Mid term Exams

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Sec :- B

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Deptt :- BE (C)

Subject:- Structural Analysis

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Q1) Write a detail note in your own words on different types of loads that different types of Structures are designed to support throughout its life. Elaborate with examples?

Loads:-

Overall force exerted on a body or structure.

Amount of work alloted to an individual, group, machine, or system. By extension, a load is the amount of production expected by or from a producer.

Types of load:-

1.) Dead loads
2.) Imposed loads
3.) Wind loads
4.) Snow loads
5.) Earthquake loads
6.) Special 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 throughout the life span.

2.) Imposed Loads:-

The second vertical load that is considered in design of a structure is imposed loads or live loads. These loads are either movable or moving loads without any acceleration or impact.

3.) Wind loads:-

Wind load is primarly horizontal load caused by the movement of air relative to earth. Wind load is required to be considered in Structural design especially when the heat of the building exceeds two times the dimensions tranverse to the exposed wind surface.

4.) Snow loads:-

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

5.) Earthquake Loads:-

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

Types of Structures:-

i) Trusses:-

When span of a structure is required to be large and its depth is not an important criterion for design, a truss may be selected. Trusses consist of slender elements, usually arranged in trianglar fashion.

ii) Cables And Arches:-

Two other forms of structures used to span long distances are the cable and arch. Cables are usually flexible and carry their loads in tension.

Arch achieves its strength in compression, since it has a reverse curvature to that of the cable. Arch must be rigid.

iii) Frames:-

Frames are often used in buildings and are composed of beams and columns that are pin or fixed connected. like trusses, frames are extend in two or three dimensions.

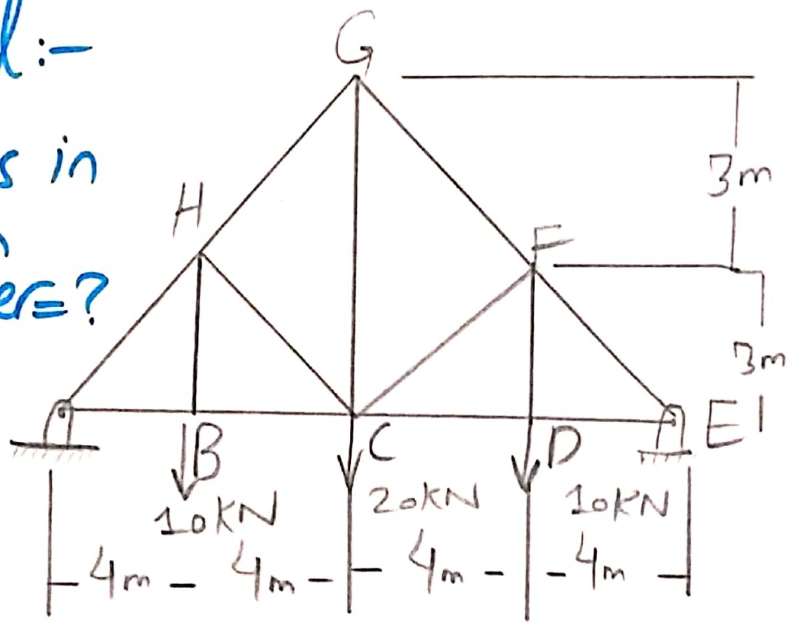
iv.) Surface Structures:-

A Surface Structure is made from a material having a very small thickness compared to its other dimensions. Sometimes this material is very flexible and can take the form of a tent or air-inflated Structure, In both cases the material acts as a membrane that is subjected to pure tension.

Q2.) Determine the force in each member of the truss. State if the members are in tension or compression. Assume all members are pin connected?

Sol:-

Forces in each member?



Support reactions:-

$\Sigma f_y = 0 \uparrow^{+} \downarrow^{-}$

$R_A + R_E = 40 \rightarrow (*)$

$\Sigma M_A = 0$ ↻-

$R_E(16) + 10(12) + 20(8) + 10(4) = 0$

$R_E = \frac{320}{16} = 20\ KN$

Put it in, eq (*)

$R_A = 40 - 20$

$R_A = 20\ KN$

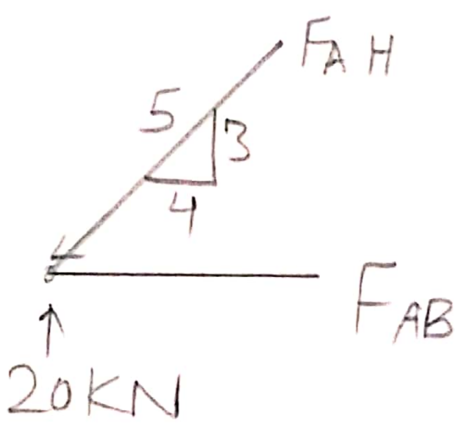
Now determining force in each member.

Joint A:-

$\Sigma f_y = 0 \; ; \; -3/5\,(F_{AH}) + 20KN = 0$

$\Rightarrow -0.6\,(F_{AH}) = -20KN$

$F_{AH} = 33.33KN\ (C).$



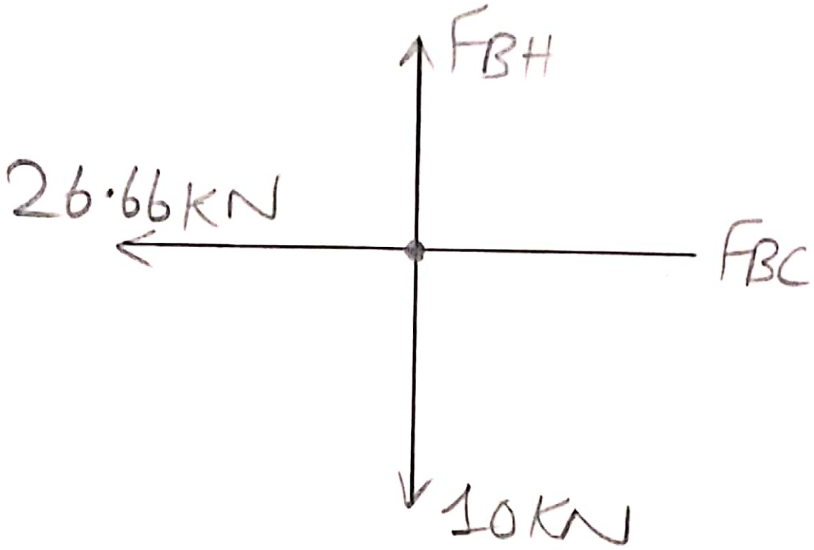
$\Sigma f_x = 0; -4/5\,(33.33) + F_{AB} = 0$

$F_{AB} = 26.66\ KN\ (T)$

Joint B:-

$\Sigma f_x = 0;\ F_{BC} = 26.66\,KN\ (T)$

$\Sigma f_y = 0;\ F_{BH} = 10\ KN\ (T)$



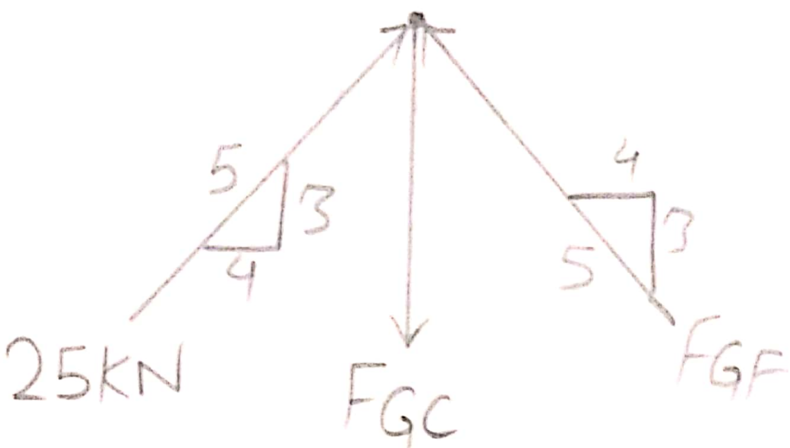
Joint G:-

$\Sigma f_x = 0;\ 4/5(25) - 4/5(F_{GF}) = 0$

$F_{GF} = 25\,KN\ (C)$

$\Sigma f_y = 0;\ 3/5\,(25) + 3/5(25) - F_{GC} = 0$

$F_{GC} = 30\ KN\ (C).$



Joint H:-

$\Sigma f_y = 0; 3/5(33.33) - 10KN + 3/5(F_{HC}) - 3/5(F_{HG}) \rightarrow$ (i)

$\Sigma f_x = 0; 4/5(33.33) - 4/5(F_{HC}) - 4/5(F_{HG}) \rightarrow$ (ii)

So now Solving eq (i) & (ii)

$19.98 - 10 + 0.6 F_{HC} - 0.6 F_{HG} = 0 \rightarrow$ (iii)

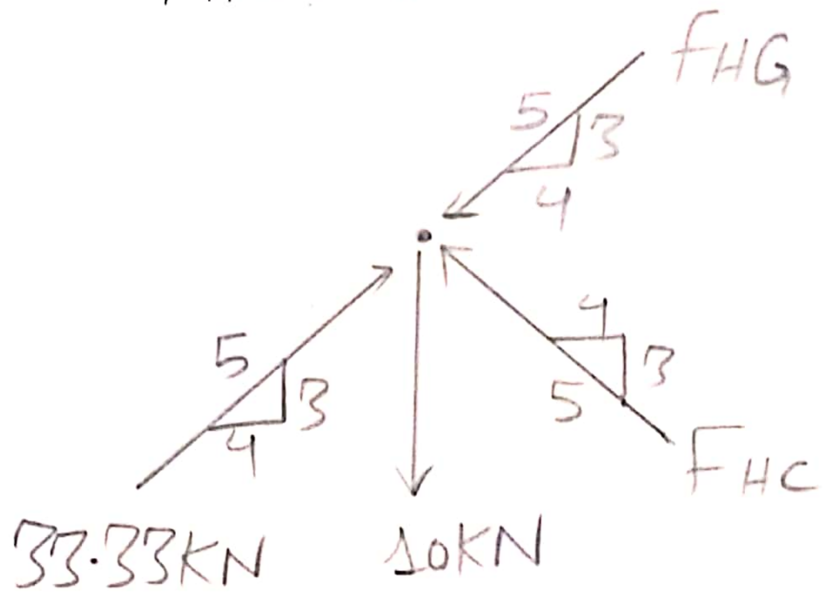
$26.66 - 0.8 F_{HC} - 0.8 F_{HG} = 0 \rightarrow$ (iv)

Now,

Multiplying eq (iii) by 1.34 and then add with eq (iv) we get,

$F_{HG} = 25$ KN (C).

$F_{HC} = 8.34$ KN (C).



Due to Symmetrical loading of Geometry we get,

$F_{AB} = F_{ED} = 26.66$ KN (T)

$F_{BC} = F_{DC} = 26.66$ KN (T)

$F_{BH} = F_{DF} = 10$ KN (T)

$F_{HG} = F_{FG} = 25$ KN (C)

$F_{HC} = F_{FC} = 8.34$ KN (C)

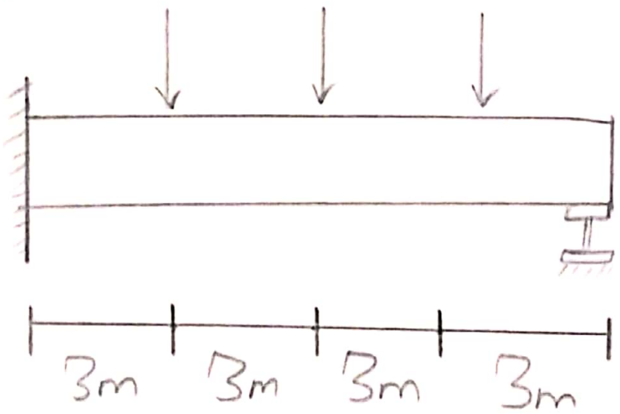
$F_{AH} = F_{EF} = 33.33$ KN (C).

Q3.) Determine the slope at A and displacement at C of the beam in the figure by

a.) Moment Area Theorem and

Take $E = 200$ GPa, $I = 6(10^6)\ mm^4$.

Sol:-



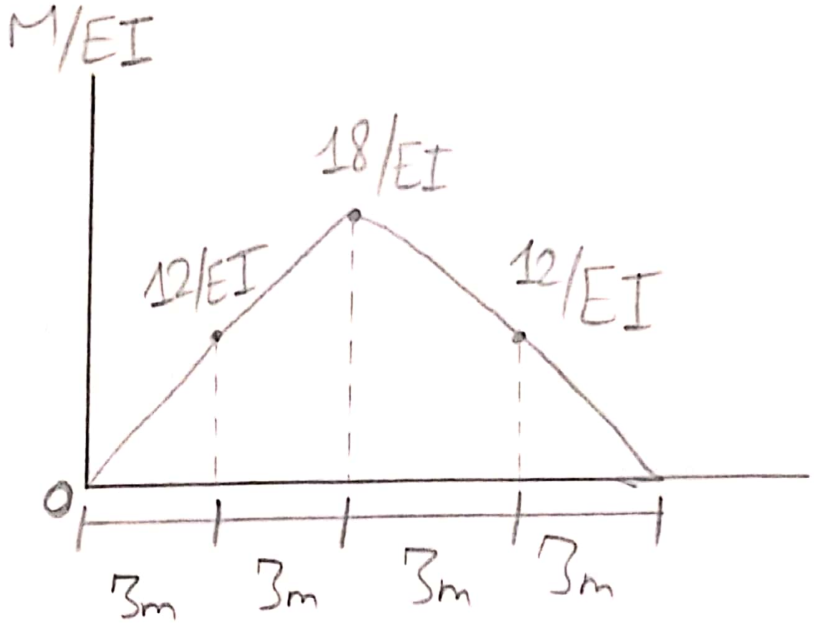
Given that:-

$E = 200$ GPa, $I = 6 \times 10^6\ mm^4$

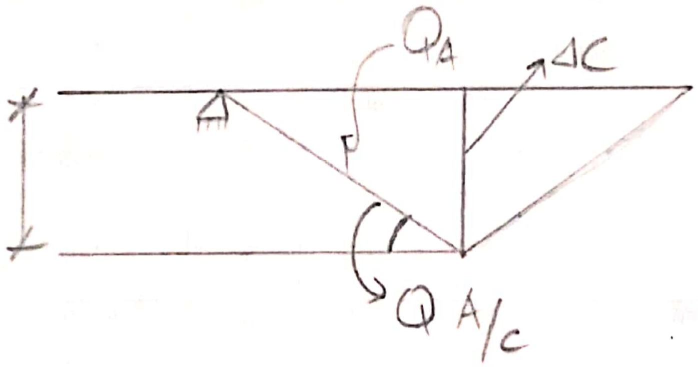
Determine Slope at point 'A' and displacement at 'C' using Moment Area Theorem.

i) Finding out M/EI Diagram of elastic curve.

Moment Diagram:-



Elastic Curve:-



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

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

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

$$\phi_{A/C} = \left(\frac{63}{EI}\right)$$

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

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

$$\phi_A = 0.0525 \text{ rad}$$

Ans

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

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

So, we get,

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

$$\Delta_C = 202 \text{ mm}$$

Ans.