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Section :- A

Subject :- Structure - I

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Question#01

write a detail note in your own words on different types of load that different types of structure are designed to support throughout its life Elaborate with example?

Answer:-

Load:-

load is the external forces acting on very small area on a perpendicular point of a supporting structural elements.

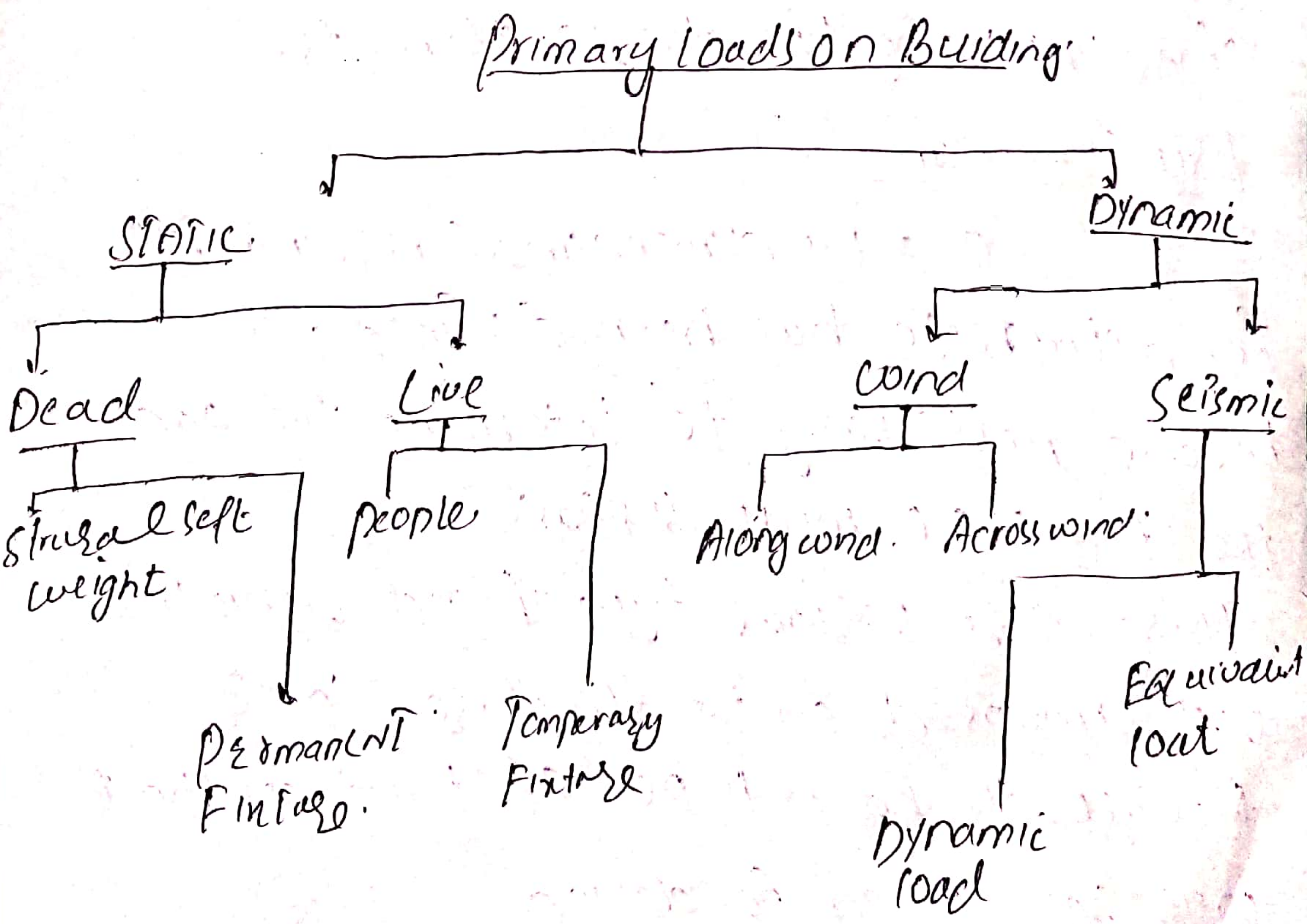
Explanation:-

One the dimensional requirements for a structure has been defined. It become nessessary to determine the load the structure must support.
There are various type of load which will imposed on the structure that provide the basic type of structure that will be chosen for design.

For example:

High-rise structures must endure large lateral loading caused by wind and so shear walls and tubular frame system are selected whereas buildings located in area prone to earthquakes must be design have ductile frames and connections.

Types Of load:-



(1) Dead load:-

Dead load consists of selfweight of structure (beam, columns, slab and strutsetc equipment permanently attached to structure such as furniture load home accessories etc.

As Dead load consists of weight of various structural members and the weight of any object which are permanently attached.

For example:-

weight of columns, beams and girders the roof slab, floor slab, windows Doors electrical fixtures and other elements.

Live loads:-

load caused by Contents of objects with in or on a building are called occupancy load This loads includes allowance for the weight of people moveable Partitions mechanical equipments etc

Live loads can vary both in their magnitude and location They may be caused by the weight of the object temporarily placed on a structure moving vehicles or natural forces.

various Types of live will be discussed below

① wind load:-

when the speed of the wind is high it cause the massive damage to a

P.T.O

to a structure.

wind exerts three types of forces on a structure. uplift load. wind flow pressure that creat a strong lifting effects, much like the effect on air plane wings. shear load: Horizental wind pressure that could cause racking of wall making a building Tilt.

The wind pressure is high to that creat a massive damage the reason is that the pressure exerted by wind is proportional to the square of the wind speed.

This effect of lateral loading can be ~~[illegible]~~ developed by wind can cause racking or leaning of a building frame. To resists this effect, engineers often use cross bracing or diagnal bracing

Building loads:

A building load is simply a force that a house frame needs to resists. The frame must be designed to with stand eight of these loads in which wind and snow etc are present.

The floor of the building are assumed to be subjected to uniform live load which depend on the purpose on which the building is design.

Highway Bridge loads:

The primary live loads on Bridge spans are those due to traffic and the heaviest vehicle loading encountered is that caused by a series of trucks.

The major load components of highway bridges are dead load live (static and dynamic) environmental load (temperature wind earthquakes) and other

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And Other loads (collision, emergency braking) load components are random variables Their variation is described by the cumulative distribution function.

Impact loads:-

An impact load is one whose time of application on a material is less than one third of the natural period of vibration of that material. Cyclic loads on a structure can lead to fatigue damage, cumulative damage, or failure These loads can be repeated loadings on a structure or can be due to vibration.

The percentage increase of the live load due to impact is called the impact factor.

Snow load :-

Snow loads constitute to the vertical loads in the building. But these loads are considered only in the snowfall places.

The minimum snow load on a roof area or any other area above ground which is subjected to snow accumulation is obtained by the expression

$$S = \mu S_0$$

where S = Design snow load on plane area or roof

μ = shape coefficient and

S_0 = Ground snow load

In some part of country roof loading due to snow can be quite severe and therefore protection failure is of primary concern.

Earthquake loads:

Earthquake forces Constitude to Both vertical and Horizental on the building But specially earthquakes produced lateral loadings on the structure throught the structure interaction with the ground. The magnitude of an earthquake load depend on the amount and type ground accelerator

The total vibration caused by earthquake may be resolved into three mutually perpendicular directions usually taken as vertical and two horizental direction

The moment in vertical direction donot caused force in super structure to any significant extent: But the Horizental moment of the Building at

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the time of earth quake is to be considered while designing.

Load Transfer:

Load
↓
Roof Surface
↓
Roof slab
↓
Beams
↓
Columns
↓
Foundation
↓
Subsoil.

Foundation transfer all the loads safely to ground.

Different structures are designed to support the load:

→ Braced Frame.
(It is a device used as a supporting beam in a building that imparts rigidity and steadies the structures).

→ Rigid Frame structure.

→ Infilled Frame Structures
(infilled serve also as external walls or internal partitions, the system is an economical way of stiffening and strengthening the structure).

→ Flate plate and Flat Slab Structures
(Flate Plate is a twoway reinforced concrete framing system utilizing a slabe uniform).

→ Shear wall structure

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(Shear wall):

- Concrete wall
- punches are limited because of torsional and flexural rigidity.
- In most lateral loads are carried by shear wall.

→ Coupled wall structure

→ wall-frame structures

→ Frame tube structures
(• Gravity loads are distributed b/w the tubes and interiors columns or walls. lateral loading acts at the perimeter)

→ Hybride structure

→ Core and outrigger system

→ Bundled tube structure

→ The trussed tube

⟵⟶

Structure

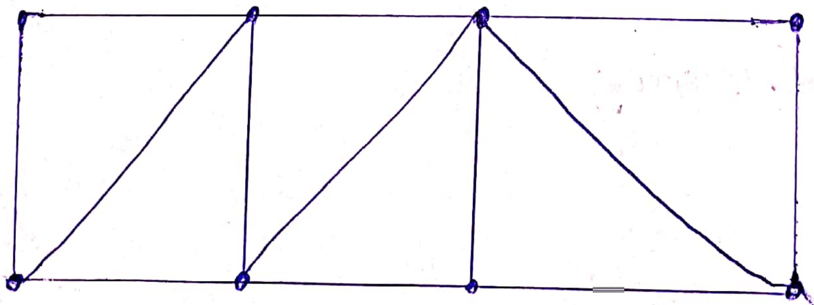
A structure refer to a system of connected parts used to support a load. is called structure.

Types OF Structure:

1) **Trusses**:

→ A Trusses is a structural comprising one or more triangular units constructed with straight members whose ends are connected at joints or nodes

→ If all the bars lies in a plane the structure is a planar trusses



Different types of Trusses: (12b)

→ Perfect Trusses $(m = 2j - 3)$

→ Deficient Trusses $(m < 2j-3)$.

→ Redundant Trusses $(m > 2j-3)$

Here m = member

j = joints

2) Cables And Arches:

Cables and arches are Closely related to each other and hence they are grouped in this Course in the same module. For long span structure eg incase bridges) engineers Commonly use Cable or arch construction due to their efficiency.

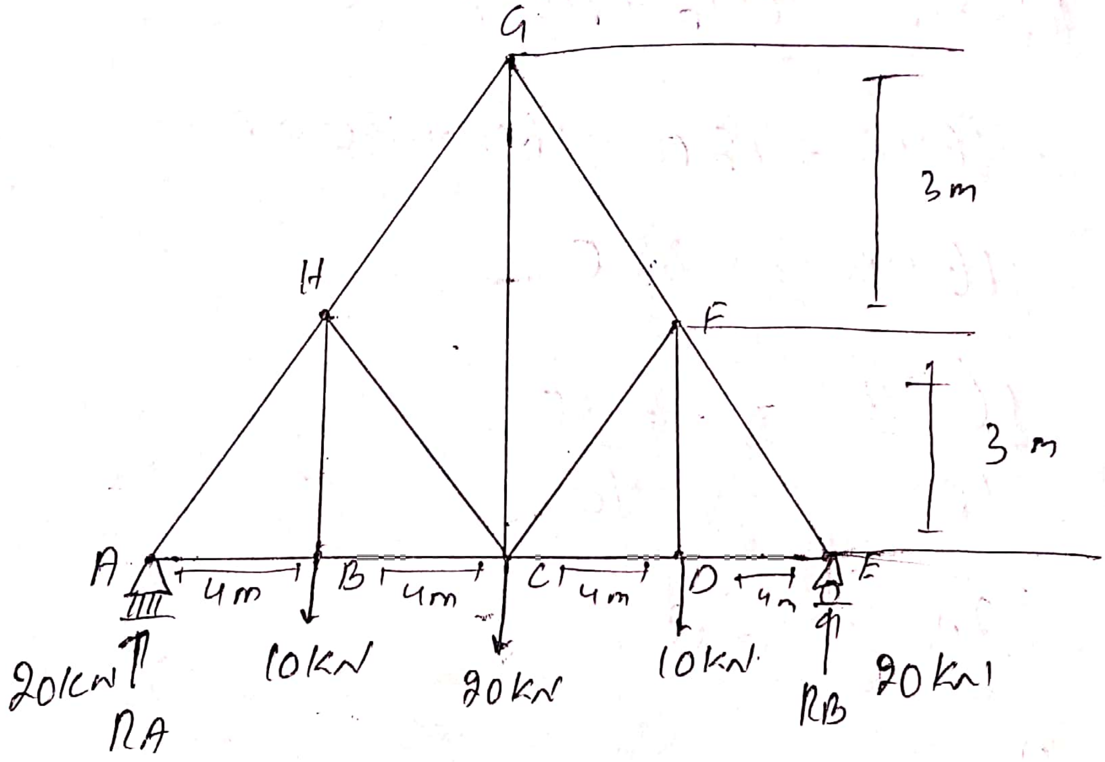
12c

3) Frames

Frames are often in building and are open composed of beams and colums that are either pin or fixed connected. The loading on a frame caused bending of its members and it has a rigid joint connections

Question # 02. (13)

Determine the forces in each member of the truss. State if the members are in tension or compression. Assume all members are pin connected.



Solution:

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Support Reactions:

$\sum F = 0$ ↑⁺ ↓⁻

$R_A + R_B = 40$

$\sum M = 0$ ↻⁻ ↺⁺

$-R_B \times 16 + 10 \times 12 + 20 \times 8 + 10 \times 4 = 0$

$-16R_B + 120 + 160 + 40 = 0$

$16R_B = 320$

$\frac{16R_B}{16} = \frac{320}{16}$

$\boxed{R_B = 20}$

As

$R_A + R_B = 40$

then

$R_A = 40 - 20$

$\boxed{R_A = 20}$

Now we find angle

As we know that this Structure is symetrical then: So,

$R_A = 20$, $R_B = 20$

angle

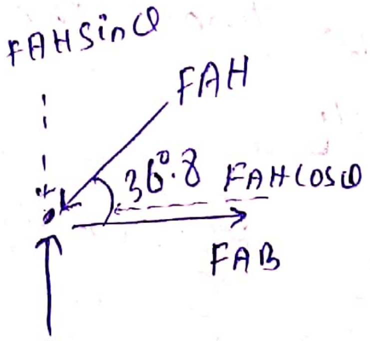
$\theta A = \tan^{-1}\left(\frac{3}{4}\right)$

$\theta A = \tan^{-1}(0.75)$

$\theta A = 36.87^0$

Now Analysis of joints:-

Joint A:-



$\Sigma Fy = 0 \Longrightarrow (+) \uparrow$

~~FAB = FAH Cos 36.87~~

$20 = FAH \sin 36.87$

$FAH = \frac{20}{\sin 36.87}$

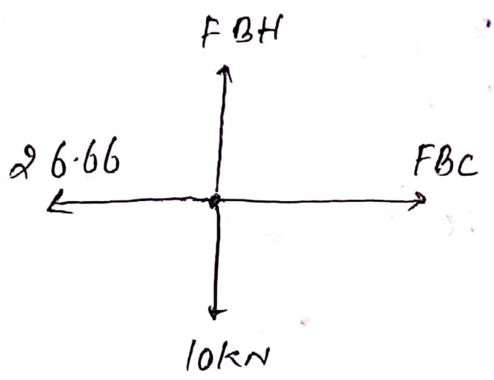
So, $\boxed{FAH = 33.33 kN}$ (C)

$\sum F_x = 0 \rightarrow \oplus$

$F_{AB} = F_{AH} \cos 36.87$

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

JOINT # B



$\sum F_x = 0$

As we know that

Directly

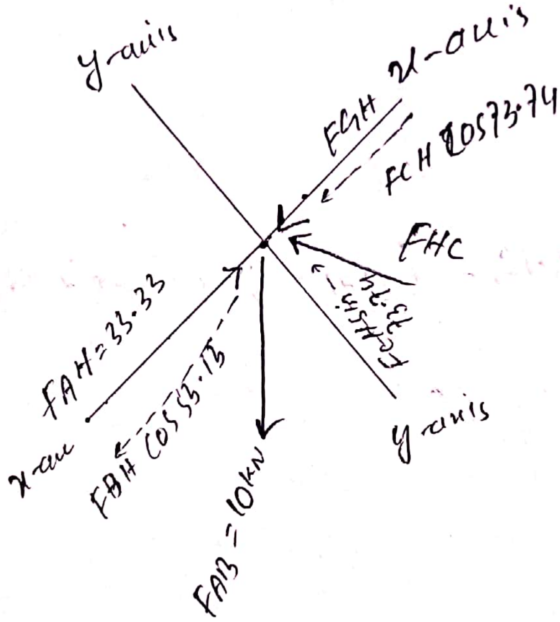
$F_{BC} = 26.66\,kN$ (T)

$\sum F_y = 0$

$F_{BH} = 10\,kN$ (T)

JOINT # "H"

As orientation of x-axis along "AG" then we get



As the angle between FGH and FCH is

$\boxed{73.74^{0}}$

And the angle between "FAH and "FBH"

$\boxed{53.13^{0}} \Rightarrow \tan^{-1}(1.33) = 53.13^{0}$

Now,

$\Sigma F_y = 0$

$F_{CH} \sin 73.74 = 10 \sin 53.13$

$$F_{CH} = \frac{10 \sin 53.13}{\sin 73.74}$$

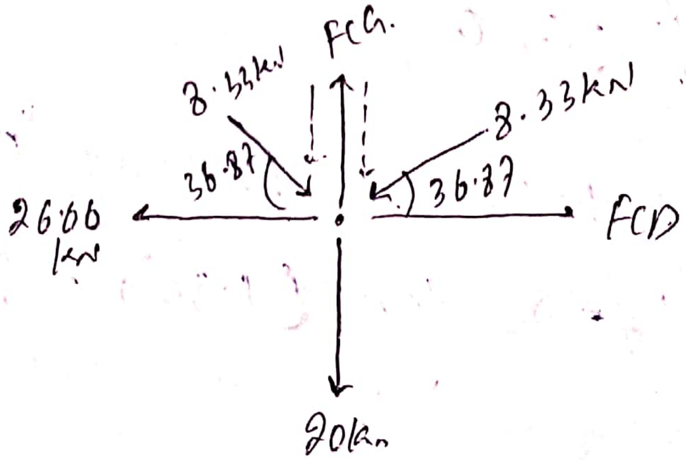
$F_{CH} = 8.33 \text{ kN}$ (C)

$\Sigma F_x = 0$

$33.33 - 10\cos 53.13 - F_{GH} - 8.33\cos 73.74 = 0$

$F_{GH} = 25 \text{ kN}$ (C)

JOINT C



$\Sigma F_x = 0$

$F_{CD} = 26.66 \text{ kN}$ (T)

$\Sigma F_y = 0$

$F_{CG} = +20 + 8.33 \sin(36.87) + 8.33 \sin(36.87)$

$F_{CG} = 29.99 kN$ (T)

As we know that the Truss is symmetric so,

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

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

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

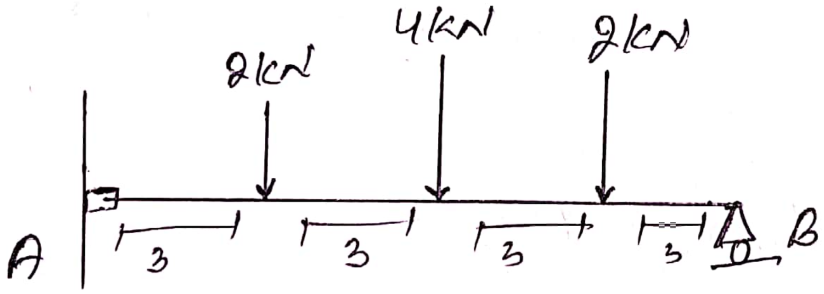
$F_{HG} = F_{FG} = 25 kN$ (C)

$F_{HC} = F_{FC} = 8.34 kN$ (C.)

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

Question No # 03.

Determine the slope A and displacement at C of the beam in the figure by moment of Area theorm Take E = 200GPa. $I = 6(10^6) mm^4$



Required:-

$\theta A = ?$

$\Delta C = ?$

And in the question we have given the following data.

$E = 200 GPa = 200 \times 10^9 Pa.$

$I = 6 \times 10^6 mm^4 = 6 \times 10^{-6} \cdot 10^{-12} m^4$

$I = 6 \times 10^{-6} m^4$

First we find support Reaction

$\Sigma F_y = 0$ ↑+ ↓−

$RA + RB = 8$

$\Sigma M = 0$ ↻− ↺+

$-RB \times 12 + 2 \times 9 + 4 \times 6 + 2 \times 3 = 0$

$-12RB + 18 + 24 + 6 = 0$

$\frac{12RB}{12} = \frac{48}{12}$

$\boxed{RB = 4}$

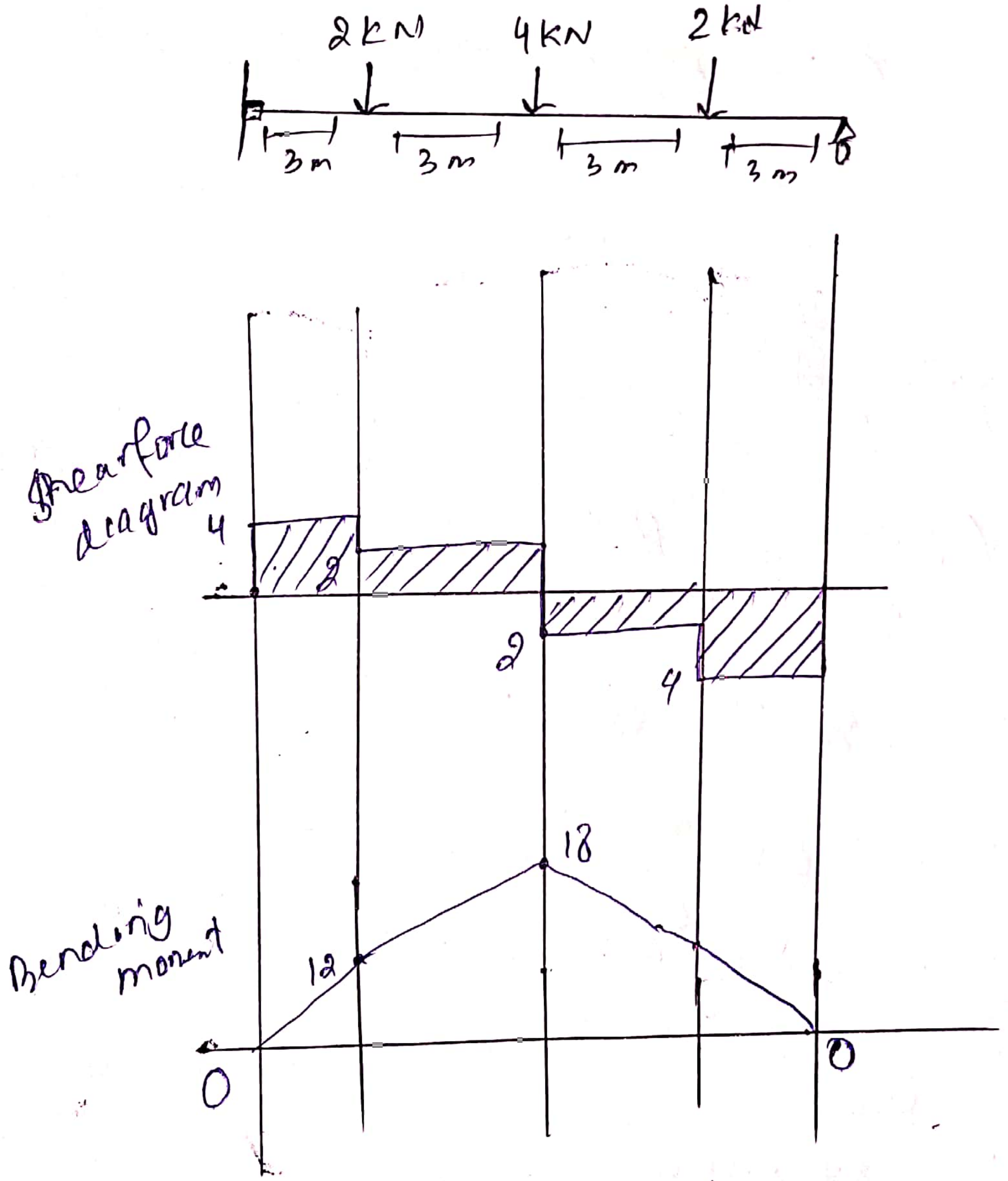
As we know that

$RA + RB = 8$

$RA + 4 = 8$

$\boxed{RA = 4}$

Now we draw the Bending diagram of the following beam.



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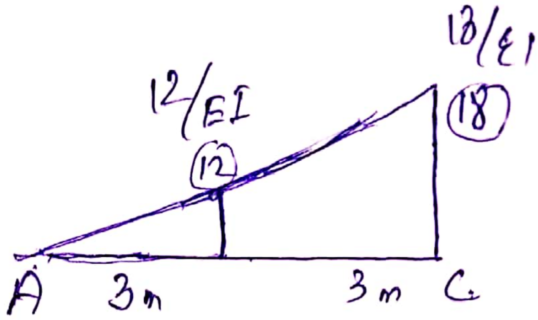
First we find the slope at point "A" of the beam.

$\theta A \Rightarrow$ Area b/w the Points A and C



$$\theta_A = \left(\frac{12 \times 3}{2}\right) + \left(\frac{12+18}{2}\right) \times 3 = 63/EI \ (kN/m^2)$$

As from the question:

$E = 200 \times 10^9 \ Pa$

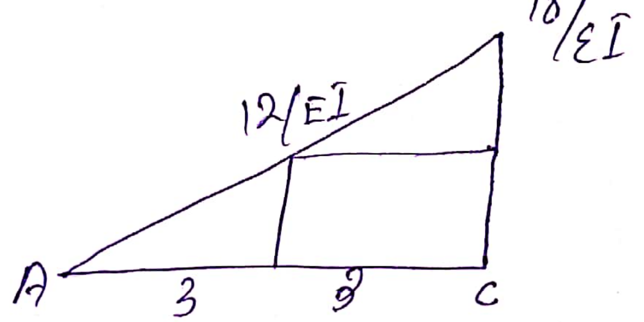
$I = 6 \times 10^{-6} \ m^4$

$$\theta A = \frac{63}{200 \times 10^9 \times 6 \times 10^{-6}}$$

$$\boxed{\theta A = 0.0525 \ rad}$$

Now we find the deflection at point 'B' of the beam.

So, Dc (Deflection at mid-span) will be equal to first moment of area between point A and C.



$$Dc = \frac{2}{3}\times 3\left(\frac{12\times 3}{2}\right) + \left[\left(3+\frac{3}{2}\right)(12\times 3)\right]$$

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

$$Dc = 36 + 162 + 45 \Rightarrow 243\ KN.m^3/EI$$

$$Dc = \frac{243\times 10^3 m^3}{200\times 10^9\times 6\times 10^{-6}}$$

$$Dc = 0.2025\ m$$