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Section:
A

Subject:
Structure Analysis (I)

Dept:
Civil Engineering

Semester:
4th

Answer No 1

Types of Loads on Structures and Buildings

In a construction two major factors considered are Safety and economy. If the loads are taken higher then economy is affected. If economy is considered and loads are taken lesser then safety is affected.

Types of loads acting on a structure:

1. Dead loads
2. Imposed loads
3. Wind loads
4. Snow loads
5. Earth quake loads

1. **Dead loads:**

The first vertical load that is considered is dead load. Dead loads are permanent or stationary loads which are transferred to structure through out the life span. Dead load is primarily due to self weight of structural members, permanent partition walls, fixed permanent equipments and weight of different materials. It majorly consists of weight of roofs, beams, walls and column etc which are otherwise the permanent parts of the building.

2. Imposed loads or live loads:

The second load that is considered in design of a structure is imposed loads or live loads. Live loads are either movable or moving loads without any acceleration or impact. These loads are assumed to be produced by the intended use or occupancy of the building including weights of movable partitions or furniture etc.

Live loads keeps on changing time to time. These loads are to be suitably assumed by the designer. It is one of the major load in design.

3. Wind loads:

Wind load is primarily horizontal load caused by the movement of air relative to earth. Wind load is required to be considered in structural design especially when the height of the building exceeds two times the dimensions transverse to the exposed wind surface.

For low rise buildings upto four or five stories, the wind load is not critical because the moment of resistance provided by the continuity of floor system to column connection and walls provided between columns are sufficient to accommodate the effect of these forces.

4. Snow loads:

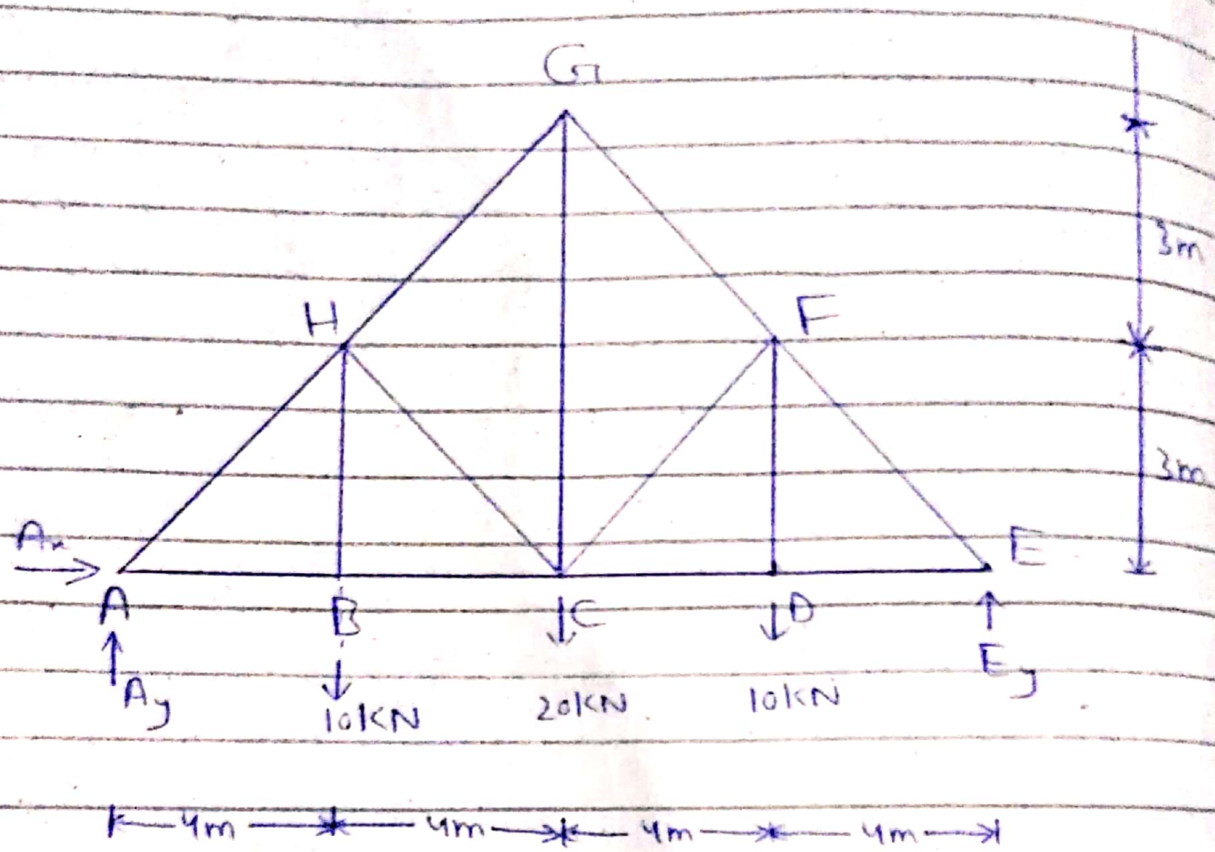
Snow loads constitute to the vertical loads in the building. But these types of loads are considered only in ~~case of~~ snow fall places.

5. Earthquake loads:

Earthquake forces constitute to both vertical and horizontal forces on the building. The total vibration caused by earth quake may be resolved into three mutually perpendicular directions, usually taken as one vertical and two horizontal directions.

The movement in vertical direction do not cause forces in superstructure to any significant extent. But the horizontal movement of the building at the time of earthquake is to be considered while designing.

Solution: No (2)



1) Find Reactions of unknown supports.

$\Sigma F_x = 0$

Taking moment at A

+↺ (Assumptions)

$\Sigma M_A = 0$

$\Sigma M_A = (-E_y \times 16m) + (10KN \times 12m)$

$\Sigma M_A = (-E_y \times 16m) + (10kN \times 12) + (20kN \times 8m)$
$+ (10kN \times 4m)$

$= (-E_y \times 16m) + (120kNm) + (160kNm) + (40kNm)$

$= (-E_y \times 16m) + 320kNm = 0$

$= -E_y 16 = -320$

$\Rightarrow E_y = \frac{+320}{+16}$

$\Rightarrow \boxed{E_y = 20kN}$

Now the sum of all vertical forces to find A_y

$-\downarrow \uparrow +$ (Assumptions)

$\Sigma F_y = 0$

$\Sigma F_y = A_y - 10kN - 20kN - 10kN + E_y = 0$

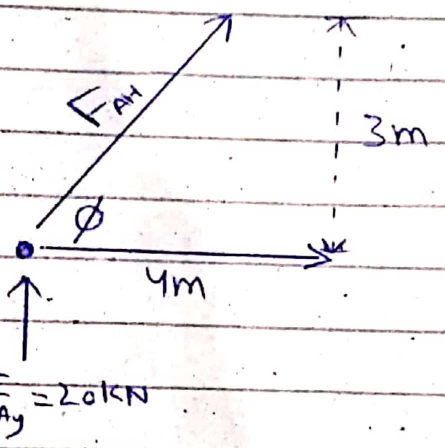
$= A_y - 40kN + 20kN = 0$

$= A_y - 20kN = 0$

$\Rightarrow$ $\boxed{A_y = 20kN}$

Now we will use the method of joints to find the forces acting on the joints.

Joint A:



$$\tan\phi = \frac{3}{4}$$

$$\phi = \tan^{-1}\left(\frac{3}{4}\right)$$

$$\boxed{\phi = 36.86^\circ}$$

$$\Sigma F_y = 0$$

$$\Sigma F_y = A_y + F_{AH}\sin\phi = 0$$

(4)

$\Sigma F_y = 20kN + F_{AH} \sin(36.86°) = 0$

$\Sigma F_y = F_{AH} \sin(36.86°) = -20kN$

$\Sigma F_y = F_{AH} = \dfrac{-20kN}{\sin(36.86°)}$

$\Sigma F_y = F_{AH} = -33.33kN$

$F_{AH} = -33.33kN$ (Compression)

Now the horizontal forces are

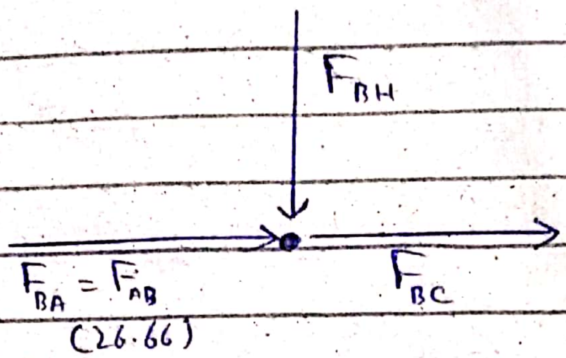
$\Sigma F_x = F_{AB} + F_{AH} \cos\phi$

$\Sigma F_x = F_{AB} + (-33.33)\cos(36.86°) = 0$

$\Sigma F_x = F_{AB} - 26.66 = 0$

$F_{AB} = 26.66$ (Tension)

Joint B:



$\Sigma F_x = 0$

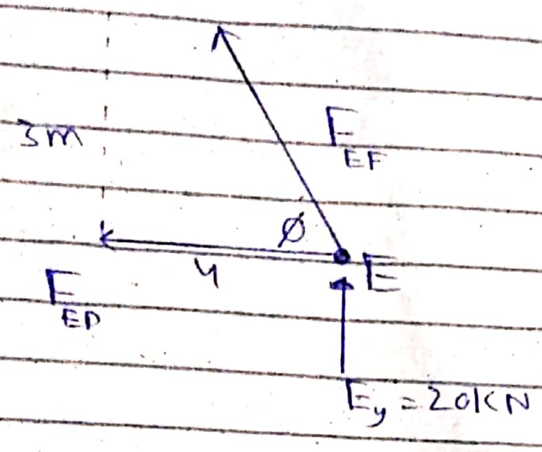
$\Sigma F_x = F_{BA} + F_{BC} = 0$

$\Sigma F_x = 26.66 + F_{BC} = 0$

$\Sigma F_x = F_{BC} = -26.66\,kN$ (Compression)

~~Joint E~~:

Joint E:



$$\tan\phi = \frac{3}{4}$$

$$\phi = \tan^{-1}\left(\frac{3}{4}\right)$$

$$\boxed{\phi = 36.86^\circ}$$

$$\Sigma F_y = 0$$

$$\Sigma F_y = 20kN + \sin\phi F_{EF}$$

$$\Sigma F_y = 20kN + \sin(36.86)F_{EF}$$

$$\Sigma F_y = F_{EF}\sin(36.86^\circ) = -20kN$$

$$\Sigma F_y = F_{EF} = \frac{-20\,KN}{\sin(36.86^\circ)}$$

$$F_{EF} = -33.33\,KN \text{ (Compression)}$$

$$\Sigma F_x = 0$$

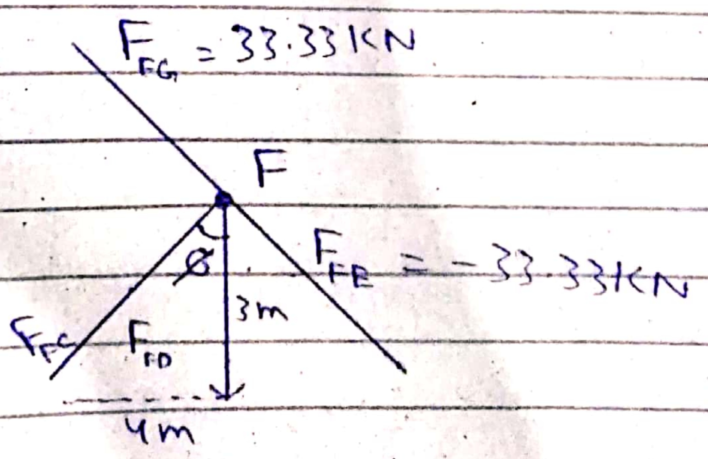
$$\Sigma F_x = F_{ED} + F_{EF}\cos\phi$$

$$\Sigma F_x = F_{ED} + (-33.33)(0.8) = 0$$

$$\Sigma F_x = F_{ED} + (-26.66) = 0$$

$$\Sigma F_x = F_{ED} = 26.66 \text{ (Tension)}$$

<u>Joint F:</u>



$$\tan\phi = \frac{4}{3}$$

$$\phi = \tan^{-1}\left(\frac{4}{3}\right)$$

$$\boxed{\phi = 53.13^\circ}$$

$$\Sigma F_x = \sin\phi \, F_{FC} \quad \text{— (1)}$$

$$\Sigma F_y = F_{FC}\cos\phi - F_{FD}$$

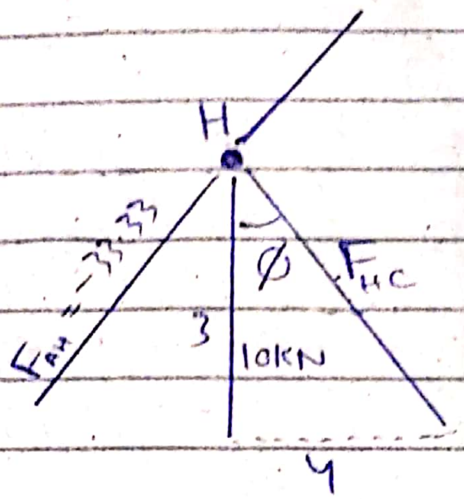
$$\Sigma F_y = F_{FC}\cos\phi - 10kN = 0$$

$$\Sigma F_y = F_{FC}\cos\phi = 10kN$$

$$F_{FC} = \frac{10kN}{\cos(53.13^\circ)}$$

$$F_{FC} = 16.67 \, kN \text{ (Tension)}$$

Joint H:



$$\phi = \tan^{-1}\left(\frac{4}{3}\right)$$

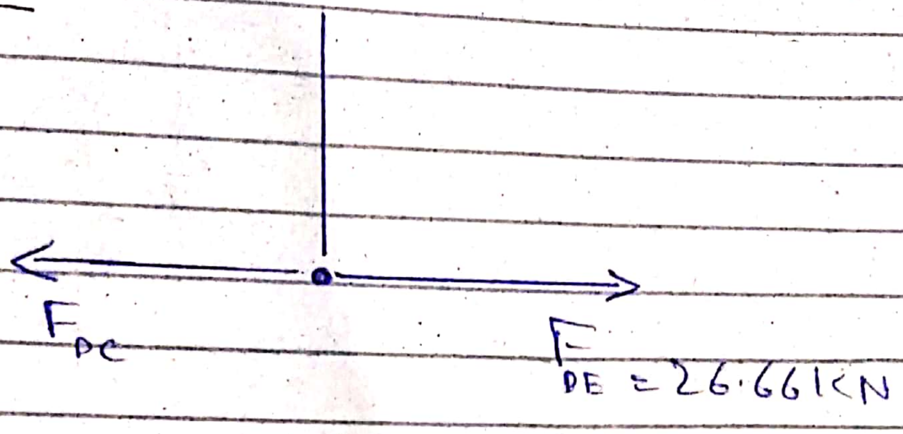
$$\boxed{\phi = 53.13^\circ}$$

$$\Sigma F_y = F_{HC}\cos\phi - 10kN = 0$$

$$\Sigma F_y = F_{HC} = \frac{10kN}{\cos(53.13)}$$

$$\boxed{F_{HC} = 16.66\ kN\ (\text{Tension})}$$

Joint D:



$\Sigma F_x = 0$

$\Sigma F_x = F_{DC} + 26.66\,KN = 0$

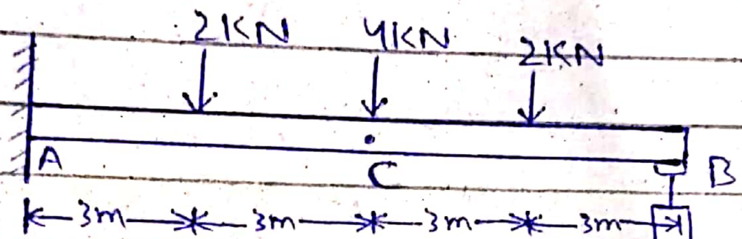
$\Sigma F_x = F_{DC} = -26.66$

$F_{DC} = -26.66$ (compression)

Member	Direction
AH/HA	-33.33 (Compression)
AB/BA	26.66 (Tension)
BC/CB	-26.66 (Compression)
ED/DE	26.66 (Tension)
EF/FE	-33.33 (Compression)
DC/CD	-26.66 (Compression)
HG/GH	33.33 (Tension)
FG/GF	33.33 (Tension)
FC/CF	16.67 (Tension)
HC/CH	16.67 (Tension)

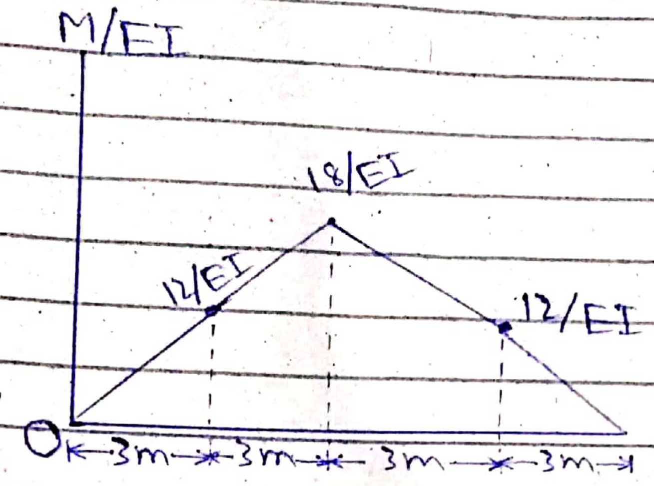
Q3: Determine Slope at A and displacement at C of the beam in the figure. Take E = 200 GPa, I = $6 \times 10^6 mm^4$

Solution:

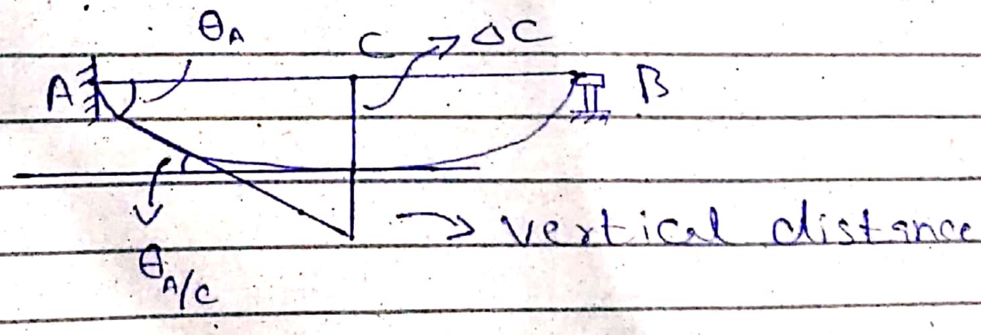


First we will draw the M/EI diagram of the given beam and then the elastic curve of the given beam.

M/EI diagram:



Elastic Curve:



$$\theta_{A/C} = \frac{1}{2}\left(\frac{12}{EI}\right)(3) + \left(\frac{12}{EI}\right)(3) + \frac{1}{2}\left(\frac{6}{EI}\right)(3)$$

$$\theta_{A/C} = \left(\frac{18}{EI}\right) + \left(\frac{36}{EI}\right) + \left(\frac{9}{EI}\right)$$

$$\theta_{A/C} = \frac{63}{EI}$$

$$\theta_{A/C} = \frac{63}{(200\times10^6)(6\times10^6)(1000)^{-4}}$$

$$\theta_{A/C} = 0.0525 \text{ rad}$$

Here $\theta_{A/C} = \theta_A$

$$t_{A/C} = \left[\frac{1}{2}\left(\frac{12}{EI}\right)(3)\right]\left[\frac{2}{3}(3)\right] + \left[\frac{12}{EI}(3)\right]\left[3+\frac{1}{2}(3)\right]$$

$$+ \left[\frac{1}{2}\left[\frac{6}{EI}\right](3)\right]\left(3+\frac{2}{3}(3)\right)$$

$$t_{A/C} = 0.202 \text{ m}$$

Here $\Delta C = t_{A/C}$

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