IQRA NATIONAL UNIVERSITY

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SECTION: A

Dept.: BE(C)

Semester: 2nd

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Subject: ENGINEERING MECHANICS

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Q1 Given Data

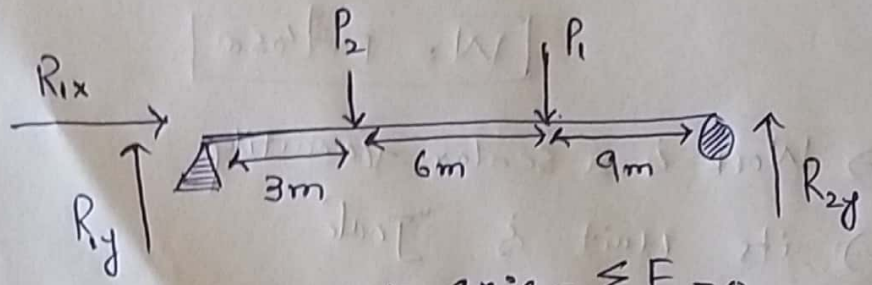
$P_1 = 200 + 5 \cdot ID = 200 + 16095$

$\boxed{P_1 = 16295\,N}$

$P_2 = 500 + 5 \cdot ID = 500 + 16095\,N$

$\boxed{P_2 = 16595\,N}$

Diagram.



Sum of forces along x-axis $= \Sigma F_x = 0$

$\boxed{R_{1x} = 0\,N}$

Sum of forces along y-axis $\Sigma F_y = 0$.

$R_{1y} + R_{2y} = P_1 + P_2 = 16295\,N + 16595\,N$

$R_{1y} + R_{2y} = 32890\,N$ ——— (1)

Sum of Torque $\Sigma \vec{T} = 0$

$$R_{1y} = \frac{P_1 \times 9m + P_2 \times 15m}{18m} = \frac{16295N \times 9m + 16595N \times 15m}{18m}$$

$\boxed{R_{1y} = 21976.66\,N}$

Eq(1) $\Rightarrow R_{2y} = 32890N - R_{1y} = 32890N - 21976.66N$

$\boxed{R_{2y} = 10913.33\,N}$

So Reaction are

$\boxed{R_{1x} = 0N,\ R_{1y} = 21976.66N,\ R_{2y} = 10913.33N}$ Ans.

Q2

$P = 100 + S.ID$

$= 100 + 16095$

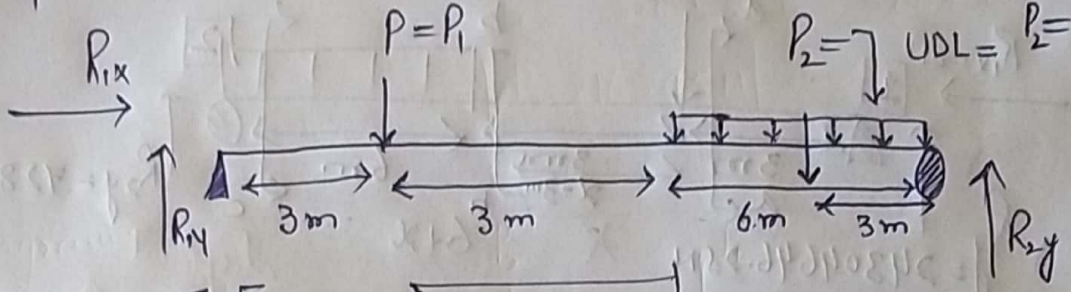
$P_1 = P = 16195\ N$

$UDL = 150 + S.ID$

$= 150 + 16095 = 16245\ \frac{kN}{m}$

$P_2 = UDL \times 6m$

$P_2 = 97170\ kN$



Now $\Sigma F_x = 0$ $\quad \boxed{R_{1x} = 0\ N}$

$\Sigma F_y = 0$

$R_{1y} + R_{2y} = P_1 + P_2 = 16195N + 97170000N = 97186195N$ — Eq(1)

$R_{1y} = \frac{P_1 \times 9m + P_2 \times 3m}{12m} = \frac{16195N \times 9m + 97170000N \times 3m}{12m}$

$= \frac{145755Nm + 291510000Nm}{12m}$

$\boxed{R_{1y} = 24304646.25\ N}$

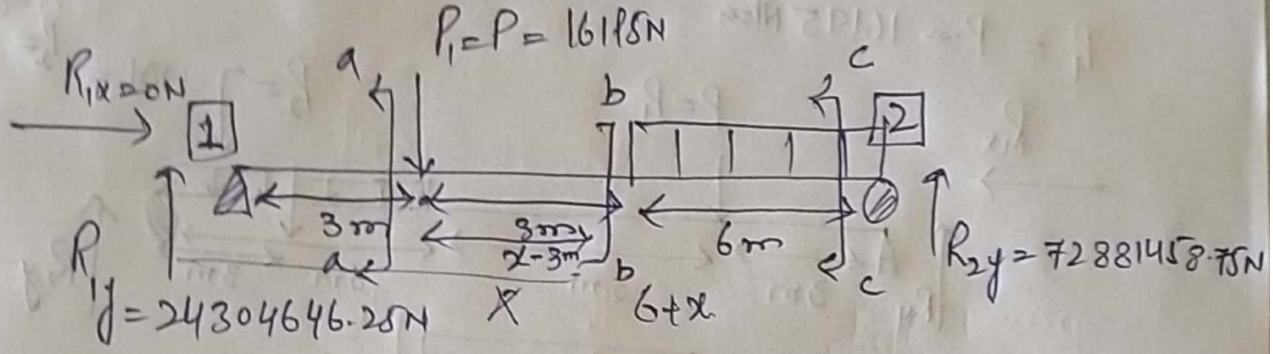
$R_{2y} = 97186195N - R_{1y} = 97186195N - 24304646.25N$

$\boxed{R_{2y} = 72881548.75N}$

Reactions are

$\boxed{R_{1x} = 0N,\ R_{1y} = 24304646.25N,\ R_{2y} = 72881548.75N}$

Shear force at different sections



$0m \leq x \leq 3m$

Section a–a

$-V_{aa} + 24304646.25N = 0$

$V_{aa} = 24304646.25N$

at $x = 0m$

1) $V_{aa} = +24304646.25N$

2) at $x = 3m$

$V_{aa} = 24304646.25N$

$3m \leq x \leq 6m$

Section b–b.

$-V_{bb} - P_1 + R_{1y} = 0$

$-V_{bb} = P_1 - R_{1y}$

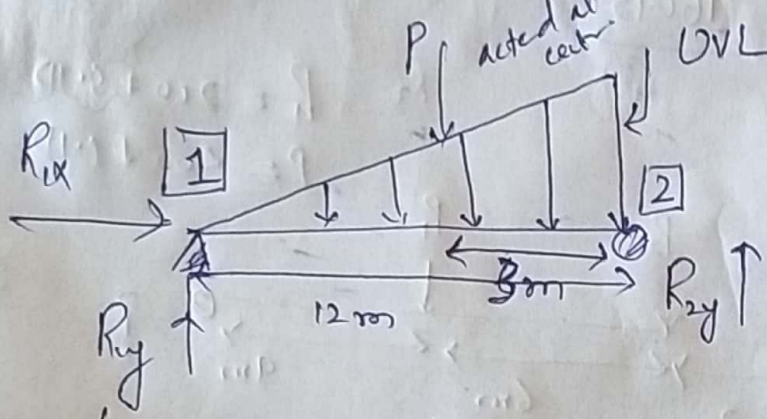
$-V_{bb} = 16185N - 24304646.25N$

$V_{bb} = +24288457.25N$

at Section c–c

$6m \leq x \leq 12m$

Q3. UVL = $\frac{S.I.D}{1000} = \frac{16095}{1000} = 16.095 = 16\,kN/m$



$P = (16\,kN/m \times 12m) = 192\,kN$

(This force act at $\frac{1}{3}$ of length from Max side).

$\boxed{R_{1x} = 0}$ $\quad \Sigma F_x = 0$

$\boxed{R_{1y} + R_{2y} = 192\,kN}$ Eq ①

Now $\Sigma M = 0$ at point 1

$(R_{2y} \times 12m) - (192\,kN \times 9m) = 0$

$R_{2y} = \frac{192\,kN \times 9m}{12m} = 144\,kN$

$\boxed{R_{2y} = 144\,kN}$

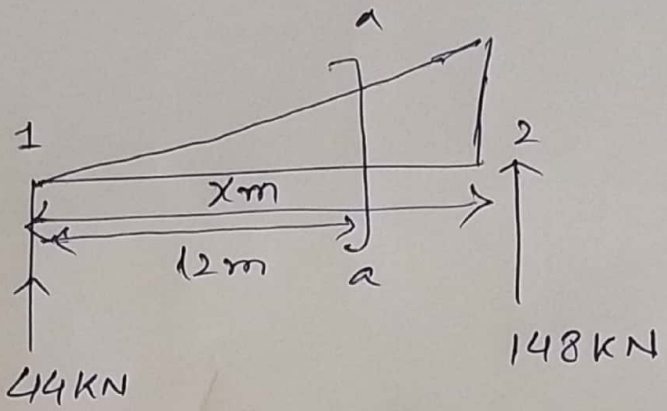
$R_{1y} = 192\,kN - R_{2y}$

$= 192\,kN - 144\,kN$

$\boxed{R_{1y} = 48\,kN}$

$\boxed{R_{1x} = 0N,\ R_{1y} = 48kN,\ R_{2y} = 144kN}$

Shear forces



Section a-a

$0m \leq x \leq 12m$ ~~W_0 KN/m~~ $= \frac{16}{12}$

From law of similar triangles

$$\frac{16\ KN/m}{12\ m} = \frac{W_0\ KN/m}{x\ m} \Rightarrow W_0 = \left(\frac{16x}{12}\right) KN/m$$

Moment

$$W_0 = \left(\frac{16x}{12}\right) KN/m \qquad \Sigma M = 0$$

Q=5

Work: The dot product of force and displacement is called work or If a force is applied on a body and it displace the body through displacement 'd' in its own direction is called work.

Mathematically

$$W = \vec{F} \cdot \vec{d}$$

$$\boxed{W = Fd\cos\theta}$$

→ Work is a scalar quantity

→ its unit is "Joule"

Power: The time rate of doing work done is called Power. or The dot product of force and velocity is called power.

$$P = W/t$$

$$P = \frac{\vec{F} \cdot \vec{d}}{t} = \vec{F} \cdot \frac{\vec{d}}{t} = \vec{F} \cdot \vec{v}$$

$$\boxed{P = \vec{F} \cdot \vec{v}}$$

Unit = Watt

Energy: The ability of a body to do work is called energy. Its unit of measurment is Joule. There are two basic form of energy.

① K.E: The energy possessed by a body due to its motion called K.E.

$$K.E = \frac{1}{2}mv^2$$

② P.E: The energy possessed by a body due to its position in a field of force is called P.E

$$P.E = mgh.$$

Examples of energy

P, W, E

1. Hydroelectric energy
2. Wind energy
3. Tidal energy
4. Wave energy
5. Solar energy ?
6. energy from Biomass.