

Module - IV

Matrix method of Analysis

Two types of matrix method:

- (i) Flexibility matrix method
- (ii) Stiffness " " "

Flexibility & Stiffness:

The need for the analysis of high degree indeterminate structure & development of computers have given rise to this new method is called matrix method.

There are two types of matrix method -
(i) Flexibility matrix, (ii) Stiffness matrix.

Stiffness matrix method	Flexibility matrix method
<p>1. The systematic development of slope deflection method in the matrix form has given rise to stiffness matrix method.</p> <p>2. In this method the basic unknowns are displacement.</p> <p>3. In this method the equations of equilibrium are formed & solved to get slope & deflection at the joint. By using these moment & shear forces are calculated.</p>	<p>1. The systematic development of consistent deformation method in a matrix form has led to flexibility matrix method.</p> <p>2. In this method basic unknowns are redundant forces.</p> <p>3. In this analysis first identify basic determinate structure & thereby identify redundant forces. The number of redundant forces are equal to the degree of static</p>

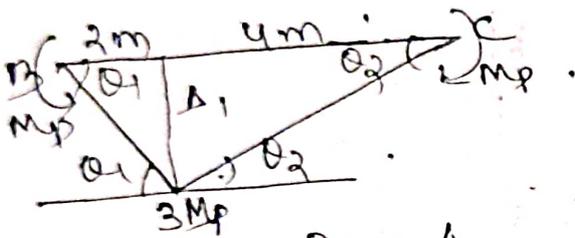
Stiffness matrix method	Flexibility matrix method
4. This method is also known as equilibrium method or displacement method	4. This method is also known as Force method or compatibility method.

Date - 1/1/19

Q: Determine the collapse load w_c for the frame shown in figure -

Solⁿ

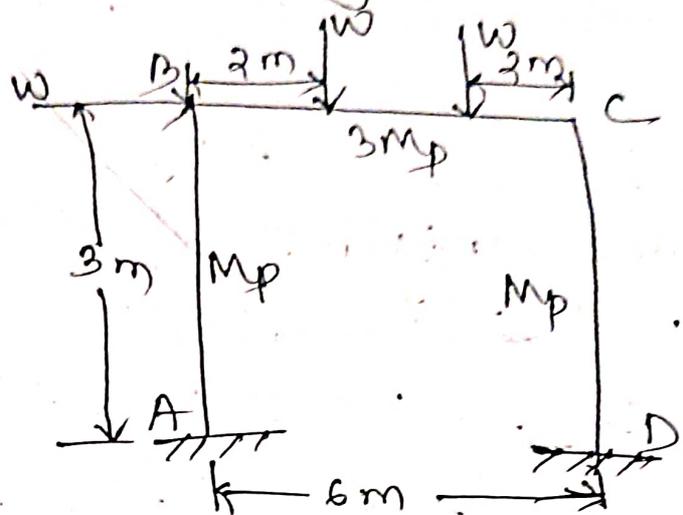
(i) Beam Mechanism (I)
in BC



$$2\theta_1 = 4\theta_2 = \Delta_1$$

$$\Rightarrow \theta_1 = \frac{4}{2}\theta_2$$

$$\boxed{\theta_1 = 2\theta_2}$$



$$I.W. = Mp\theta_1 + Mp\theta_2 + 3Mp\theta_1 + 3Mp\theta_2$$

$$= 2Mp\theta_2 + Mp\theta_2 + 6Mp\theta_2 + 3Mp\theta_2$$

$$= 12Mp\theta_2$$

$$E.W. = w_c \Delta_1 + w_c \Delta_2$$

$$= w_c \times 4\theta_2 + w_c \times 2\theta_2$$

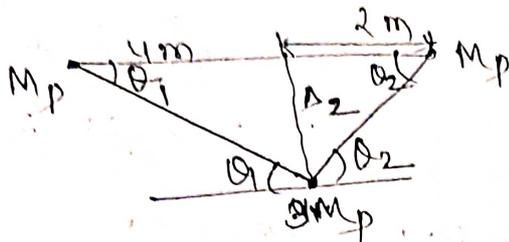
$$= 6w_c\theta_2$$

$$I.W. = E.W.$$

$$\Rightarrow 12Mp\theta_2 = 6w_c\theta_2$$

$$\Rightarrow w_c = 2Mp$$

10.
 (11) Beam mechanism (11) in BC



~~I.W. = Mp~~ $4\theta_1 = 2\theta_2 = \Delta$

$\Rightarrow \theta_2 = \frac{2\theta_1}{0.5\theta_1}$

~~I.W. = Mp\theta_1 + Mp\theta_2 + 3Mp\theta_1 + 3Mp\theta_2~~

~~$\frac{0.5Mp\theta_2 + Mp\theta_2}{0.5Mp\theta_2 + Mp\theta_2} + 3 \times 0.5Mp\theta_1 + 3Mp\theta_2$~~

I.W. = $Mp\theta_1 + Mp\theta_2 + 3Mp\theta_1 + 3Mp\theta_2$

= $Mp\theta_1 + 2Mp\theta_1 + 3Mp\theta_1 + 6Mp\theta_1$

= $12Mp\theta_1$

E.W. = $w_c A_1 + w_c A_2$

= $w_c 2\theta_1 + w_c 4\theta_1$

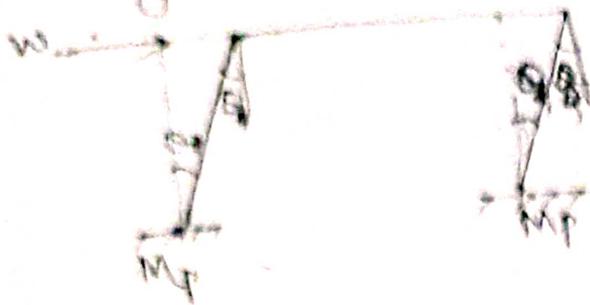
= $6w_c\theta_1$

I.W. = E.W.

$\Rightarrow 12Mp\theta_1 = 6w_c\theta_1$

$\Rightarrow \boxed{w_c = 2Mp}$

(11) sway mechanism



$$I.W. = M_p \theta + M_p \theta + M_p \theta + M_p \theta$$

$$= 4 M_p \theta$$

$$E.W. = w_c \Delta$$

$$= w_c \times 30$$

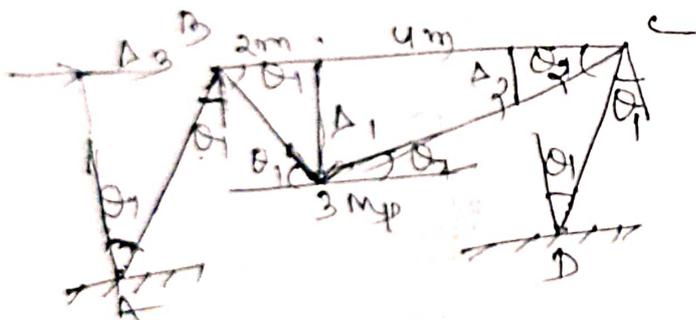
$$I.W. = \delta E.W.$$

$$\Rightarrow 4 M_p \theta = w_c \times 30$$

$$\Rightarrow w_c = \frac{4}{3} M_p$$

$$= 1.33 M_p$$

(12) Combined Mechanism (E)



$$2\theta_1 = 4\theta_2 = \Delta_1$$

$$\Rightarrow \theta_1 = 2\theta_2$$

$$\Delta_2 = 2\theta_1 = \theta_2$$

$$3\theta_1 = 6\theta_2 = \Delta_3$$

$$\begin{aligned}
 I.W. &= M_p \theta_1 + 3M_p(\theta_1 + \theta_2) + M_p \theta_2 + M_p \theta_1 + M_p \theta_1 \\
 &= 2M_p \theta_2 + 6M_p \theta_2 + 3M_p \theta_2 + M_p \theta_2 + 2M_p \theta_2 + 2M_p \theta_2 \\
 &= 16M_p \theta_2
 \end{aligned}$$

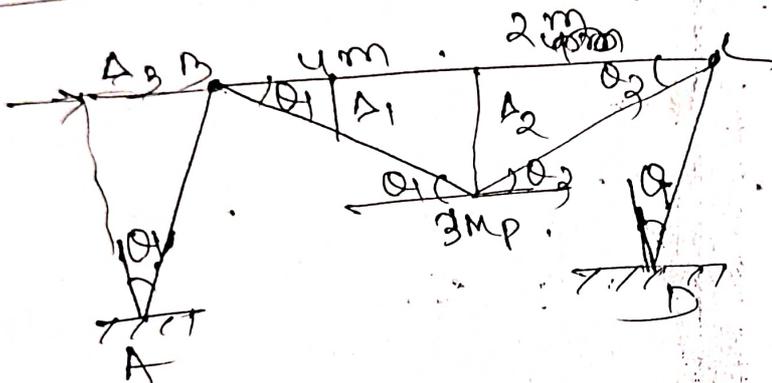
$$\begin{aligned}
 E.W. &= w_c \times 4\theta_2 + w_c \times 2\theta_2 + w_c \times 6\theta_2 \\
 &= 12w_c \theta_2
 \end{aligned}$$

$$I.W. = E.W.$$

$$\Rightarrow 16M_p \theta_2 = 12w_c \theta_2$$

$$\Rightarrow w_c = \frac{16}{12} M_p = 1.33 M_p$$

(V) combined mechanism (II) ?



$$4\theta_1 = \delta_2 = 2\theta_3$$

$$\Rightarrow \theta_3 = 2\theta_1$$

$$\delta_1 = 2\theta_3$$

$$\delta_3 = 3\theta_1 = 6\theta_2$$

$$\begin{aligned}
 I.W. &= M_p \theta_1 + 3M_p(\theta_1 + \theta_2) + M_p \theta_2 + M_p \theta_1 + M_p \theta_1 \\
 &= 16M_p \theta_1
 \end{aligned}$$

$$\begin{aligned}
 E.W. &= w_c \delta_1 + w_c \delta_2 + w_c \delta_3 \\
 &= w_c 2\theta_1 + w_c 4\theta_1 + w_c 3\theta_1 \\
 &= 12w_c \theta_1
 \end{aligned}$$