

# Engineering Mechanics



## Final paper

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**Section:** A  
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**Department:** Civil Engineering  
**Semester:** 2  
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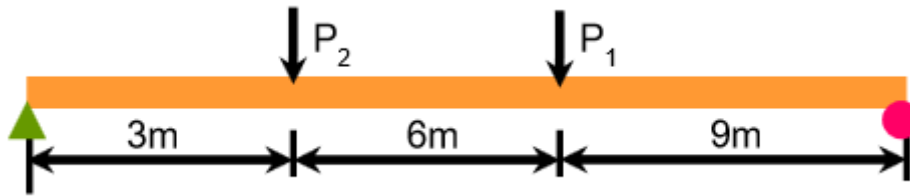
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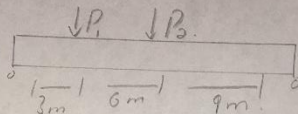
**Q1: Find the support reactions, Show all your calculations.**

**(P1 = 200 + Student ID No) , (P2 = 500 + Student ID No)**



**GIVEN DATA:-**

Pg# (1)



As we know Student ID.

For P<sub>1</sub>.

$$P_1 = 200 + 16115$$

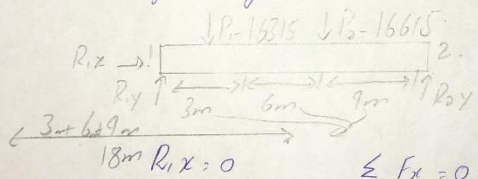
Now For P<sub>2</sub>

$$P_2 = 16315$$

$$P_3 = 500 + 16115$$

$$P_3 = 16615$$

Now Diagrammatically.



$$18m \quad R_{1x} = 0 \quad \sum F_x = 0$$

$$R_{1y} + R_{2y} = 16315 - 16615 = 0 \quad \sum F_y = 0$$

$$R_{1y} + R_{2y} = 16315 + 16615$$

$$\underline{R_{1y} + R_{2y} = 32930N} \rightarrow \text{Eq (1)}$$

$$R_{1y} = \left[ \frac{(16315 \times 4) + (16615 \times 15)}{18} \right] \text{ Pg\# (2)}$$

$$R_{1y} = \frac{146835 + 249225}{18}$$

$$R_{1y} = \frac{396060}{18}$$

$$\underline{R_{1y}} = \underline{22003.3 \text{ N}} \rightarrow \text{eq (2)}$$

Put eq (2) in eq (1), we get

$$R_{1y} + R_{2y} = 32930$$

$$22003.3 + R_{2y} = 32930$$

$$\Rightarrow R_{2y} = 32930 - 22003.3$$

$$\underline{R_{2y}} = \underline{10926.7 \text{ N}}$$

$$\underline{R_{1x}} = 0 \text{ N}, \quad \underline{R_{1y}} = 22003.3 \text{ N}, \quad \underline{R_{2y}} = 10926.7 \text{ N}$$



**Q2: Draw the neat shear force diagram, Show all your calculations.**

**(P = 100 + Student ID No) , (UDL = 150 + Student ID No)**

GIVEN: Pg #137

$P = 100 + 16115$  ,  $UDL = 150 + 16115$

$P = 16215 \text{ kN}$        $UDL = 16265 \text{ kN/m}$

$P = 16215$        $16265 \times 6$   
 $97590 \text{ kN}$

A — 3m — 3m — 6m — D

Sol.

$\sum M_A = 0$

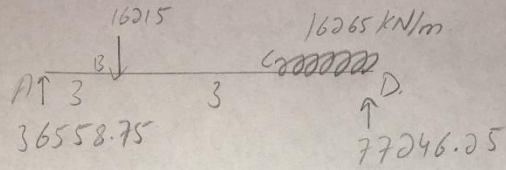
$$16215 \times 3 + 97590 \times 9 - R_D \times 12 = 0$$
$$48645 + 878310 = 12 R_D$$
$$926955 = 12 R_D$$
$$\Rightarrow \frac{926955}{12} = R_D$$
$$R_D = 77246.25 \text{ kN}$$

$\sum M_D = 0$

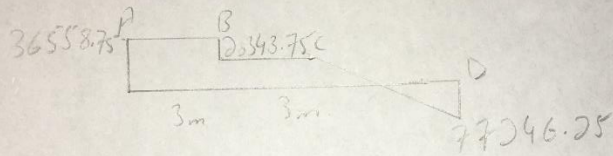
$$R_A \times 12 - 16215 \times 9 - 97590 \times 3 = 0$$
$$R_A \times 12 - 145935 - 292770 = 0$$
$$R_A \times 12 = 438705$$
$$\Rightarrow R_A = \frac{438705}{12}$$

$R_A = 36558.75 \text{ kN}$

Pg. # (4)



Shear force diagram.



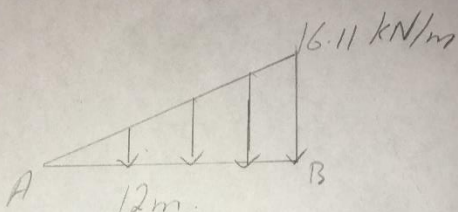
**Q3: Draw the neat shear force and bending moment diagrams, Show all your calculations.**

**(UVL = Student ID No /1000)**

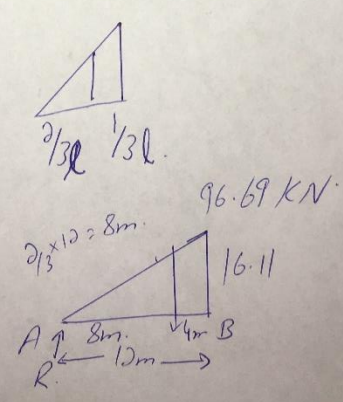
Q.3 Pg# (5)

S.F and B.M diagrams.

UVL:  $16115/1000 = 16.11 \text{ kN/m}$ .



Sol: Total load  $\frac{1}{2} \times b \times h$   
 $= \frac{1}{2} \times 12 \times 16.11$   
 $= \underline{\underline{96.69 \text{ kN}}}$



$\frac{2}{3}l$   $\frac{1}{3}l$

$\frac{2}{3} \times 12 = 8\text{m}$

96.69 kN

A  $\uparrow$  8m  $\downarrow$  4m B  
R.  $\leftarrow$  12m  $\rightarrow$



$M_A \Rightarrow$ 

$$96.69 \times 8 - R_B \times 12 = 0$$

$$773.52 = 12R_B$$

$$\Rightarrow \frac{773.52}{12} = R_B$$

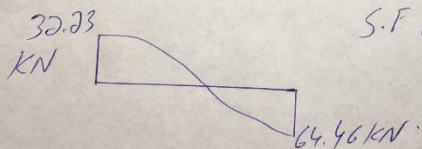
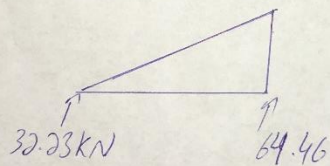
$$\underline{R_B = 64.46 \text{ kN}}$$

 $M_B \Rightarrow$ 

$$R_A \times 12 = 96.69 \times 4$$

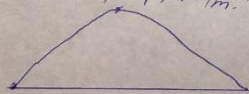
$$12R_A = 386.76$$

$$\Rightarrow \underline{R_A = 32.23 \text{ kN}}$$



S.F diagram = 2°

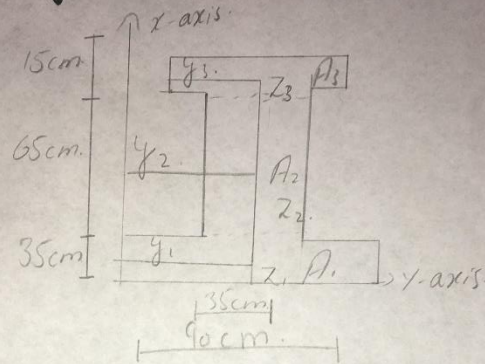
9.27 kN/m B.M diagram = 3°



Q4 (a) Find the centroid of the given shape, Show all your calculations

Q:4) a Find the centroid of the given shape, show all your calculations.

Bg 4 (7)



Sol:

Establish the coordinate system.

Divide the composite area into different simple areas.

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

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

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

Finding centre point of each ~~form~~ area from the origin.

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

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

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



Now For  $Z$ .

Pg. 4/81

$$Z_1 = 0.35/2 = \underline{0.175 \text{ m}}$$

$$Z_2 = 0.35 + (0.65/2) = 0.35 + 0.325 = \underline{0.675 \text{ m}}$$

$$Z_3 = 0.35 + 0.65 + 0.15/2 = 0.35 + 0.65 + 0.075$$

$$Z_3 = \underline{1.075 \text{ m}}$$

$$Y_c = \frac{A_1 Y_1 + A_2 Y_2 + A_3 Y_3}{A_1 + A_2 + A_3}$$

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

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

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

$$Y_c = \underline{\underline{0.6615 \text{ m}}}$$

$$Z_c = \frac{A_1 Z_1 + A_2 Z_2 + A_3 Z_3}{A_1 + A_2 + A_3}$$

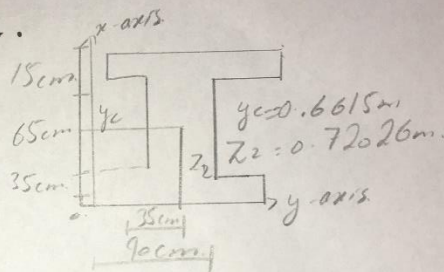
$$Z_c = \frac{(0.315 \times 0.175 \text{ m}) + (0.2275 \times 0.675 \text{ m}) + (0.0975 \times 1.075 \text{ m})}{0.43525}$$

$$= \frac{0.05512 + 0.153562 + 0.104812}{0.43525}$$

pg # (9)

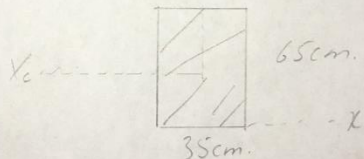
$$= \frac{0.313445}{0.43525}$$

$$Z_c = \underline{0.72026 \text{ m}}$$



Part (b)

Moment of Inertia for (65 cm x 35 cm).



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

$$I = \frac{35 \cdot 274625}{12}$$

$$I = \frac{9611875}{12}$$

$$I = \underline{\underline{800989.58 \text{ cm}^4}}$$

Pg#(10)

Radius of gyration.

$$r_{x_b} = \frac{h}{\sqrt{12}} = \frac{65}{\sqrt{12}} = 18.76 \text{ cm.}$$

$$r_{y_b} = \frac{b}{\sqrt{12}} = \frac{35}{\sqrt{12}} = 10.1 \text{ cm.}$$

$$r_x = \frac{h}{\sqrt{3}} = \frac{65}{\sqrt{3}} = 37.52 \text{ cm.}$$

Section modulus:-

$$S = \frac{bh^3}{6}$$

$$S = \frac{35 \times (65)^3}{6}$$

$$S = \frac{35 \times 4225}{6}$$

$$S = \frac{147875}{6}$$

$$S = \underline{\underline{24645.83 \text{ cm}^3}}$$



**Q5: Explain work, energy and power in details along with practical examples from daily life.**

### **WORK**

Work may be defined as (When a force act on a body, it displaces a body in the direction of force then work is said to be done)

### **OR**

The scalar product of force and displacement is known as work.

### **SYMBOL**

It is denoted by 'w'

### **MATHEMATICALLY**

Mathematically it can be written as

Work = force . displacement

$$W = F \cdot S$$

It is a transfer of energy. The work is done on object when we transfer energy to that object.

### **UNIT**

The S.I unit of work is Joule "J"

The work done will be 1 Joule if a unit of force act on a body and displace it through a unit distance in the direction of force

$$\mathbf{J = N.m}$$

### **QUANTITY**

It is a scalar quantity

### **EXAMPLE**

Pushing the table over ground it cover some distance.

Pushing a car horizontally from rest.

Walking up stairs

## **ENERGY**

The ability of a body to do work is called energy

### **TYPES OF ENERGY**

There are two types of energy

Kinetic Energy

Potential Energy

### **MATHEMATICALLY**

Mathematically it can be written as

$$E = mc^2$$

### **EXAMPLE**

Example of energy is “energy obtained from batteries and generators”

Burning of fire transfer heat energy

Light energy is also example of energy

### **UNIT**

The unit of energy is same as that of the work i.e. “J”

## **POWER**

It is the time rate of doing work is called power

**OR**

The work done in a unit time is known as power

## **SYMBOL**

It is denoted by “P”

## **MATHEMATICALL FORM**

It can be written as

$$P = w/t$$

## **UNIT**

The S.I unit of power is **watt** (w)

The power will be one watt if a unit work is done in a unit time

$$1 \text{ watt} = 1 \text{ joule/1 sec}$$

$$1 \text{ watt} = 1 \text{ J/1 sec}$$

$$W = J \cdot S^{-1}$$

## **EXAMPLE**

Solar energy can be used to power road signs.

Shuttle puts out a few GW (Giga-watts, or  $10^9$  W) of power.