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Subject :- Structure Analysis - I

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Section :- B

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Qno 1 :-

Write a detail note on your own words on different types of loads that different types of structures are designed to support throughout its life. Elaboral with examples:

Ans

The types of loads acting on structures for buildings and other structures can broadly classified as vertical loads, horizontal loads and longitudinal loads. The vertical loads consist of dead load, live load and impact load. The horizontal load comprises of wind load and Earthquake load. The longitudinal loads ie. tractive and breaking forces are considered in special case of design of bridges, gantry girders etc.

Types of Loads on structure are
① Dead load
② Imposed load or Live Load.
③ Wind load
④ Snow load
⑤ Earthquake load
⑥ Special load.

⇒ Dead Load:-

The first vertical load that is considered is dead load. Dead loads are permanent or stationary loads which are transfered to structure throughout the life span. DL is primarily due to self weight of structural members

⇒ Live load:-

The second vertical load that is considerd in design of a structure is live load

Live loads are either movable or moving loads without any acceleration or impact. Live load keeps on changing from time to time

⇒ Wind load :-

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 heath of the building exceeds two times the dimensions traverse to the exposed wind surface

⇒ Earthquake Load :-

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

⇒ Types of structures:-

⇒ ① Truss :-

It is a structural member usually fabricated from straight pieces of metal to form a series of triangles laying in a single plane.

② Cables & Arches:-

It is a type of structure used to spam long distances. Cables are flexible and carry loads in tension, they are commonly used to support bridges, roofs. Arches achieve strength in compression and has a curvature to cables. It must be rigid to maintain its shape. Consists of shear and moment. They are used in bridge structures.

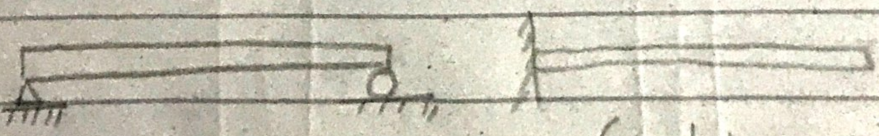
③ Frames:-

A frame structure is a structure having the combination of beam, column and slab to resist the lateral and gravity loads. Those structures are usually used to overcome the large moments developing due to the applied loading.

⇒ Structure Elements:-

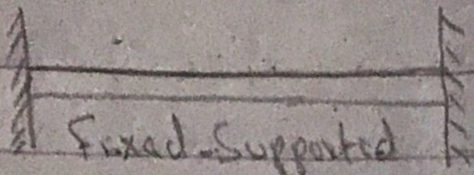
① Beams:-

Horizontal members and supports vertical loads. It resists bending moments. They carry large loads.



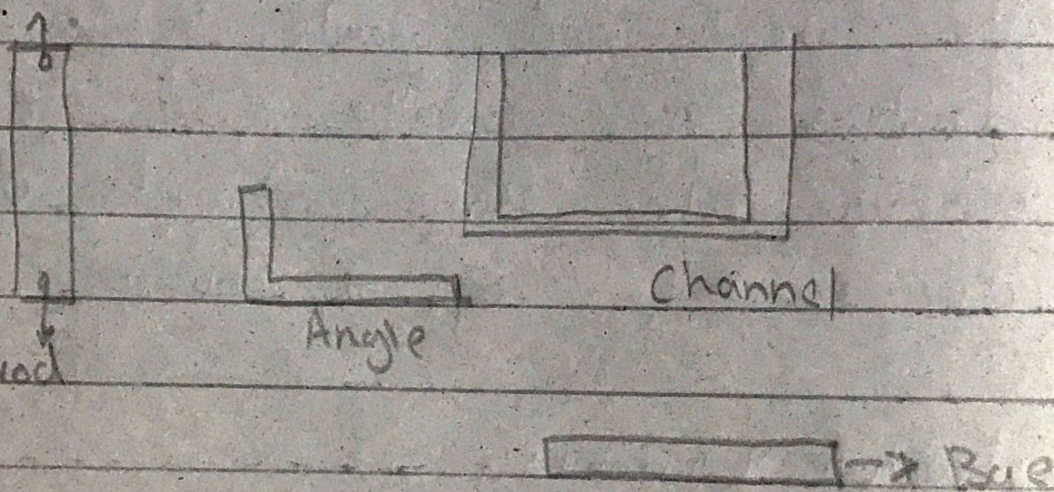
Simply supported

Cantilever Beam



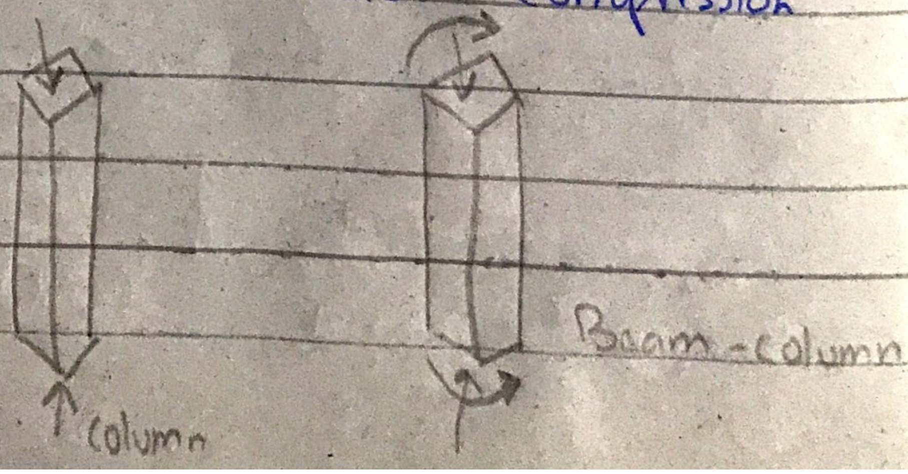

② Tie rod :-

A metal rod that joins and reinforces parts in Structure.

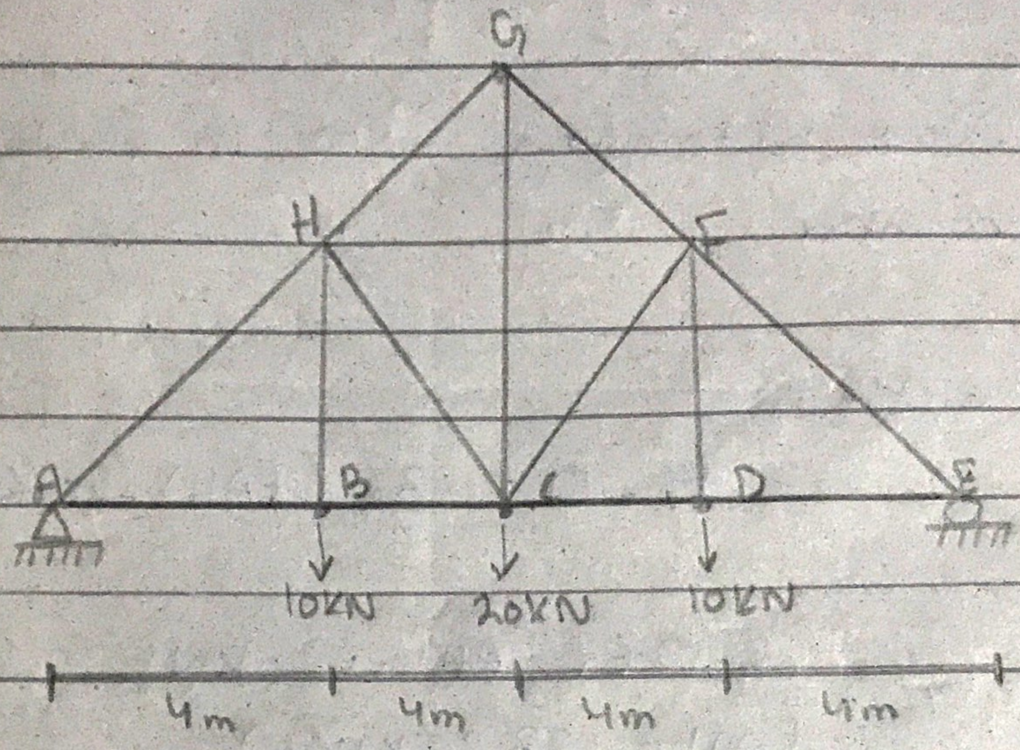



③ Columns :-

They consists of vertical members and resists compression loads.



Qno2




Forces in Each member = ?

⇒ Solution :- Support reactions:

$\Sigma F_y = 0$ ↑+ ↓−

$R_A + R_E = 40$ —— (A)

$\Sigma M_A = 0$ ↻ −

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

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

Put 40-20

⇒ $R_A = 20\,kN$

Now determining force in Each member.

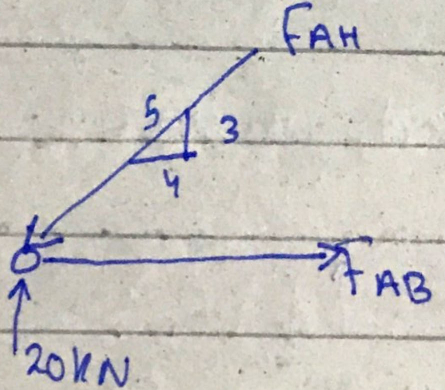
Joint A :

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

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

$$F_{AH} = 33.33\,kN\,(C)$$

Joint A :-



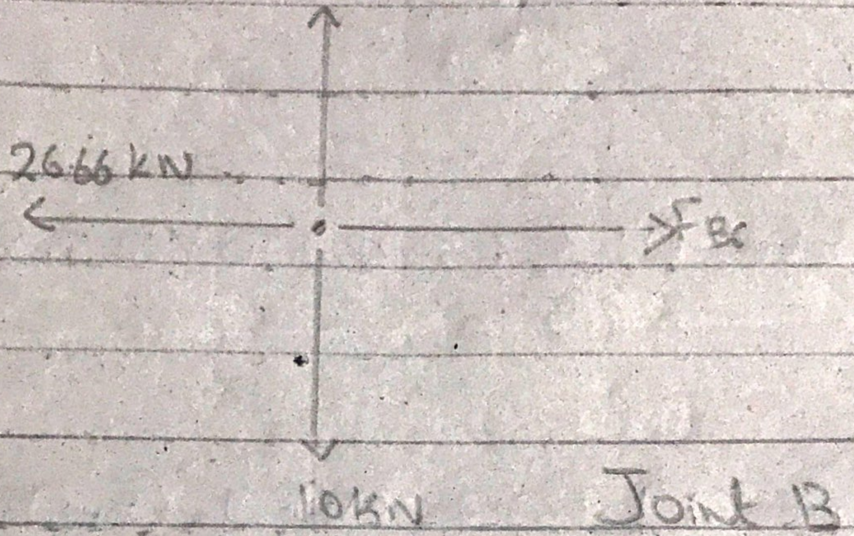

$$\Sigma f_x = 0 ; \; -\frac{4}{5}(33.33) + F_{AB} = 0$$

$$= F_{AB} = 26.66\,kN\,(T)$$

Joint B :-

$\Sigma f_x = 0 ; \; f_{BC} = 26.66 \text{ kN (T)}$

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



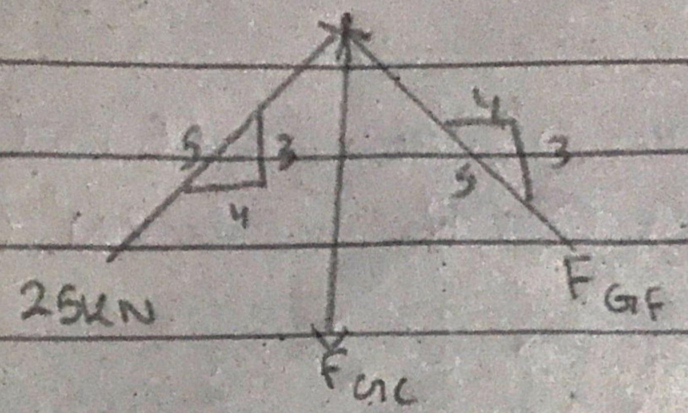

Joint G :-

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

$F_{GF} = 25 \text{ kN (c)}$

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

$F_{GC} = 30 \text{ kN (c)}$




Joint G

Joint H:-

$\Sigma F_y = 0; \frac{3}{5}(33.33) - 10\,KN + \frac{3}{5}(F_{HC}) - \frac{3}{5}(F_{HG})$ — (A)

$\Sigma F_x = 0; \frac{4}{5}(33.33\,KN) - \frac{4}{5}(F_{HC}) - \frac{4}{5}(F_{HG})$ — (B)

Solving Eq (1) and Eq (2)

$19.98 - 10 + 0.6\,F_{HC} - 0.6\,F_{HG} = 0$ — (A)

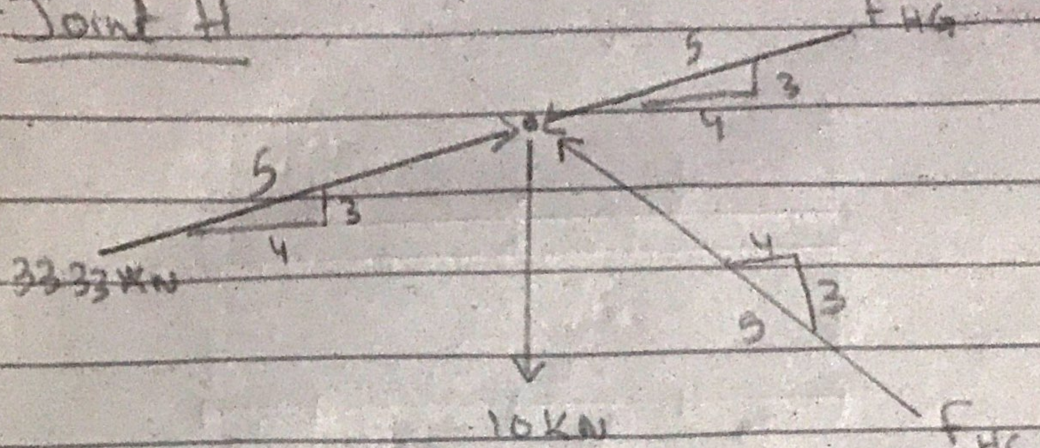
$26.66 - 0.8\,F_{HC} - 0.8\,F_{HG} = 0$ — (B)

Multiplying Eq (A) by 1.34 and then add with Eq (B) we get

$F_{HG} = 25\,KN\ (c)$

$F_{HC} = 8.34\,KN\ (c)$

## Joint H




Due to symmetrical loading & Geometry

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

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

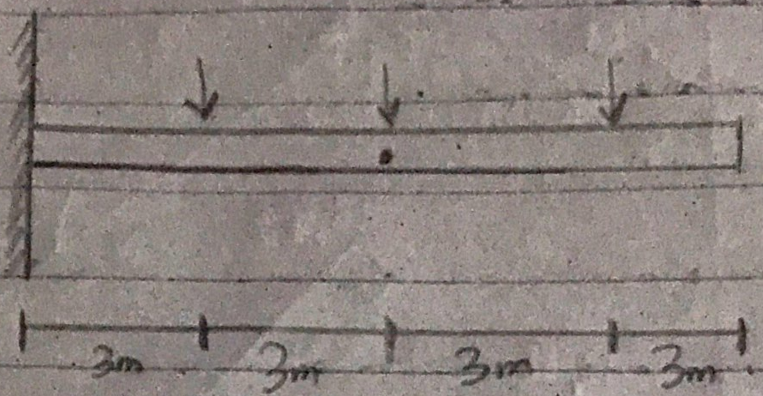
$F_{BH} = F_{DF} = 10$ KN (T)

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

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

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

Qno 3



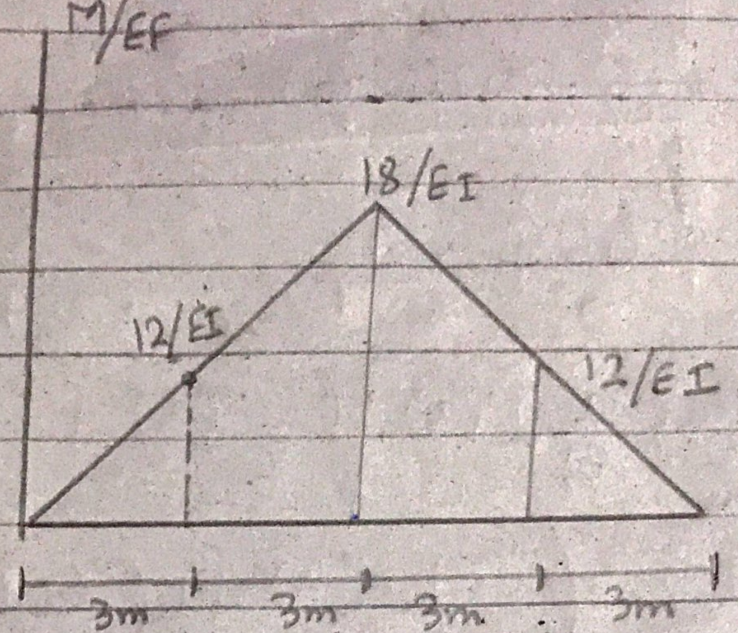

Given : E 200Gpa , I = $6 \times 10^6$ mm

Determine slope at point 'A' and displacement at 'C' using moment Area theorm.

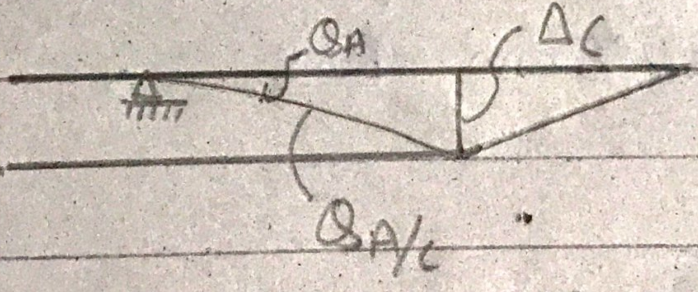
Solution:-

(i) Finding out $\frac{M}{EI}$ Diagram & Elastic curve

## Moment Diagram:




## Elastic Curve:-




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

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

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

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

$\theta_A = 0.0525$ rad

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

$= 0.202$ m

So $\Delta C = t_{A/C} = 0.202$m

$= 202$ mm Ans