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Section ——— A

Semister ——— 2nd

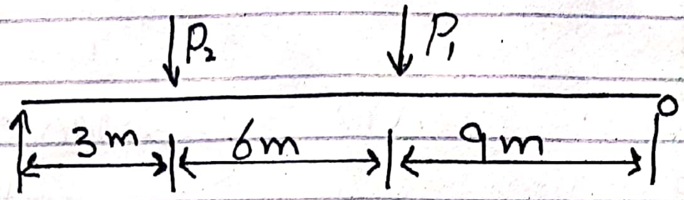
Department ——— BE (civil)

Subject ——— Engineering mechanics

Date ——— 27 June 2020

Q(1) Find the support reactions. Show all your calculations.

(P_1 = 200 + Student ID No) P_2 = 500 + Sudent ID No

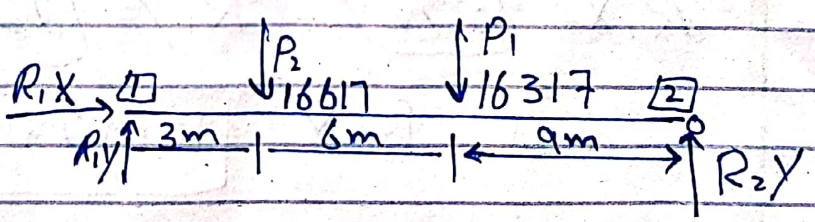


Ans. Sol: $P_1 = 200 + 16117$

$P_1 = \boxed{16317}\, N$

$P_2 = 500 + 16117$

$P_2 = \boxed{16617\, N}$



$R_1X = 0$ summation of $fx = 0$

$R_1y + R_2y - 16317 - 16617 = 0$ Summation of $fy = 0$

$R_1Y + R_2Y = 16317 + 16617$

$R_1Y + R_2Y = \boxed{32{,}934}$ — eq (1)

$R_1Y = [(16317 \times 9) + (16617 \times 15)] / 18$

$$R_1Y = \frac{146853 + 249255}{18}$$

$R_1Y = \boxed{22{,}006\,N}$ — eq 2

Put eq 2 in eq 1

$R_1Y + R_2Y = 32{,}934$

$22{,}006 + R_2Y = 32{,}934$

$R_2Y = 32{,}934 - 22{,}006$

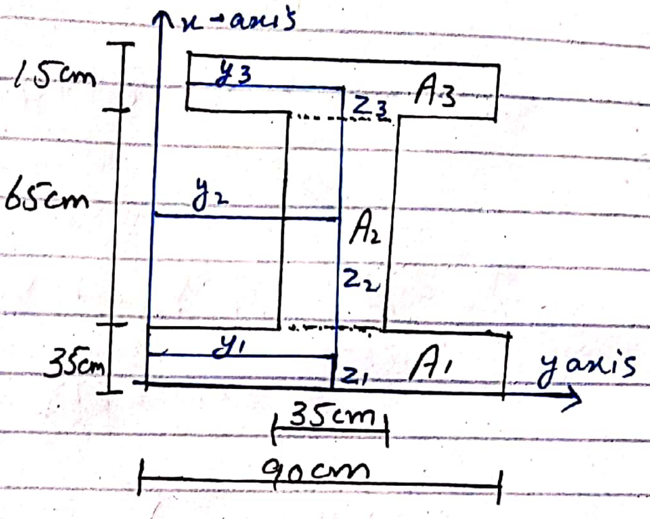
$R_2Y = 10{,}928\,N$

$R_1X = \boxed{0\text{-}N}$, $R_1Y = \boxed{22{,}006\,N}$

and $R_2Y = \boxed{10{,}928\,N}$

Scanned with CamScanner

Q(4) a) Find the centroid of the given shape, show all your calculation.



Sol: * Establish the coordinate system
* Divide the composite area into different simple areas.

$A_1 = 0.35 \times 0.9 = \boxed{0.315 m^2}$

$A_2 = 0.65 \times 0.35 = \boxed{0.2275 m^2}$

$A_3 = 0.65 \times 0.15 = \boxed{0.0975 m^2}$

Finding center ~~area~~ point of each area from the origin

$Y_1 = 0.9/2 = \boxed{0.45 m}$

$Y_2 = 0.9/2 = \boxed{0.45 m}$

$Y_3 = 0.9/2 = \boxed{0.45 m}$

$Z_1 = 0.35/2 = \boxed{0.175m}$

$Z_2 = 0.35 + (0.65/2) = \boxed{0.675m}$

$Z_3 = 0.35 + 0.65 + 0.15/2 = \boxed{0.075m}$

$$Y_c = \frac{A_1Y_1 + A_2Y_2 + A_3Y_3}{A_1 + A_2 + A_3}$$

$$= \frac{(0.315 \times 0.45) + (0.2275 \times 0.45m) + (0.0975 \times 0.45)}{0.315 + 0.2275 + 0.0975}$$

$$= \frac{0.1417 + 0.10237 + 0.04387}{0.43525}$$

$$= \frac{0.28794}{0.43525}$$

$Y_c = \boxed{0.6615m}$

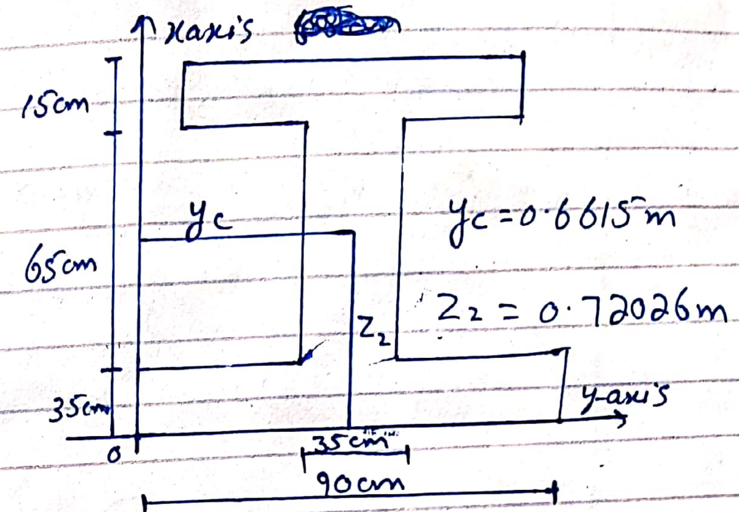
$$Z_c = \frac{A_1Z_1 + A_2Z_2 + A_3Z_3}{A_1 + A_2 + A_3}$$

$$Z_c = \frac{(0.315 \times 0.175) + (0.2275 \times 0.675) + (0.0975 \times 1.075)}{0.43525}$$

$$= \frac{0.055125 + 0.153562 + 0.104812}{0.43525}$$

$$= \frac{0.3134945}{0.43525}$$

$$Z_c = \boxed{0.72026\ m}$$



Q(5) Explain work, energy and power in details along with practical examples from daily life.

Ans. **Work**:

The application of a force through certain distance is known as work. It measured in Joules.

Work = Force × Distance travelled in direction of force.

$$W = F \cdot d$$

When force is exerted on an object. The amount of energy transfered is called the work done on the object. Mathematically work done is defined as the scaler product of force and displacement, thus it is a scaler quantity.

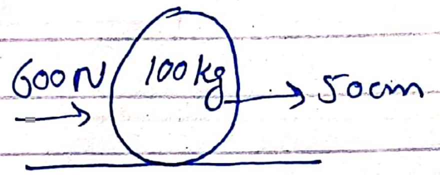
$$W = F \cdot d$$

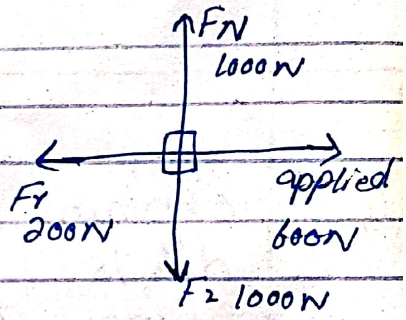
W = work done (J)

F = Force applied (N)

d = the distance (m).

Work Done by friction.





$$Work = -200N \times 50cm$$
$$\boxed{= -10{,}000 J}$$

Mathematicaly:

Work is the result of a force on a point that follows a curve x with a velocity v at each instant. The small amount of work δw that occurs over an instant of time dt is calculated as

$$\delta W = F \cdot ds = F \cdot v dt$$

Where the $F \cdot v$ is the power over the instant at the sum of those small amount at work over the trajectory.

$$W = \int_{t_1}^{t_2} f \cdot v\,dt = \int_{t_1}^{t_2} F \cdot \frac{ds}{dt}\,dt = \int_c F \cdot d$$

where c is the trajectory from $x(t_1)$ to $x(t_2)$. This integral is computed along the trajectory of the particle and is therefore said to be path dependent. If the force is always directed along this line and the magnitude of the force is F, then this integral simplifies to

$$W = \int_c F\,ds$$

where s is the displacement along the line.

$$W = \int_c F\,ds = f\int_c ds = Fs$$

In this case the dot product of the $F \cdot ds = F\cos\theta$. where θ is the angle between the force vector f and the direction of movement that is

$$W = \int_c F \cdot ds = Fs\cos\theta$$

Dimension = ML^2T^{-2}

Unit = $1\,kg\,m^2 s^{-2}$.

~~other unit foo~~

Daily life examples of work :

1) A horse pulling a plow through the field
2) A person pushing a grocery cart down the aisle of a grocery store.

3) A freshman lifting a backpack full of books upon her shoulder.
4) A weightlifter lifting a barbell above his head. etc.

Energy:

Energy is the measure of the ability of an object or a system to perform work.

Unit = Joul denoted by J.

Types of energy:

1) **Kinetic energy:**
Energy of an object due to its speed.

2) **Gravitational potential energy:**
Energy of an object due to position in a gravitational field.

3) **Elastic potential energy:**
energy stored when an object is stretched or compressed.

4) **Chemical energy:**
Energy stored in chemical bond

5) **Nuclear energy:**
Energy stored in nuclei.

6) **Heat energy:**
Hot things have more

energy than their could counterparts.

Energy can be transfered in a system in a variety of ways e.g: include the transmission of electromagnatic energy via photos, physical collision which transfer kinetic energy.

$$\Delta E = W + Q$$

E is the amount of energy transferred
W represent the work done on the system.

Q represent the heat flow into the system.

Dimention $= ML^2T^{-2}$

Daily life example of energy:

1) Heating and lighting the home
2) Running applainces and cooking.
3) Use of water pump.
4) Washing clothes.

Power:

Power is the rate at which work is done, or the rate at which energy is transferred.

Power = work done/time taken

$$P = W/t$$

- Power is measured in watt
- Power done as energy transferred is measured in joules. (J).
- time is measured in second (s).
- Common symbol of power is (P).

SI unit = watt.

In SI bas unit = $Kg\,m^2 s^{-2}$

derivation for other quantities

$$P = E/t$$

$$P = F \cdot V$$

$$P = V \cdot I$$

$$P = T \cdot \omega$$

dimension = $L^2 m T^{-3}$

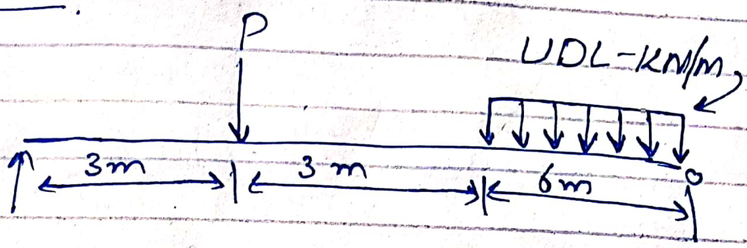
Formula = $P = \frac{W}{\Delta t}$

Daily life example of power.

* A 60 watt bulb expend 60 J of energy per second.
* All engines.
* All electronic appliances. etc.

P-(11)

(2) Given loads:



Load = P: 100+ 16117

= P = 16217 kN

Load 2 UDL = 150 + 16117

= 16267 kN/m

Support reactons

$\Sigma m_P = 0$ (↻ -)

$-(16217 \times 3) - (16267 \times 6) \times (6+3) + R_B \times 12 =$

$-(48651) - (97602)(9) + R_B \times 12 = 0$

$-4865 - \cancel{97602}\ 878418 + R_B \times 12 = 0$

$$R_B = \frac{4865 + 878418}{12}$$

$R_B = \boxed{73606.91 \text{ kN}}$

$\Sigma F_y = 0$ ↑+ ↓-

$R_A + R_B - 16217 - (16267 \times 6) = 0$

P- 12

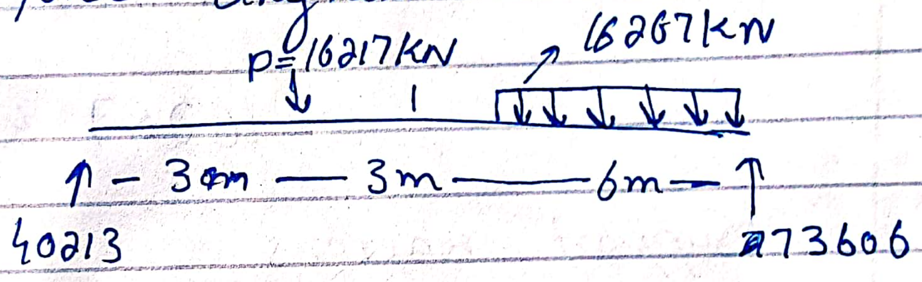
$R_A + R_B = 113819 \text{ KN}$

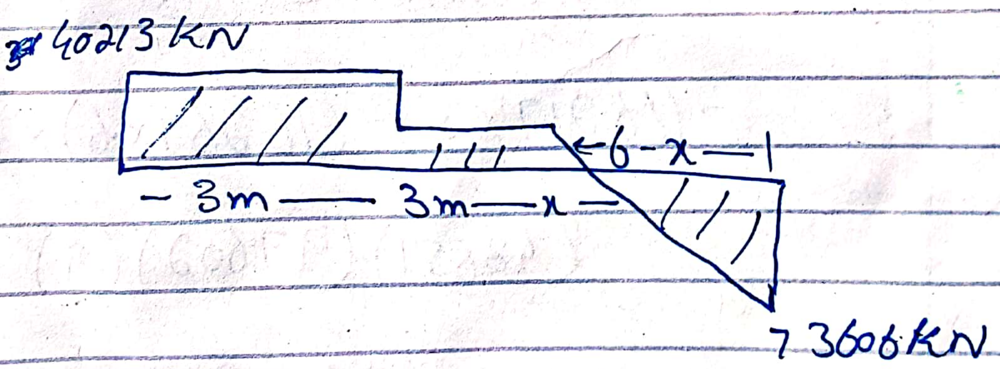
$R_A = 113819 - R_B$

$= 113819 - 73606.91$

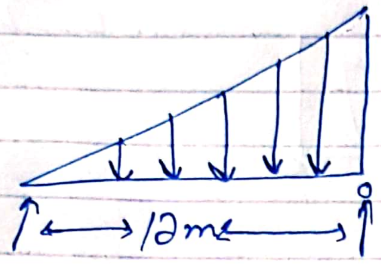
$R_A = \boxed{40213 \text{ KN}}$

Shear force diagram.



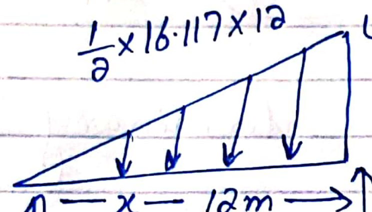


Q (3)



Given Let $UVL = \frac{ID}{1000} = \frac{16117}{1000} = 16.117$

Find S.F.D and BMD = ?



$\Sigma M_B = 0$ (Colock wise positive)

$$(R_A \times 12) - (\tfrac{1}{2} \times 16.117 \times 12 \times \tfrac{1}{2} \times 12) = 0$$

$$R_A = \frac{580}{12} = 48.351$$

$$R_A = 48.351$$

$(-\downarrow, \uparrow+)$ $\Sigma f_y = 0$

$$\Rightarrow 48.351 - (\tfrac{1}{2} \times 16.117 \times 12) + R_B = 0$$

$$R_B = 48.352 \text{ kN}$$

Slope of S.F = intensity of load

S.F – at left of A = 0

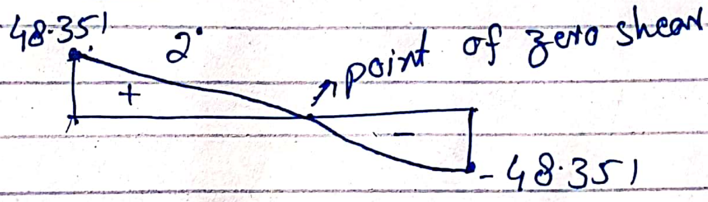
S.F at right of A = –48.351

S.F at left of B = $48.351 - \frac{1}{2} \times 16.117 \times 12$

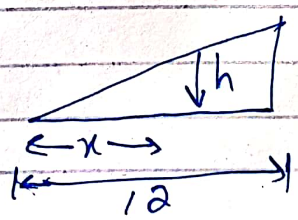
$= -48.351$

S.F at right of B = –48.351 = 0

Now S.F.D:



$(S.F)_c = 0$



$$\frac{16.117}{12} = h/x$$

$$\Rightarrow h = \frac{16.117x}{12}$$

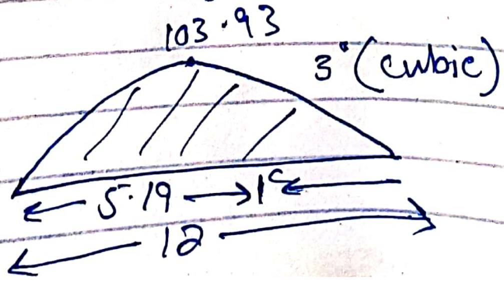
$$48.351 - \frac{1}{2} \times x \times h = 0$$

$$48.351 - \frac{1}{2} \times x^2 \times \frac{16.117x}{12}$$

$x = 5.19$ m

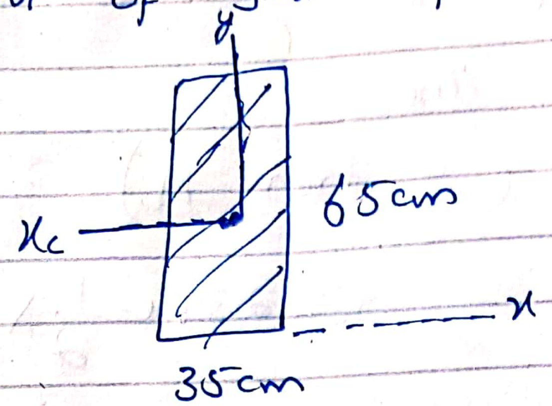
$h = 11.53$ KN/M

B.M.D By calculation bending movement at A



Q (4) Par(b)

Ans: Moment of Inertia for 65 cm × 35 cm



$$I = \frac{bh^3}{12} = \frac{35(65)^3}{12}$$

$$\boxed{I = 800,989.58\,cm^4}$$

Radius of gyration

$$r_{x_1} = \frac{h}{\sqrt{12}} = \frac{65}{\sqrt{12}} = 18.76\ cm$$

$$r_y = \frac{b}{\sqrt{b}} = \frac{35}{\sqrt{12}} = 10.1\ cm$$

$$r_x = \frac{h}{\sqrt{3}} = \frac{65}{\sqrt{3}} = 37.5\ cm$$