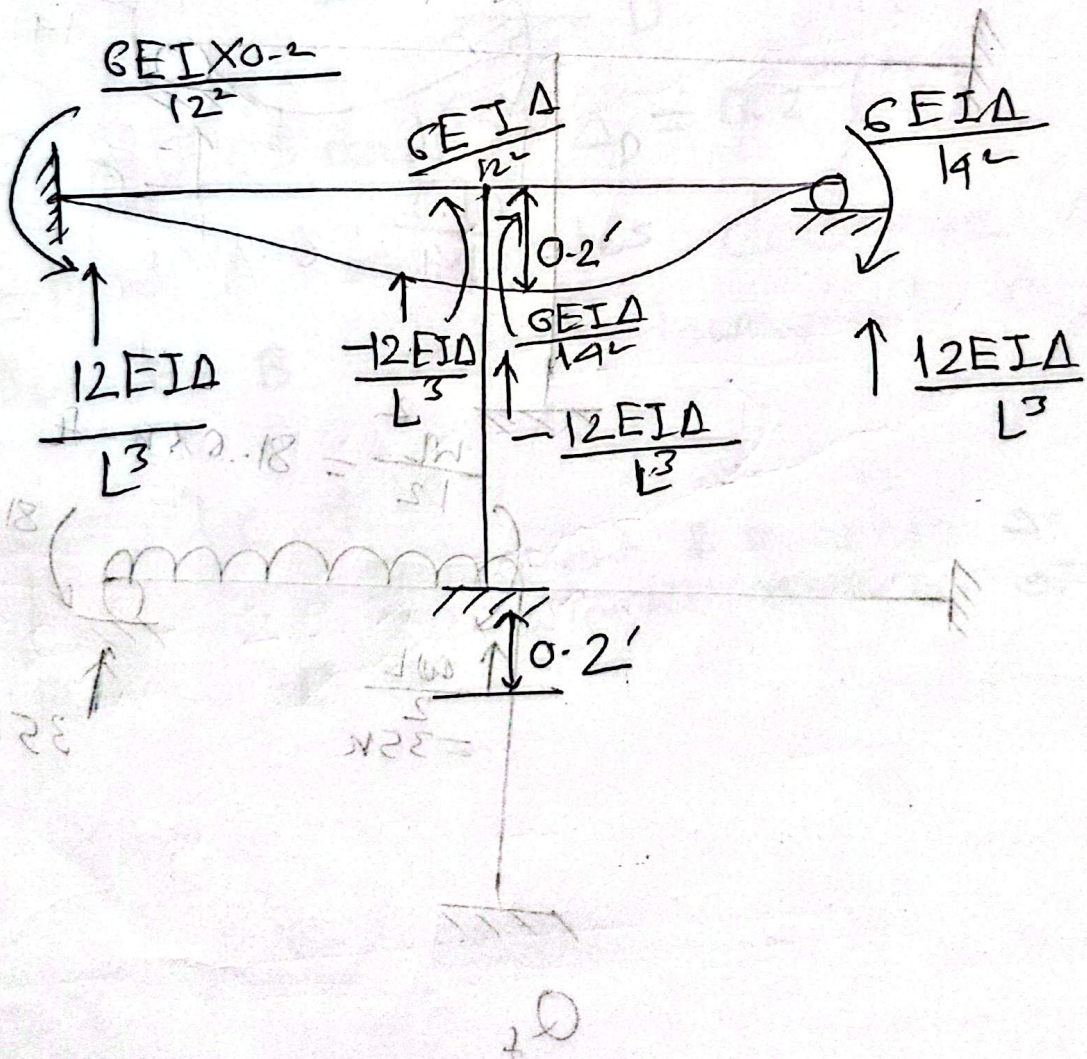
FEM → BE






$\theta_A = 0.05$ Rad
$\frac{2EI}{12} \times 0.05$
$\frac{4EI \times 0.05}{12}$
$\frac{6EI \times 0.05}{12^2}$
$-\frac{6EI \times 0.05}{12^2}$

Q_{f1}


$\frac{6EI \times 0.2}{12^2}$
$\frac{6EI\Delta}{12^2}$
$\frac{6EI\Delta}{14^2}$
0.2'
$\frac{12EI\Delta}{L^3}$
$-\frac{12EI\Delta}{L^3}$
$\frac{6EI\Delta}{14^2}$
$\frac{12EI\Delta}{L^3}$
$-\frac{12EI\Delta}{L^3}$
0.2'

$$U_1 = -\frac{139.25}{EI}$$

$$U_2 = \frac{462.605}{EI}$$

$R_{Ax} = 0^k$ $\quad R_{Ay} = 9.27^k \downarrow$

$M_A = 64.875$ ↻

$R_{Dx} = 2.58^k \longrightarrow$

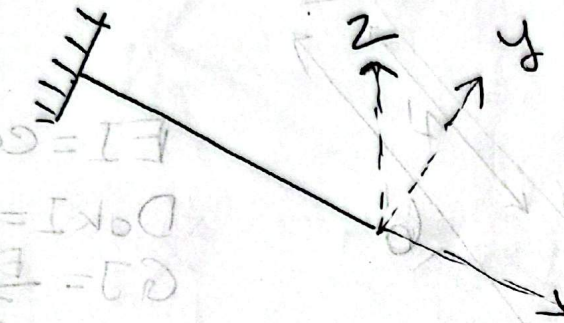
$R_{Dy} = 49.8^k \uparrow$

$M_D = 15.472^{k\text{-}ft}$ ↺

$R_{Cy} = 29.42^k \uparrow$

30.8.26 (Sunday)

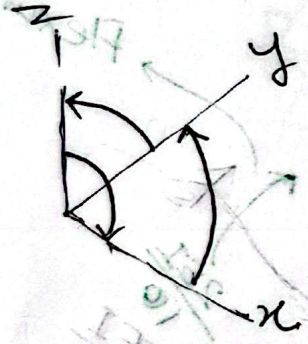
EWCE - 411 (Ziad Sir)



$\theta = \frac{TL}{GJ}$ → Torsional rigidity

G = Modulus of torsion / Shear modulus / Modulus of rigidity

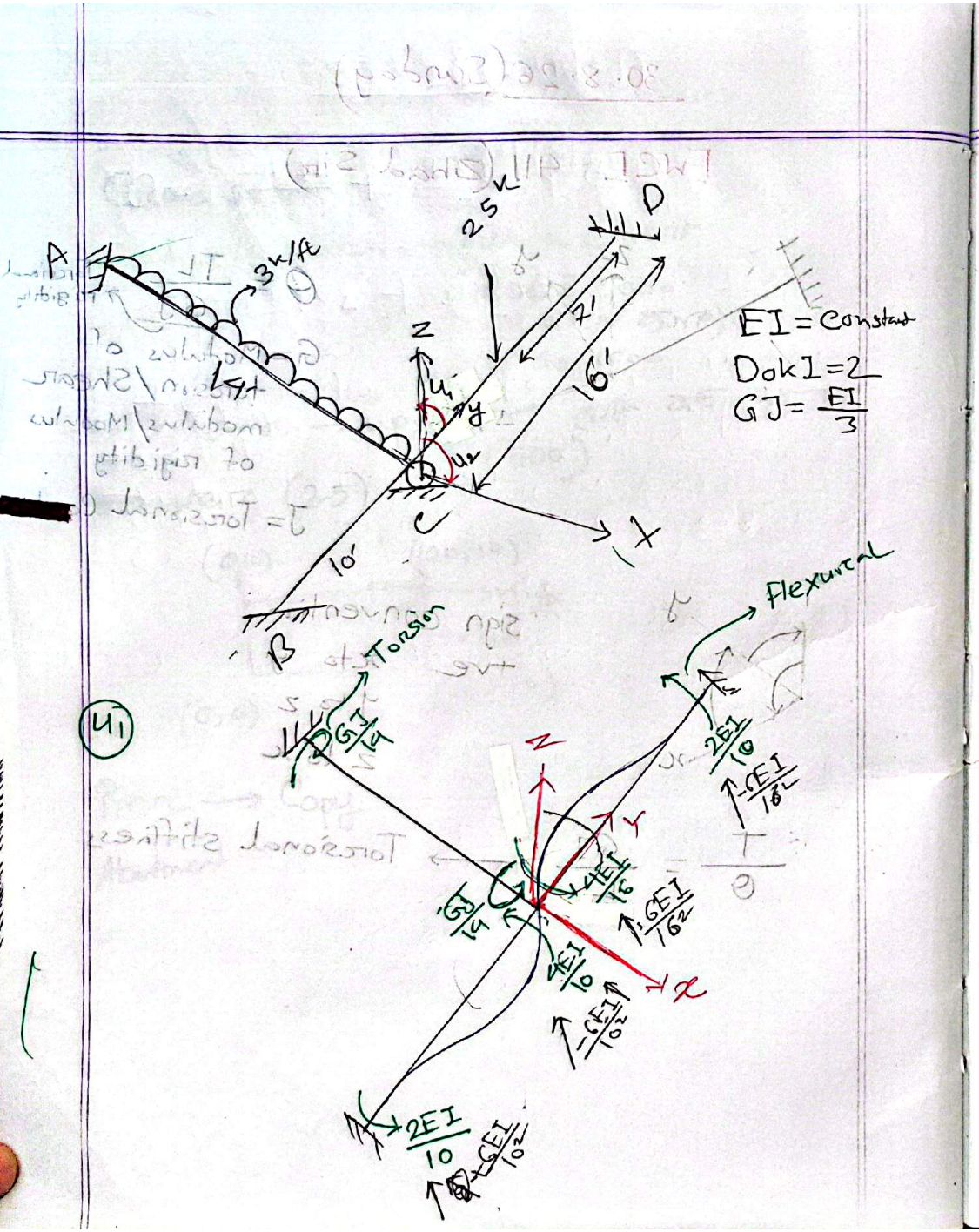
J = Torsional Constant

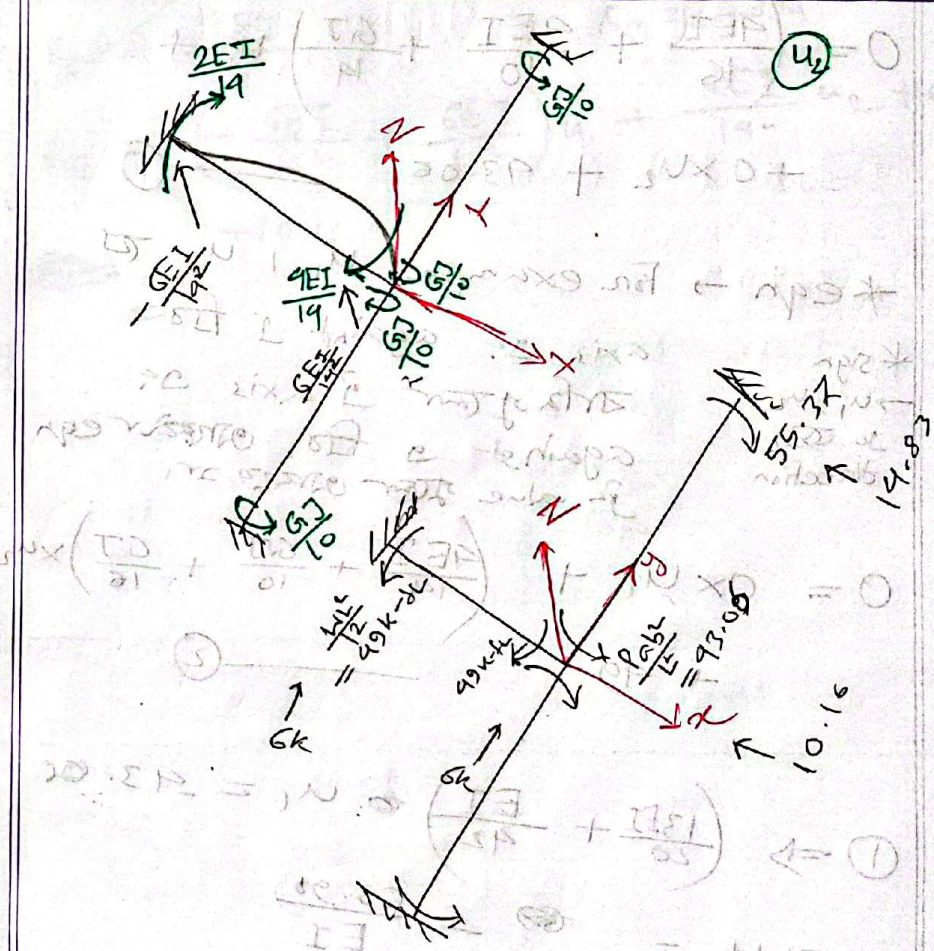


sign convention

+ve x to y
y to z
z to x

$\frac{T}{\theta} = \frac{GJ}{L}$ → Torsional stiffness


A
3k/ft
25k
D
z'
16'
z
y
x
C
10'
B
EI = Constant
Dok I = 2
GJ = EI/3
(4₁)
Torsion
Flexural
GJ/14
2EI/14
4EI/16
6EI/16²
GJ/14
4EI/10
6EI/10²
2EI/10
6EI/10²


(4₂)
2EI/14
GJ/10
GJ/10
GJ/10
4EI/14
6EI/14²
GJ/10
49k
49k-ft
6k
6k
55.37
14.83
10.16
93.05

$$0 = \left(\frac{4EI}{16} + \frac{4EI}{10} + \frac{GJ}{14}\right) u_1 +$$

$$+0 \times u_2 + 43.06 \quad \text{——— (1)}$$

* eqn → For example: u_1 ও u_1 যে axis এর against এ ধরা হয়েছে সেটার axis এর against এ ধরে, আমরা eqn এর value গুলো বসাতে হবে।

*sign → u_1, u_2 যে দিকে direction

$$0 = 0 \times u_1 + \left(\frac{4EI}{14} + \frac{GJ}{10} + \frac{GJ}{16}\right) \times u_2$$

$$+ 49 \quad \text{——— (2)}$$

$$(1) \Rightarrow \left(\frac{13EI}{20} + \frac{EI}{42}\right) u_1 = -43.06$$

$$\Rightarrow u_1 = -\frac{63.96}{EI}$$

$$u_2 = -\frac{199.17}{EI}$$

$T_D = -3 \text{ k-ft}$

$M_D = -63.36$

$R_c = 29.099$

$$R_c = \frac{4EI}{16}$$

$$R_c = \left(-\frac{6EI}{10^2} + \frac{6EI}{16^2}\right) u_1 + \frac{CEI}{14^2} u_2 + 6$$

$$+10.16$$

$$=$$

6.9.26 (Sunday)

EWCE-411 (Zihad Sir)

$\Delta = x$

$\cos\gamma = \frac{x}{1}$

$\Rightarrow x = \cos\gamma$

$\Delta = \frac{PL}{AE}$

$\Rightarrow F = \frac{AE\Delta}{L}$

$= \frac{AE\cos\gamma}{L}$

Original

Displaced

$1 \times \cos\gamma = \cos\gamma = \Delta$

U_1

$\frac{AE}{L}\cos\gamma\sin\gamma$

$\frac{AE}{L}\cos\gamma$

$\frac{AL}{L}\cos\gamma\cos\gamma$

$\frac{AE}{L}\cos\gamma$

$\frac{AE}{L}\cos\gamma$

$\frac{AE}{L}\sin\gamma$

$\frac{AE}{L}\sin\gamma\sin\gamma$

$\frac{AE}{L}\sin\gamma\cos\gamma$

$\sin\gamma$

Displaced

Original

U_2

$\frac{AE}{L}\sin\gamma\cos\gamma$

$\frac{AE}{L}\sin^2\gamma$

Δ_{jy}

Δ_{jx}

Δ_{iy}

Δ_{ix}

$\Delta x = \Delta_{jx} - \Delta_{ix}$

$\Delta y = \Delta_{jy} - \Delta_{iy}$

$\frac{AE}{L}\Delta_j\sin\gamma$

$\Delta_y\sin\gamma$

Δ_j

$\Delta x = \Delta_{jx} - \Delta_{ix}$

$\Delta y = \Delta_{jy} - \Delta_{iy}$

Δy

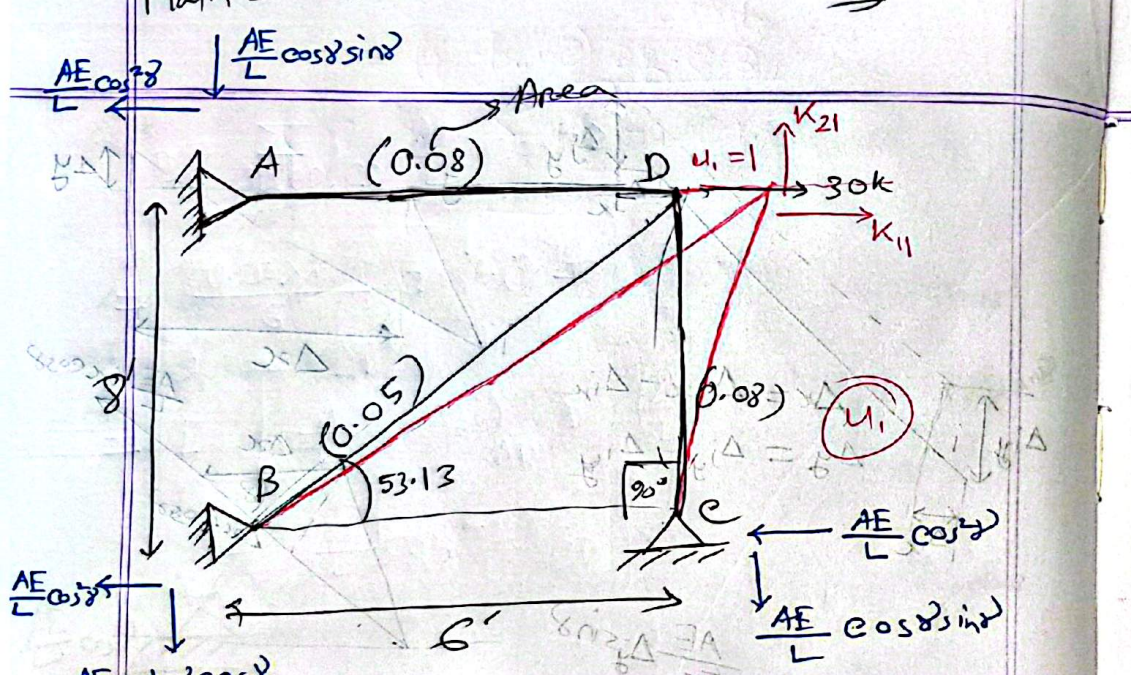
Δx

$\frac{AE}{L}\Delta x\cos\gamma$

$\Delta x\cos\gamma$

$F = \frac{AE}{L}(\Delta_x\cos\gamma + \Delta_y\sin\gamma)$

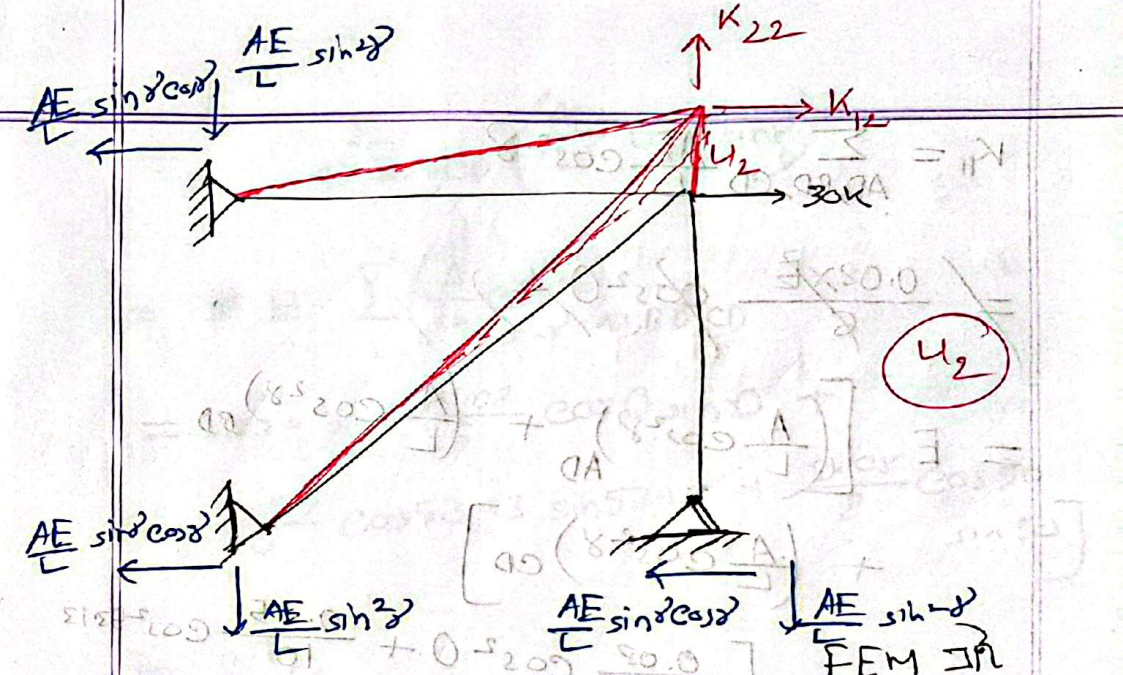
Math [Must আসতে DoK 2 নিয়ে]



$E = 1000^k/ft^2$

DoKI = 2

Reaction force on B for horizontal and vertical displacement =



FEM এর

$Q = Q_f + KU$

$\Rightarrow Q = KU$

or $P_j = KU$

$$K_{11} = \sum_{AD,BD,CD} \frac{AE}{L}\cos^2\theta$$

$$= \frac{0.08 \times E}{8}(\cos^2 0 +)$$

$$= E\left[\left(\frac{A}{L}\cos^2\gamma\right)_{AD} + \left(\frac{A}{L}\cos^2\gamma\right)_{BD} + \left(\frac{A}{L}\cos^2\gamma\right)_{CD}\right]$$

$$= 1000\left[\frac{0.08}{6}\cos^2 0 + \frac{0.05}{10}\cos^2 53.13 + \frac{0.08}{8}\cos^2 90\right]$$

$$= 15.13$$

$$K_{21} = \sum_{AD,BD,CD}\left(\frac{AE}{L}\cos\theta\sin\theta\right)$$

$$= E\sum\left(\frac{A}{L}\cos^2\gamma\sin\gamma\right)_{AD,BD,CD}$$

$$= 1000 \times \frac{0.08}{6}\cos 0\sin 0 + \frac{0.05}{10}\cos 53.13\sin 53.13 + \frac{0.08}{8}\cos 90\sin 90$$

$$= 2.4$$

$$K_{12} = \sum_{AD,BD,CD}\left(\frac{AE}{L}\cos\theta\sin\theta\right)$$

$$= 2.4$$

$$K_{22} = \sum_{AD,BD,CD}\left(\frac{AE}{L}\sin^2\gamma\right)$$

$$= 1000 \times \left[\frac{0.08}{6}\sin^2 0 + \frac{0.05}{10}\sin^2 53.13 + \frac{0.08}{8}\sin^2 90\right]$$

$$= 13.2$$

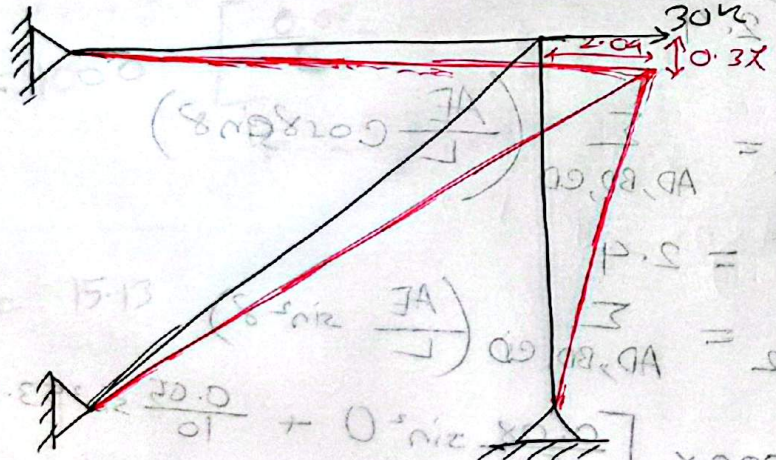
FARIHA TASNEEM

$D_J = KU$

$30 = K_{11} u_1 + K_{12} u_2$

$0 = K_{21} u_1 + K_{22} u_2$

$u_1 = 2.09 \quad u_2 = -0.3\text{x}$



$F_{AD} = \frac{AE}{L}(\Delta x \cos^2\theta + \Delta y \sin\theta)$

$= \frac{0.08 \times 1000}{6}(2.04 \times \cos 0 + 0.3\text{x} \sin 0) = 27.23^{k}(T)$

$F_{BD} = \frac{0.05 \times 1000}{10}(2.04 \times \cos 53.13 - 0.3\text{x} \times \sin 53.13) = 4.64^{k}(T)$

$F_{CD} = \frac{0.08 \times 1000}{8}(2.04 \times \cos 53.13 - 0.3\text{x} \cos 90)$

$= -3.\text{x}^{k}\ (C)$

For u_1,

$R_{Bx} = \frac{AE}{L}\cos^2\theta\, u_1 = 0.\phi$

$R_{Bx} = \left(-\frac{AE}{L}\cos^2\theta\right)u_1 - \left(\frac{AE}{L}\sin\theta\cos\theta\right)u_2$

$= \left[\left(-\frac{0.05}{10}\cos^2 53.13\right) \times 2.09 - \frac{0.05\text{x}}{10}(\sin 53.13 \cos 53.13) \times -0.3\text{x}\right] \times 1000$

$= -2.\text{x}85^{k}\ (\leftarrow)$

$$R_{By} = \left(-\frac{AE}{L}\sin\theta\cos\theta\right)u_1 + \left(\frac{AE}{L}\sin\theta\cos\theta\right)u_2$$

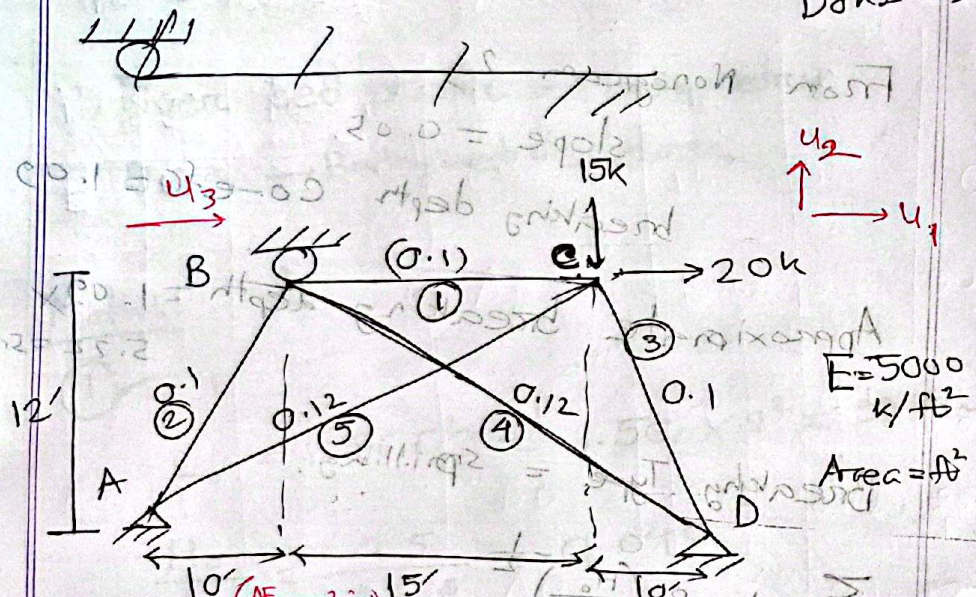
$$= +1000\left[\left(-\frac{0.05}{10}\sin 53.13 \times \cos 53.13\right)\times 2.04 - \left(\frac{0.05}{10}\sin^2 53.13 \times \cos 53.13\right)\times -0.32\right]$$

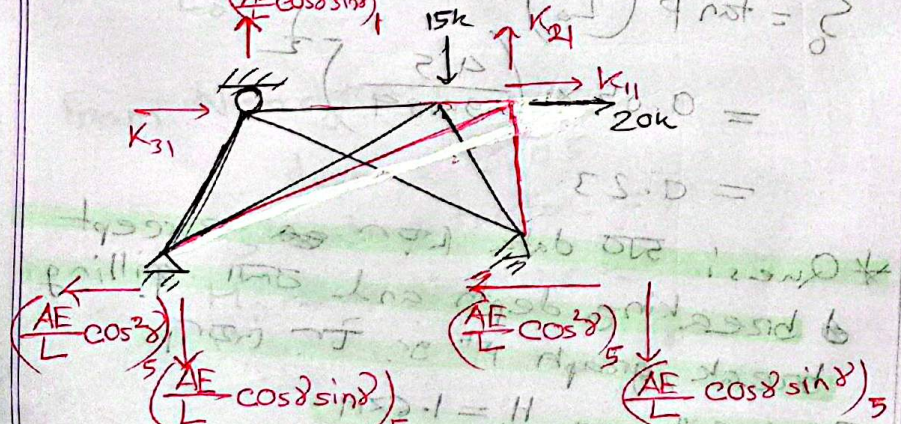
$$= -3.21^{k}\ (\downarrow)$$

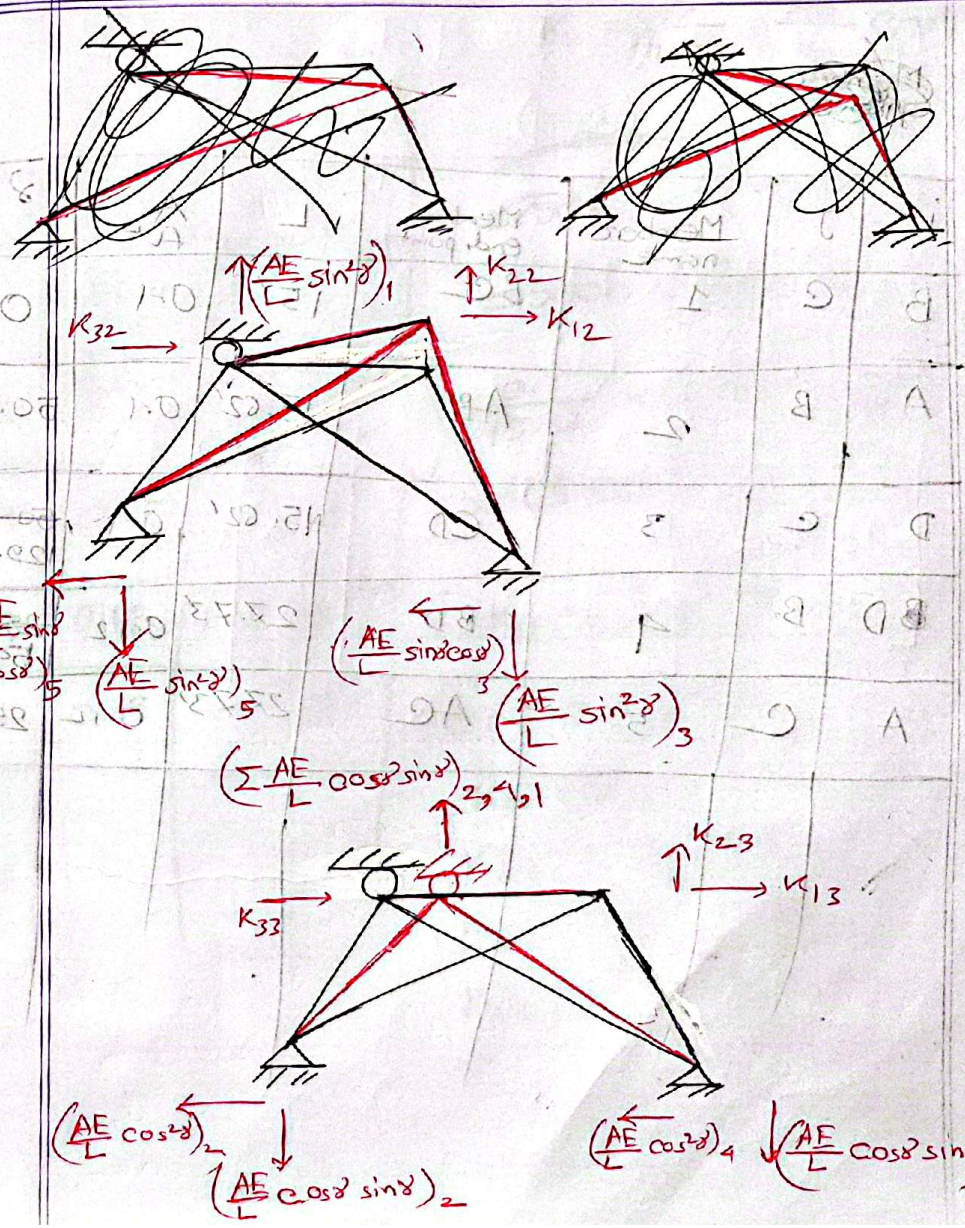
13·9·26 (Sunday)

EWCE-411 (Zihad Sir)

DoKI = 3







$R_{Ax} = 3.78\ (\leftarrow)$

$R_{Dx} = 16.22\ (\leftarrow)$

$R_{Ay} = 3.5\ (\downarrow)$

$R_{By} = 1.3\ (\uparrow)$

$R_{Dy} = 12.2\ (\uparrow)$

$F_{AB} = 3.62\ (T)$

$F_{AC} = 1.59\ (T)$

$F_{CD} = 20.43\ (C)$

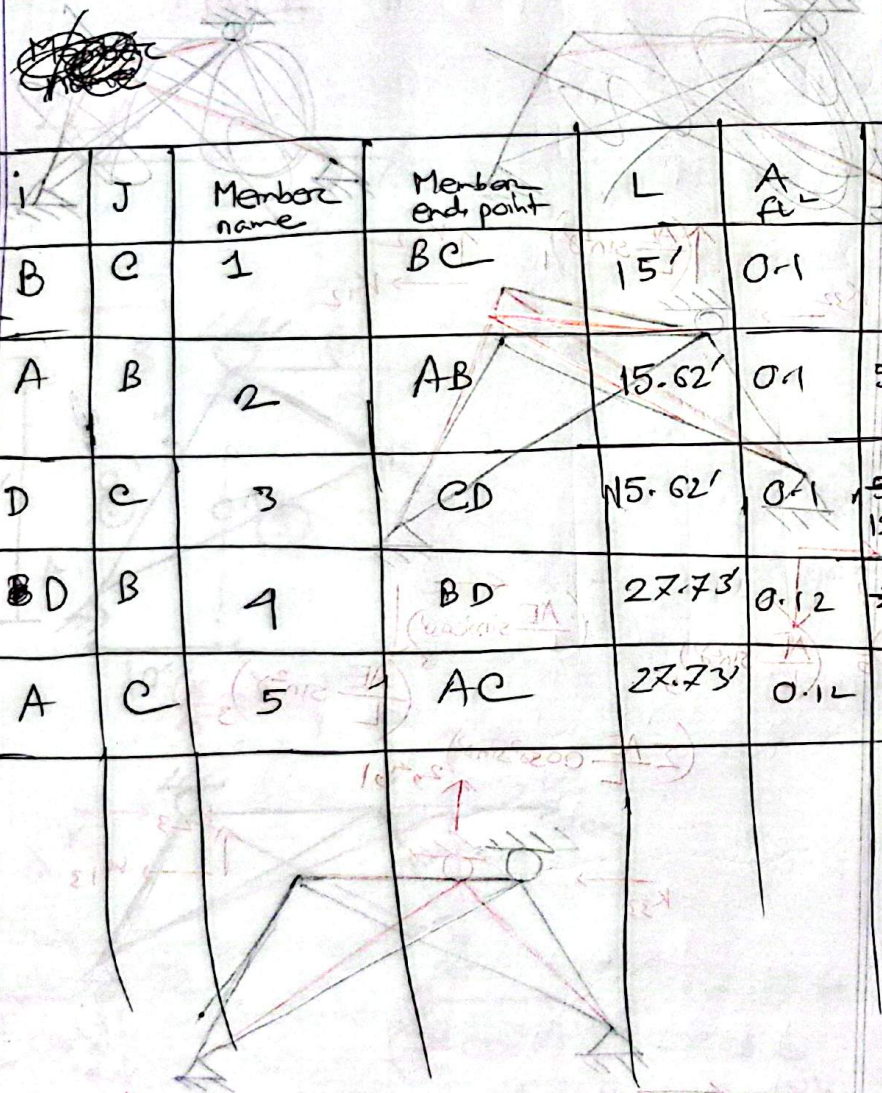
$F_{BC} = 5.47\ (T)$

$F_{BD} = 3.49\ (C)$

$$\begin{bmatrix} 20 \\ -15 \\ 0 \end{bmatrix} = \begin{bmatrix} K_{11} & K_{12} & K_{13} \\ - & - & - \\ - & - & - \end{bmatrix} \begin{bmatrix} U_1 \\ U_2 \\ U_3 \end{bmatrix}$$

i → initial point

j → 2nd point change



i	J	Member name	Member end point	L	A ft²	θ	cosθ	sinθ	cosθ sinθ
B	C	1	BC	15'	0.1	0	1	0	0
A	B	2	AB	15.62'	0.1	50.19	0.9	0.59	0.99
D	C	3	CD	15.62'	0.1	~~50.19~~ 129.81	0.9	0.59	−0.99
BD	B	4	BD	27.73'	0.12	~~25.69~~ 154.31	0.81	0.18	+ 0.39
A	C	5	AC	27.73'	0.12	25.69	0.81	0.18	0.39

$$K_{11} = \sum_{1,35} \frac{AE}{L} \cos^2\theta$$

~~$0.1 \times$~~

~~$5000 \left(\frac{0.1}{15} \times 1\right)$~~

$$= 5000 \left(\frac{0.1}{15} \times 1 + \frac{0.1}{15.62} \times 0.9 + \frac{0.12}{27.73} \times 0.81\right)$$

$$= 63.66$$

$$K_{12} = \sum_{1,3,5} \left(\frac{AE}{L} \cos\theta \sin\theta\right)$$

$$= -7.24 = K_{21}$$

$$K_{31} = K_{13} = -33.33$$

$$K_{22} = 22.93$$

$$K_{32} = K_{23} = 0$$

$$K_{33} = 69.04$$

CamScanner

Formulation of Stiffness Method [20-09-26]

& Direct Stiffness method

* Member End's shear force & moment determination.

* Qualitative deflection shape.

Formalization/Matrix

Brief

* UVL,

