Analysis of frames Subjected to Horizontal forces:-

The following approximate methods are in practice.

(i) The Portal method.
(ii) The Cantilever method.

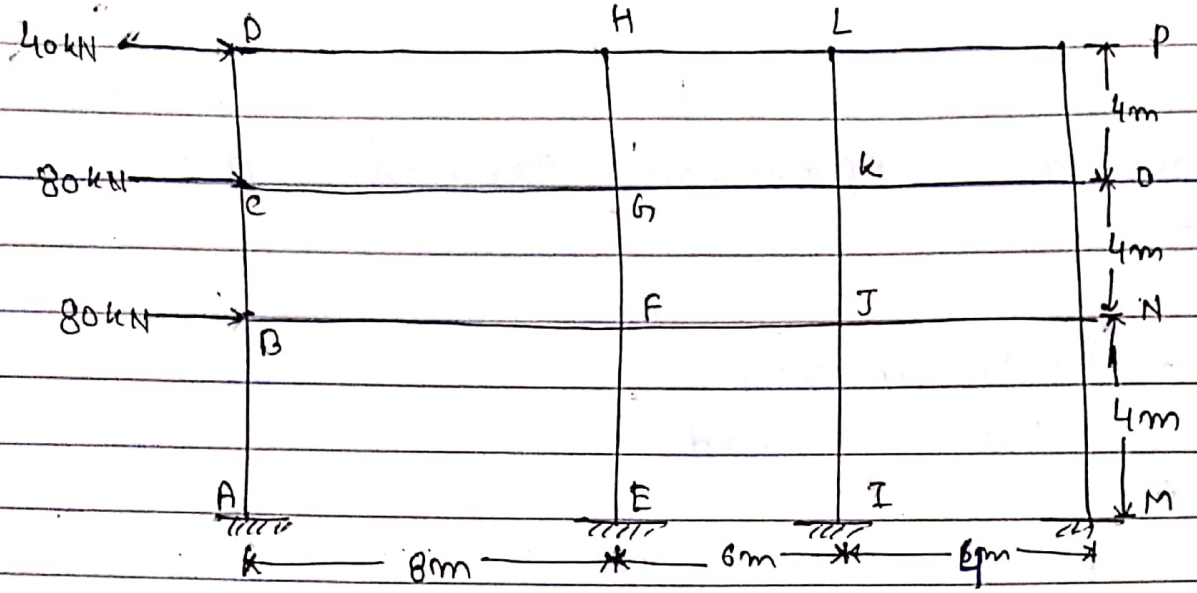
1. The Portal method:-

(a) Points of Contraflexure occur at the middle points of the members of the frame.

(b) Horizontal Shear taken by each interior Column is double the Horizontal Shear taken by each of the external Columns.

∴ By making the above two assumptions the Structure can be easily analysed.

6. Analyse the frame :-



Solution:-

We will assume that Points of Contraflexure occur at the middle Points of the individual Components

Column Shear

STOREY-3:-

Q_3 = Shear for each end Column

$\therefore 2Q_3$ = Shear for each intermediate Column

$$\therefore Q_3 + 2Q_3 + 2Q_3 + Q_3 = 40$$

$$\boxed{Q_3 = \frac{20}{3}\ kN}$$

∴ Shear for end Column $= Q_3 = \frac{20}{3}$ KN

∴ Shear for intermediate Column $= 2Q_3 = 2 \times \frac{20}{3} = \frac{40}{3}$ KN

STOREY - 2

∵ Q_2 = Shear for each end Column

∴ $2Q_2$ = Shear for each intermediate Column

$$Q_2 + 2Q_2 + 2Q_2 + Q_2 = 40 + 80$$

$$\boxed{Q_2 = 20 \text{ KN}}$$

∴ Shear for end Column $= Q_2 = 20$ KN

∴ Shear for intermediate Column $= 2Q_2 = 2 \times 20$ KN
$= 40$ KN

STOREY - 1

∴ Q_1 = Shear for each end Column

∴ $2Q_1$ = Shear for endermedial Column

$$Q_1 + 2Q_1 + 2Q_1 + Q_1 = 40 + 80 + 80$$

$$\boxed{Q_1 = \frac{100}{3} \text{ KN}}$$

∴ Shear for end Column = $\frac{100}{3}$ kN

∴ Shear for intermediate column = 2α_1 = $\frac{2 \times 100}{3} = \frac{200}{3}$ kN

Column moment:-

Storey 3:-

End Column. Moment at top or bottom = $\frac{20}{3} \times 2 = \frac{40}{3}$ kN

intermediate Column. Moment at top or bottom = $\frac{40}{3} \times 2$

$= \frac{80}{3}$ kNm

Storey 2:-

End Column: moment at top or bottom = 20 x 2 = 40 kNm

intermedial Colum. Moment at top or bottom = 40 x 2 = 80 kNm

Storey 1:-

End Column. moment at top or bottom = $\frac{100}{3} \times 2 = \frac{200}{3}$ kNm

intermediate Colum. Moment at top or bottom = $\frac{200}{3} \times 2 = \frac{400}{3}$ kNm

Beam moments :-

Storey 3 :-

$$M_{dh} = M_{dc} = \frac{40}{3} \text{ KN-m}$$

$$M_{hd} + M_{he} = M_{hg}$$

$$\frac{40}{3} + M_{he} = \frac{80}{3} \quad \therefore \quad \boxed{M_{he} = \frac{40}{3} \text{ kN-m}}$$

$$M_{ep} + M_{he} = M_{eh}$$

$$M_{ep} + \frac{40}{3} = \frac{40}{3} \times 2 \frac{80}{3}$$

$$\boxed{M_{ep} = \frac{40}{3} \text{ KN-m}} \qquad \boxed{M_{ep} = M_{po} = \frac{40}{3} \text{ kN-m}}$$

Storey - 2

$$M_{cG} = M_{cd}' + M_{cb}$$

$$= \frac{40}{3} + 20 \times 2 40$$

$$= \frac{160}{3} \text{ kN-m}$$

$$\boxed{M_{gc} = M_{cG} = \frac{160}{3} \text{ kN-m}}$$

$$M_{gc} + M_{gk} = M_{gh} + M_{gf}$$

$$\frac{160}{3} + M_{gk} = \frac{80}{3} + 40 \times 2$$

$$\boxed{M_{gk} = \frac{160}{3} \text{ kN-m}}$$

Storey - 1

$$M_{bf} = M_{BC} + M_{BA}$$

$$M_{bf} = 20 \times 2 + \frac{200}{3}$$

$$\boxed{M_{bf} = \frac{320}{3} \text{ kN-m}}$$

$$M_{fb} + M_{fj} = M_{gf} + M_{fe}$$

$$\frac{320}{3} + M_{fj} = 80 + \frac{400}{3}$$

$$\boxed{M_{fj} = \frac{320}{3} \text{ kN-m}}$$

Shear in Beams:

S.F in DH = $\frac{2\times}{}$

$M = S.F \times \frac{L}{2}$

$$SF = \frac{2M}{L}$$

S.F in DH = $\frac{2\times\frac{40}{3}}{8} =$

S.F in HL = $\frac{2\times\frac{40}{3}}{6} = \frac{80}{18} = \frac{40}{9}$ kN

S.F in LP = $\frac{2\times\frac{40}{3}}{4} = \frac{80}{12}$

S.F in CG = $\frac{2\times160}{8} = \frac{320}{24} = \frac{40}{3}$ kN

S.F in GK = $\frac{2\times\frac{160}{3}}{6} =$

S.F in KO = $\frac{2\times\frac{160}{3}}{4} = \frac{320}{12} = \frac{80}{3}$ kN

S.F in BF = $\frac{2\times\frac{320}{3}}{8} = \frac{640}{24} = \frac{80}{3}$ kN

S.F in FJ = $\frac{2\times\frac{320}{3}}{6} = \frac{640}{18} = \frac{320}{9}$ kN

S.F in JN = $\frac{2\times\frac{320}{3}}{4} =$

$= \frac{640}{12}$

$= \frac{160}{3}$