# INTERNATIONAL INSTITUTE OF INFORMATION TECHNOLOGY, HYDERABAD

## RA WORK

## VIRTUAL LAB – STRUCTURAL LAB

### PART-1

| | |
|---|---|
| Single | 1 - 14 |
| Continuous | 15- 21 |
| -------------------------- | |
| Plate | 25-29 |
| Truss | 30-35 |

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## Notations

E = modulus of elasticity, $N/mm^2$

I = moment of inertia, $m^4$

$\ell$ = span length of the bending member, m

M = maximum bending moment, kN-m.

P = total concentrated load, kN.

R = reaction load at bearing point, kN.

V = shear force, kN.

W = total uniform load, kN.

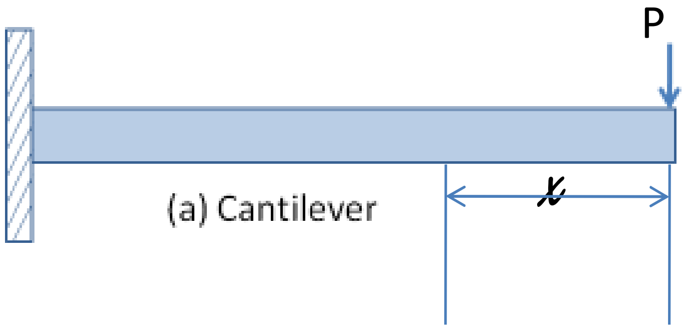
$w$ = load per unit length, kN/m.

$\triangle$ = deflection or deformation, m.

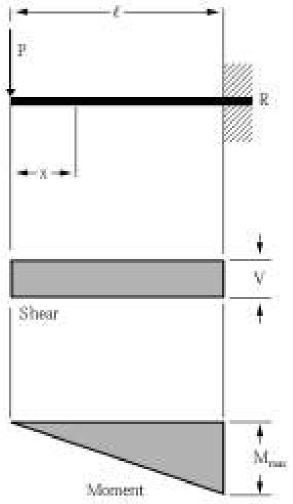
$x$ = horizontal distance from reaction to point on beam, m.

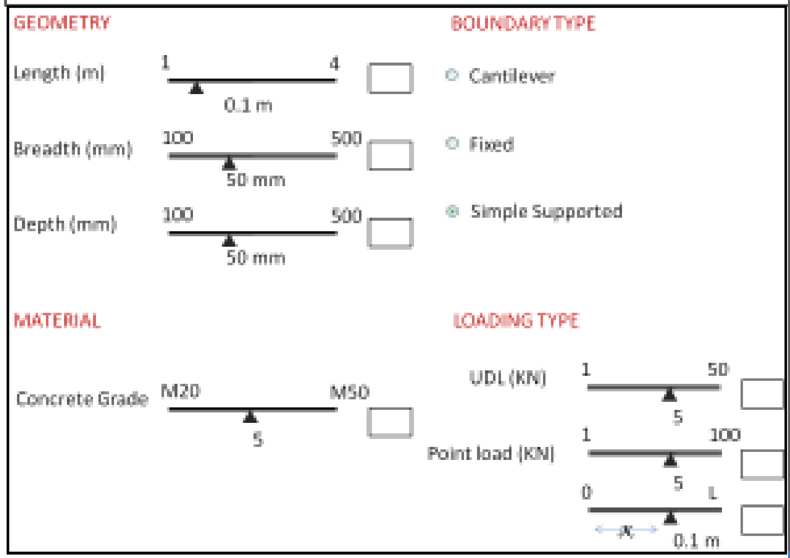
# SINGLE BEAM

# SAMPLE



(a) Cantilever





$$R = V \; . \; . \; . \; . \; . \; . \; . \; . \; . \; . \; . \; . \; . \; . \; . \; . \; . \; = P$$

$$M_{max} \text{ (at fixed end)} \; . \; . \; . \; . \; . \; . \; . \; . \; . \; . \; . \; = P\ell$$

$$M_x \; . \; . \; . \; . \; . \; . \; . \; . \; . \; . \; . \; . \; . \; . \; . \; . \; . \; . \; = Px$$

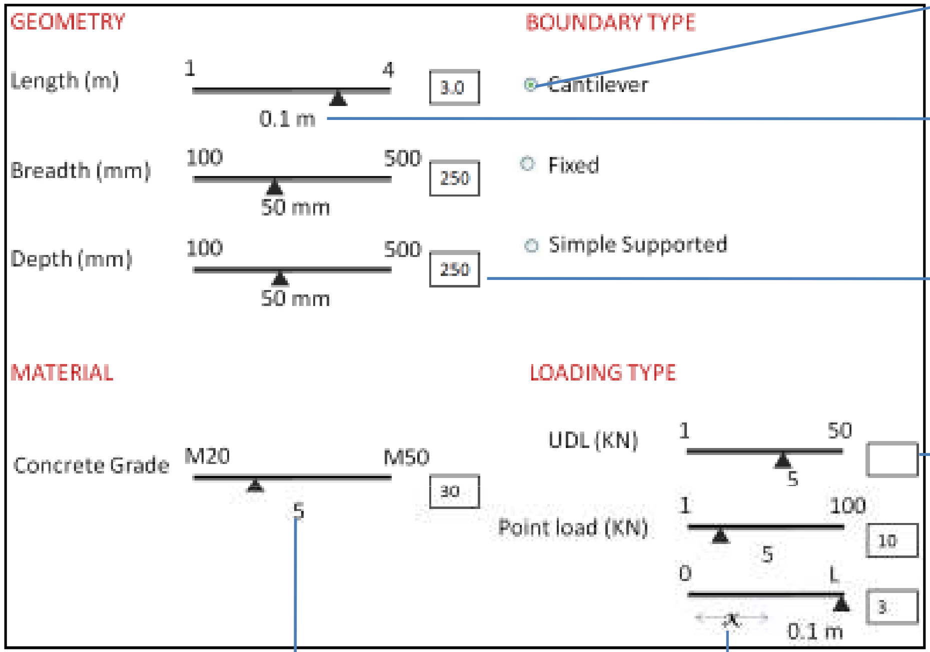
$$\Delta_{max} \text{ (at free end)} \; . \; . \; . \; . \; . \; . \; . \; . \; . \; . \; . \; = \frac{P\ell^3}{3EI}$$

$$\Delta_x \; . \; . \; . \; . \; . \; . \; . \; . \; . \; . \; . \; . \; . \; . \; . \; . \; . \; . \; = \frac{P}{6EI}(2\ell^3 - 3\ell^2 x + x^3)$$

# SINGLE BEAM

# INPUT

## INPUT



GEOMETRY

Length (m) 1 4 0.1 m 3.0

Breadth (mm) 100 500 50 mm 250

Depth (mm) 100 500 50 mm 250

BOUNDARY TYPE

● Cantilever

○ Fixed

○ Simple Supported

MATERIAL

Concrete Grade M20 M50 5 30

LOADING TYPE

UDL (KN) 1 50 5 ☐

Point load (KN) 1 100 5 10

0 L x 0.1 m 3

Selected type of beam for using formulations (radio button)

Length can be varied from 1 m to 4 m, in gaps of 0.1 m

Selected dimension is shown in the box which will be used for calculations

Empty box should take the value zero.

This number shows the increment or decrement of original number

‘x’ distance from the right end where point load is to be applied

# SINGLE BEAM CALCULATIONS

## Input Data

l = 3 m
b = 0.25 m
d = 0.25 m

## Youngs Modulus

E = 5000 x sqrt(30)
= 27386.12 N/mm$^2$
= 2.73 x 10$^7$ kN/m$^2$

I = (b*d$^3$)/12
= 3.25 x 10$^{-4}$ m$^4$

## Beam Type selected

Cantilever

## Deflection Calculations

$$\Delta_x = \frac{P}{6EI}(2l^3 - 3l^2 x + x^3)$$

## Shear Force Calculations

$$V = P$$

## Bending Moment Calculations

$$M_x = Px$$

At any point ‘x’

SINGLE BEAM CALCULATIONS

Any doubts:

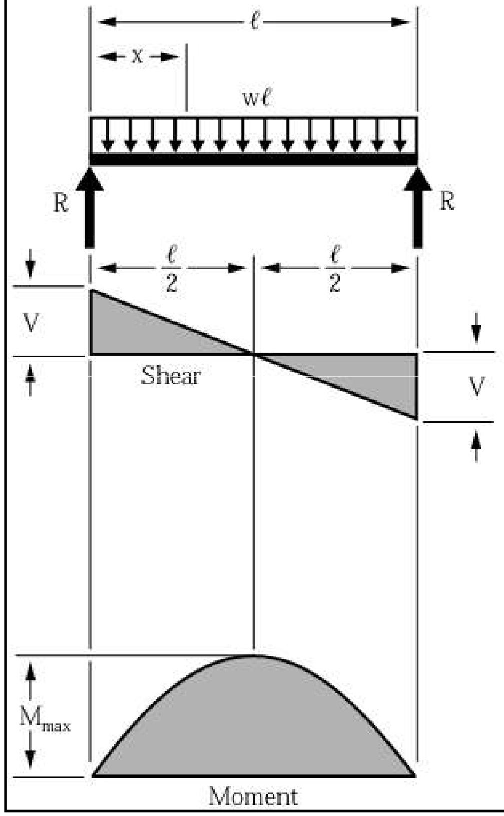
Information missing:

# SAMPLE DIAGRAMS

PART-III

## List of figures & Equations:

## Figure 1 Simple Beam–Uniformly Distributed Load



$$R = V \quad \ldots\ldots\ldots\ldots \quad = \frac{w\ell}{2}$$

$$V_x \quad \ldots\ldots\ldots\ldots \quad = w\left(\frac{\ell}{2} - x\right)$$

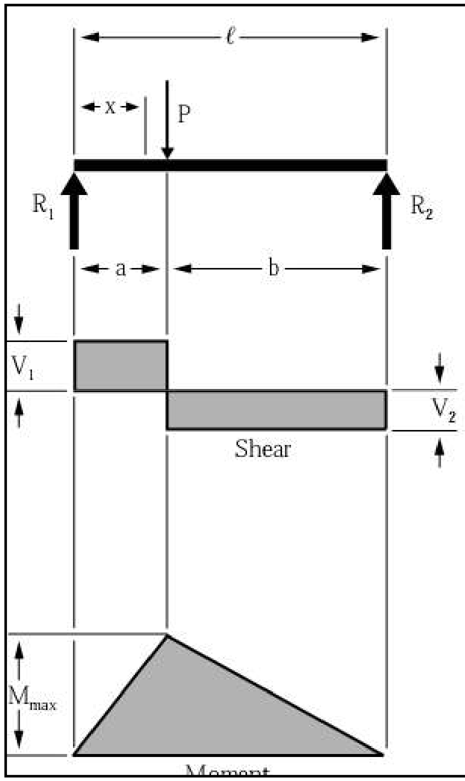
$$M_{max} \text{ (at center)} \quad \ldots\ldots\ldots \quad = \frac{w\ell^2}{8}$$

$$M_x \quad \ldots\ldots\ldots\ldots \quad = \frac{wx}{2}(\ell - x)$$

$$\Delta_{max} \text{ (at center)} \quad \ldots\ldots\ldots \quad = \frac{5w\ell^4}{384\,EI}$$

$$\Delta_x \quad \ldots\ldots\ldots\ldots \quad = \frac{wx}{24\,EI}(\ell^3 - 2\ell x^2 + x^3)$$

## Figure 2 Simple Beam–Concentrated Load at Any Point



$$R_1 = V_1 \text{ (max when } a < b) \quad \ldots\ldots \quad = \frac{Pb}{\ell}$$

$$R_2 = V_2 \text{ (max when } a > b) \quad \ldots\ldots \quad = \frac{Pa}{\ell}$$

$$M_{max} \text{ (at point of load)} \quad \ldots\ldots\ldots \quad = \frac{Pab}{\ell}$$

$$M_x \text{ (when } x < b) \quad \ldots\ldots\ldots\ldots \quad = \frac{Pbx}{\ell}$$

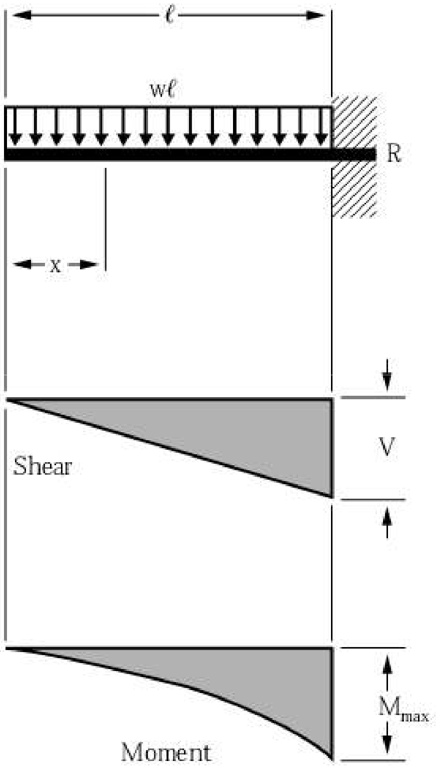
$$\Delta_{max} \left( \text{at } x = \sqrt{\frac{a(a+2b)}{3}} \text{ when } a > b \right) \quad . \quad = \frac{Pab(a+2b)\sqrt{3a(a+2b)}}{27EI\ell}$$

$$\Delta_a \text{ (at point of load)} \quad \ldots\ldots\ldots \quad = \frac{Pa^2b^2}{3EI\ell}$$

$$\Delta_x \text{ (when } x < a) \quad \ldots\ldots\ldots\ldots \quad = \frac{Pbx}{6EI\ell}(\ell^2 - b^2 - x^2)$$

$$\Delta_x \text{ (when } x > a) \quad \ldots\ldots\ldots\ldots \quad = \frac{Pa(\ell - x)}{6EI\ell}(2\ell x - x^2 - a^2)$$

## Figure 3 Cantilever Beam–Uniformly Distributed Load



$$R = V \ldots\ldots\ldots\ldots = w\ell$$

$$V_x \ldots\ldots\ldots\ldots = wx$$

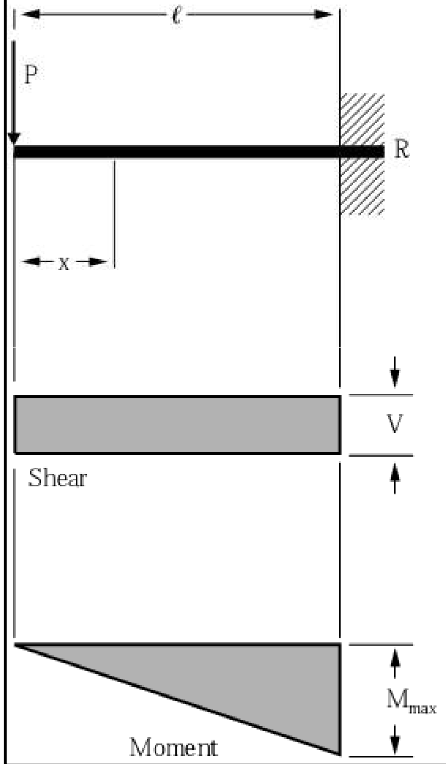
$$M_{max} \text{ (at fixed end)} \ldots\ldots = \frac{w\ell^2}{2}$$

$$M_x \ldots\ldots\ldots\ldots = \frac{wx^2}{2}$$

$$\Delta_{max} \text{ (at free end)} \ldots\ldots = \frac{w\ell^4}{8EI}$$

$$\Delta_x \ldots\ldots\ldots\ldots = \frac{w}{24EI}(x^4 - 4\ell^3x + 3\ell^4)$$

## Figure 4 Cantilever Beam–Concentrated Load at Free End



$R = V$ . . . . . . . . . . . . . . . $= P$

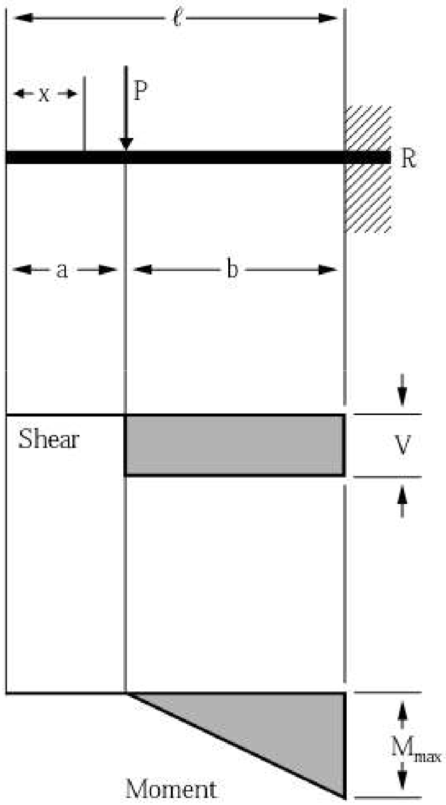
$M_{max}$ (at fixed end) . . . . . . . . . . $= P\ell$

$M_x$ . . . . . . . . . . . . . . . $= Px$

$\Delta_{max}$ (at free end) . . . . . . . . . $= \dfrac{P\ell^3}{3EI}$

$\Delta_x$ . . . . . . . . . . . . . . . . $= \dfrac{P}{6EI}(2\ell^3 - 3\ell^2 x + x^3)$

## Figure 5 Cantilever Beam–Concentrated Load at Any Point



$R = V$ . . . . . . . . . . . . . . $= P$

$M_{max}$ (at fixed end) . . . . . . . . . $= Pb$

$M_x$ (when $x > a$) . . . . . . . . . $= P(x - a)$

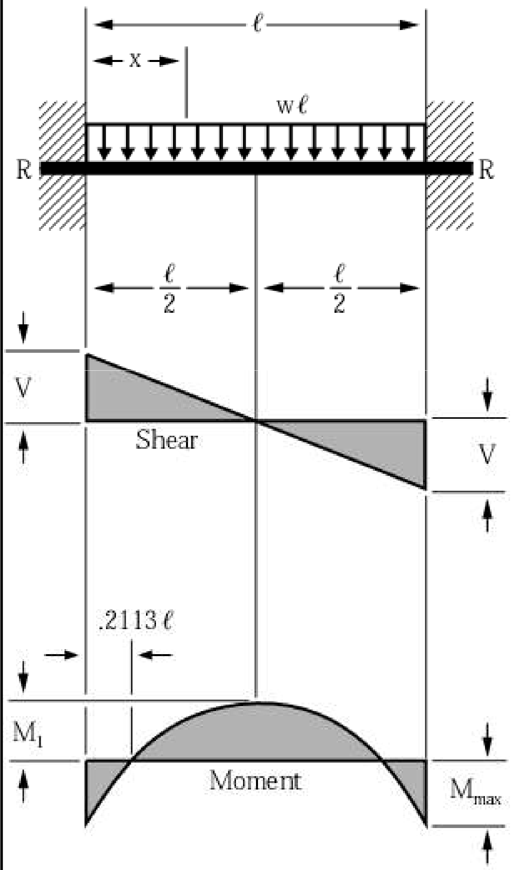
$\Delta_{max}$ (at free end) . . . . . . . . . $= \dfrac{Pb^2}{6EI}(3\ell - b)$

$\Delta_a$ (at point of load) . . . . . . . . $= \dfrac{Pb^3}{3EI}$

$\Delta_x$ (when $x < a$) . . . . . . . . . . $= \dfrac{Pb^2}{6EI}(3\ell - 3x - b)$

$\Delta_x$ (when $x > a$) . . . . . . . . . . $= \dfrac{P(\ell - x)^2}{6EI}(3b - \ell + x)$

## Figure 6 Beam Fixed at Both Ends–Uniformly Distributed Load



$$R = V \ldots\ldots\ldots\ldots = \frac{w\ell}{2}$$

$$V_x \ldots\ldots\ldots\ldots = w\left(\frac{\ell}{2} - x\right)$$

$$M_{max} \text{ (at ends)} \ldots\ldots\ldots\ldots = \frac{w\ell^2}{12}$$

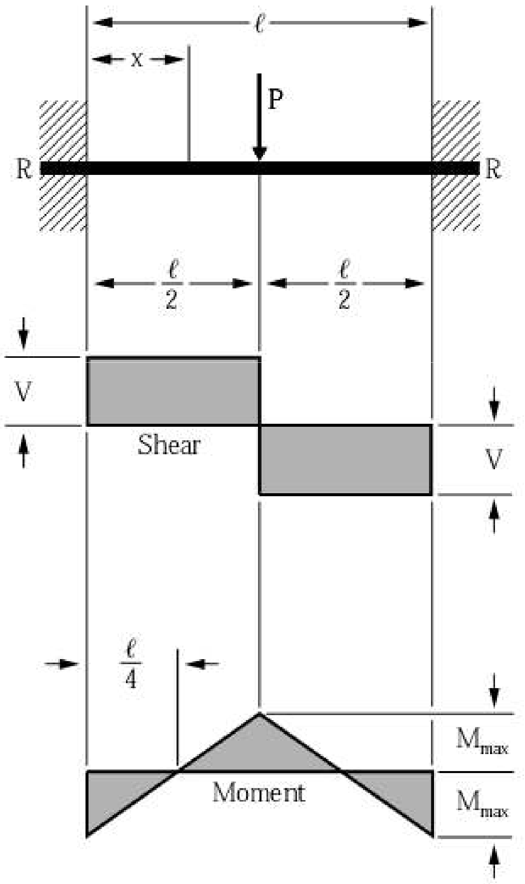
$$M_1 \text{ (at center)} \ldots\ldots\ldots\ldots = \frac{w\ell^2}{24}$$

$$M_x \ldots\ldots\ldots\ldots = \frac{w}{12}(6\ell x - \ell^2 - 6x^2)$$

$$\Delta_{max} \text{ (at center)} \ldots\ldots\ldots\ldots = \frac{w\ell^4}{384EI}$$

$$\Delta_x \ldots\ldots\ldots\ldots = \frac{wx^2}{24EI}(\ell - x)^2$$

## Figure 7 Beam Fixed at Both Ends–Concentrated Load at Center



$$R = V \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad = \frac{P}{2}$$

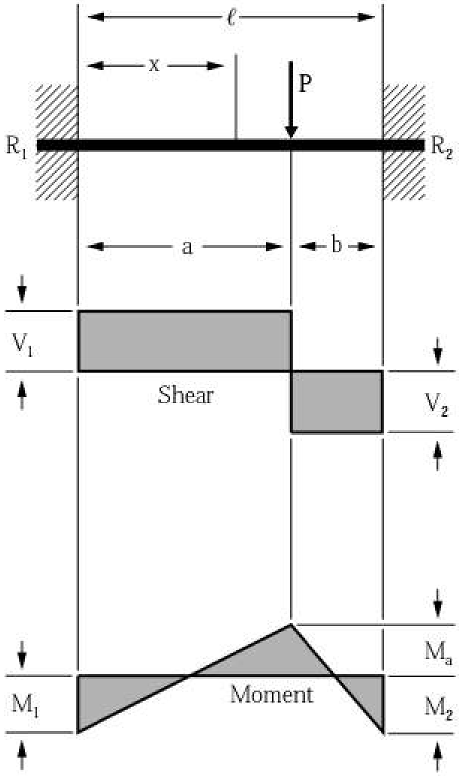
$$M_{max} \text{ (at center and ends)} \quad \ldots\ldots\ldots \quad = \frac{P\ell}{8}$$

$$M_x \left( \text{when } x < \frac{\ell}{2} \right) \quad \ldots\ldots\ldots\ldots \quad = \frac{P}{8}(4x - \ell)$$

$$\Delta_{max} \text{ (at center)} \quad \ldots\ldots\ldots\ldots \quad = \frac{P\ell^3}{192EI}$$

$$\Delta_x \left( \text{when } x < \frac{\ell}{2} \right) \quad \ldots\ldots\ldots\ldots \quad = \frac{Px^2}{48EI}(3\ell - 4x)$$

## Figure 8 Beam Fixed at Both Ends–Concentrated Load at Any Point



$$R_1 = V_1 \text{ (max when } a < b\text{)} \quad \dots\dots \quad = \frac{Pb^2}{\ell^3}(3a + b)$$

$$R_2 = V_2 \text{ (max when } a > b\text{)} \quad \dots\dots \quad = \frac{Pa^2}{\ell^3}(a + 3b)$$

$$M_1 \text{ (max when } a < b\text{)} \quad \dots\dots\dots \quad = \frac{Pab^2}{\ell^2}$$

$$M_2 \text{ (max when } a > b\text{)} \quad \dots\dots\dots \quad = \frac{Pa^2b}{\ell^2}$$

$$M_a \text{ (at point of load)} \quad \dots\dots\dots \quad = \frac{2Pa^2b^2}{\ell^3}$$

$$M_x \text{ (when } x < a\text{)} \quad \dots\dots\dots\dots \quad = R_1x - \frac{Pab^2}{\ell^2}$$

$$\Delta_{\max}\left(\text{when } a > b \text{ at } x = \frac{2a\ell}{3a + b}\right) \quad \dots \quad = \frac{2Pa^3b^2}{3EI(3a + b)^2}$$

$$\Delta_a \text{ (at point of load)} \quad \dots\dots\dots \quad = \frac{Pa^3b^3}{3EI\ell^3}$$

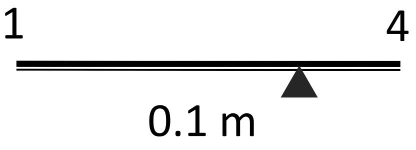
$$\Delta_x \text{ (when } x < a\text{)} \quad \dots\dots\dots\dots \quad = \frac{Pb^2x^2}{6EI\ell^3}(3a\ell - 3ax - bx)$$

# Continuous Beams

PART-II

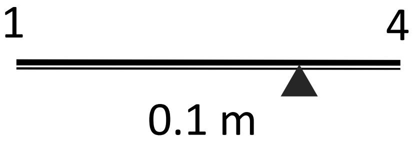
## GEOMETRY

Length1 (m)



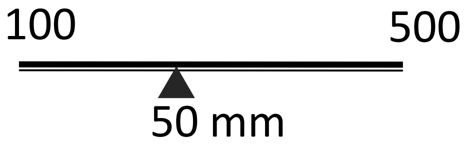
3.0

Length2 (m)



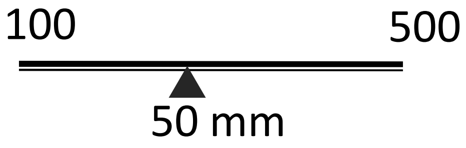
3.0

Breadth (mm)



250

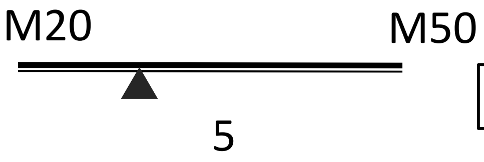
Depth (mm)



250

## MATERIAL

Concrete Grade



30

## BOUNDARY TYPE

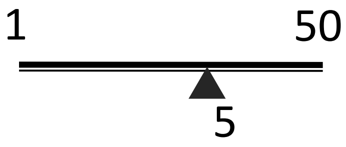
● Simple Supported

○ Cantilever

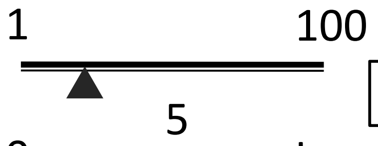
○ Fixed

## LOADING TYPE

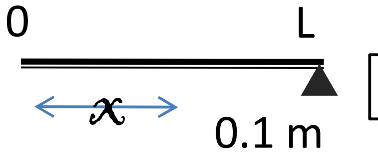
UDL (KN)



Point load (KN)

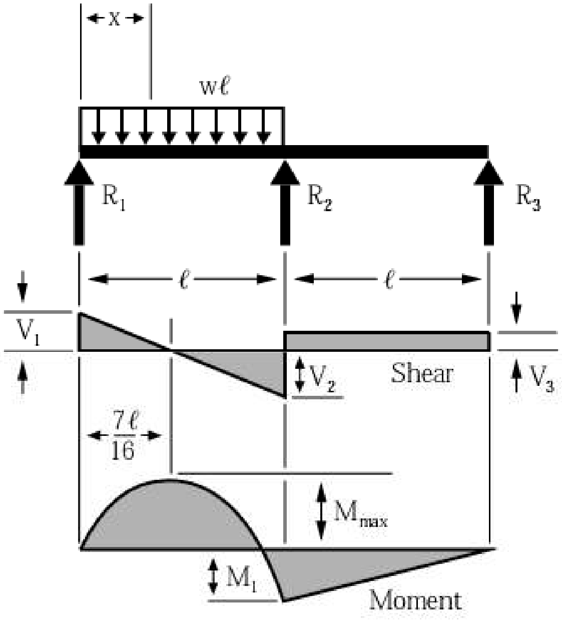


10 10



3 3

## Figure 9 Continuous Beam–Two Equal Spans–Uniform Load on One Span



$$R_1 = V_1 \dots \dots = \frac{7}{16} w\ell$$

$$R_2 = V_2 + V_3 \dots \dots = \frac{5}{8} w\ell$$

$$R_3 = V_3 \dots \dots = -\frac{1}{16} w\ell$$

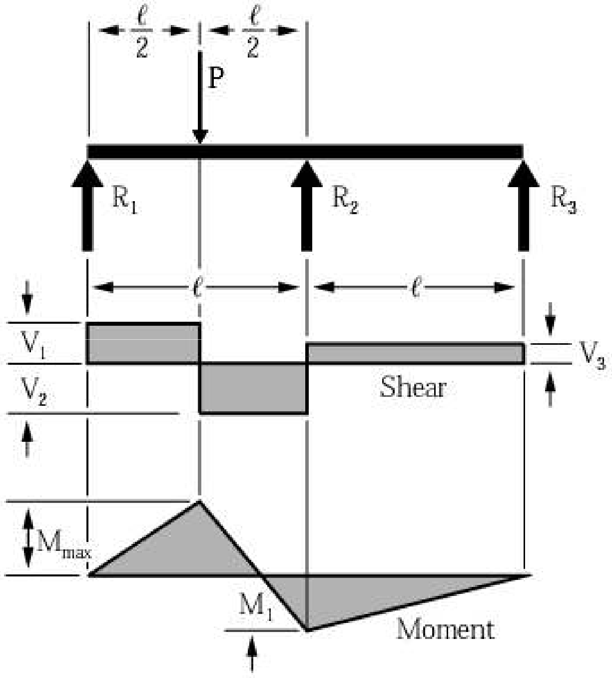
$$V_2 \dots \dots = \frac{9}{16} w\ell$$

$$M_{max} \left( \text{at } x = \frac{7}{16}\ell \right) \dots \dots = \frac{49}{512} w\ell^2$$

$$M_1 \text{ (at support } R_2) \dots \dots = \frac{1}{16} w\ell^2$$

$$M_x \text{ (when } x < \ell) \dots \dots = \frac{wx}{16}(7\ell - 8x)$$

## Figure 10 Continuous Beam–Two Equal Spans–Concentrated Load at Center of One Span



$$R_1 = V_1 \quad \ldots\ldots\ldots\ldots\ldots \quad = \frac{13}{32}P$$

$$R_2 = V_2 + V_3 \quad \ldots\ldots\ldots\ldots \quad = \frac{11}{16}P$$

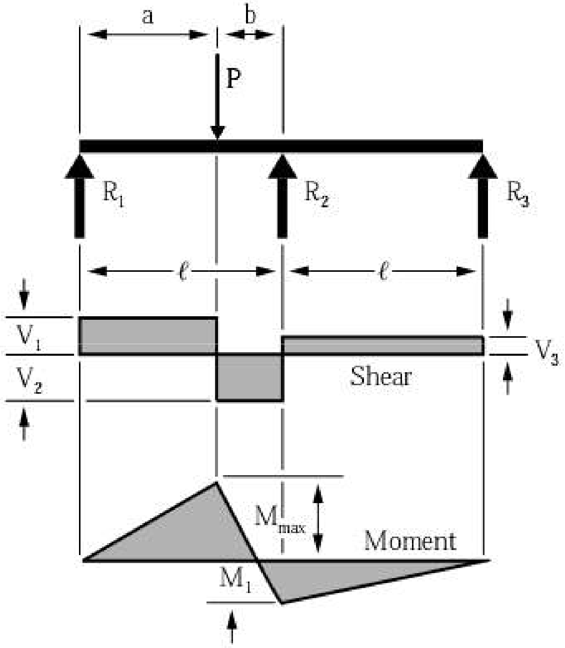
$$R_3 = V_3 \quad \ldots\ldots\ldots\ldots\ldots \quad = -\frac{3}{32}P$$

$$V_2 \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad = \frac{19}{32}P$$

$$M_{max} \text{ (at point of load)} \quad \ldots\ldots\ldots \quad = \frac{13}{64}P\ell$$

$$M_1 \text{ (at support } R_2\text{)} \quad \ldots\ldots\ldots\ldots \quad = \frac{3}{32}P\ell$$

## Figure 11 Continuous Beam–Two Equal Spans–Concentrated Load at Any Point



$$R_1 = V_1 \quad \dots\dots\dots \quad = \frac{Pb}{4\ell^3}\left(4\ell^2 - a(\ell + a)\right)$$

$$R_2 = V_2 + V_3 \quad \dots\dots\dots \quad = \frac{Pa}{2\ell^3}\left(2\ell^2 + b(\ell + a)\right)$$

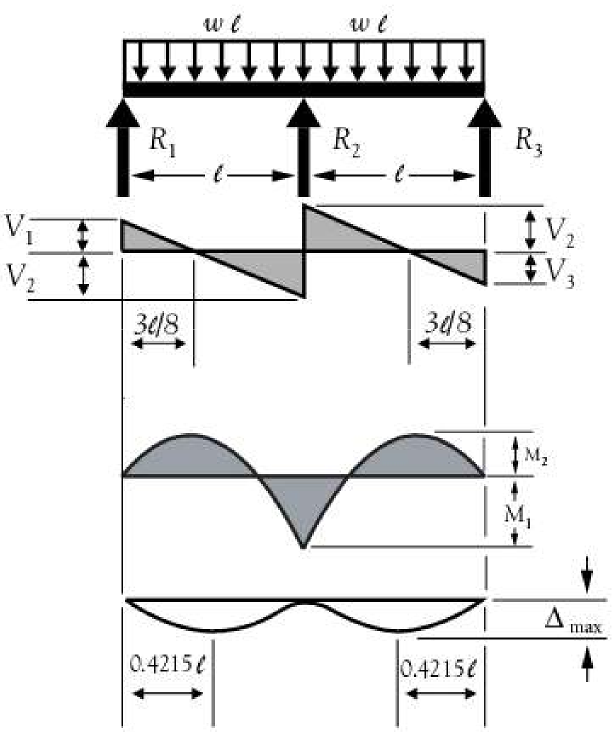
$$R_3 = V_3 \quad \dots\dots\dots \quad = -\frac{Pab}{4\ell^3}(\ell + a)$$

$$V_2 \quad \dots\dots\dots \quad = \frac{Pa}{4\ell^3}\left(4\ell^2 + b(\ell + a)\right)$$

$$M_{max} \text{ (at point of load)} \quad \dots\dots\dots \quad = \frac{Pab}{4\ell^3}\left(4\ell^2 - a(\ell + a)\right)$$

$$M_1 \text{ (at support } R_2\text{)} \quad \dots\dots\dots \quad = \frac{Pab}{4\ell^2}(\ell + a)$$

## Figure 12 Continuous Beam–Two Equal Spans–Uniformly Distributed Load



$$R_1 = V_1 = R_3 = V_3 \ \dots\dots \ = \frac{3w\ell}{8}$$

$$R_2 \ \dots\dots \ = \frac{10w\ell}{8}$$

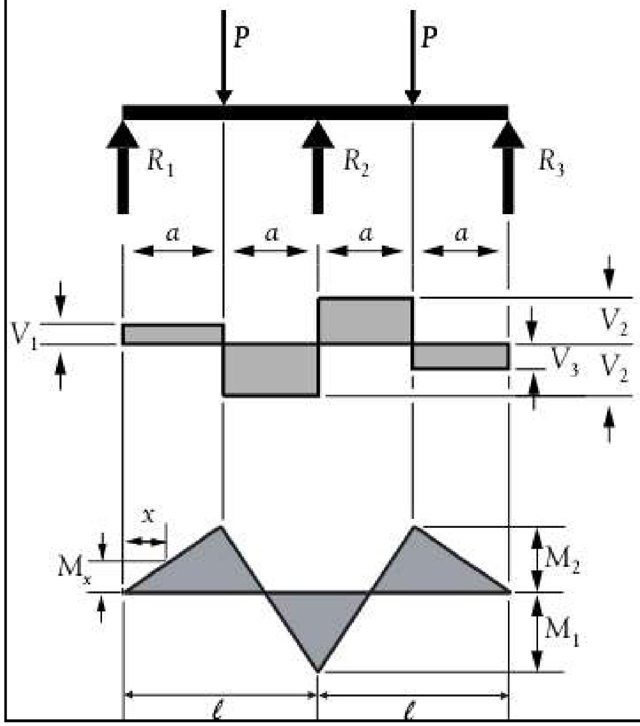
$$V_2 = V_{max} \ \dots\dots \ = \frac{5w\ell}{8}$$

$$M_1 \ \dots\dots \ = \frac{w\ell^2}{8}$$

$$M_2 \left(\text{at } \frac{3\ell}{8}\right) \ \dots\dots \ = \frac{9w\ell^2}{128}$$

$$\Delta_{max} \ (\text{at } 0.4215\ \ell, \text{ approx. from } R_1 \text{ and } R_3) \ \dots \ = \frac{w\ell^4}{185EI}$$

## Figure 13 Continuous Beam–Two Equal Spans–Two Equal Concentrated Loads Symmetrically Placed



$$R_1 = V_1 = R_3 = V_3 \ldots\ldots\ldots\ldots = \frac{5P}{16}$$

$$R_2 = 2V_2 \ldots\ldots\ldots\ldots\ldots\ldots = \frac{11P}{8}$$

$$V_2 = P - R_1 \ldots\ldots\ldots\ldots\ldots = \frac{11P}{16}$$

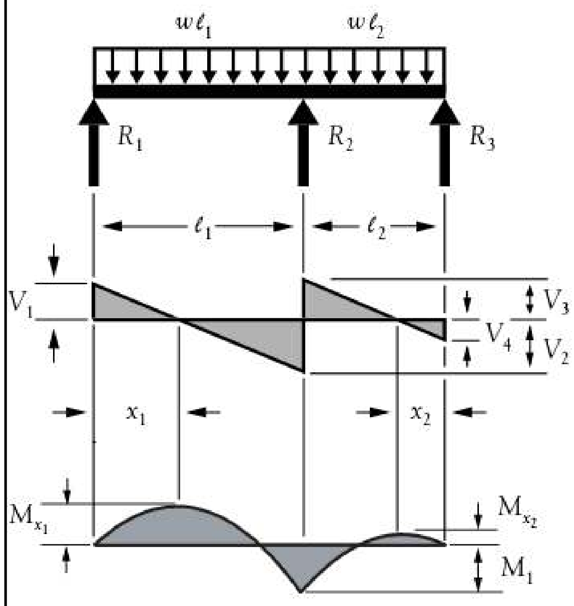
$$V_{max} \ldots\ldots\ldots\ldots\ldots\ldots\ldots = V_2$$

$$M_1 \ldots\ldots\ldots\ldots\ldots\ldots\ldots = -\frac{3P\ell}{16}$$

$$M_2 \ldots\ldots\ldots\ldots\ldots\ldots\ldots = \frac{5P\ell}{32}$$

$$M_x \text{ (when } x < a) \ldots\ldots\ldots\ldots = R_1 x$$

## Figure 14 Continuous Beam–Two Unequal Spans–Uniformly Distributed Load



$$R_1 \ldots\ldots = \frac{M_1}{\ell_1} + \frac{w\ell_1}{2}$$

$$R_2 \ldots\ldots = w\ell_1 + w\ell_2 - R_1 - R_3$$

$$R_3 = V_4 \ldots\ldots = \frac{M_1}{\ell_2} + \frac{w\ell_2}{2}$$

$$V_1 \ldots\ldots = R_1$$

$$V_2 \ldots\ldots = w\ell_1 - R_1$$

$$V_3 \ldots\ldots = w\ell_2 - R_3$$

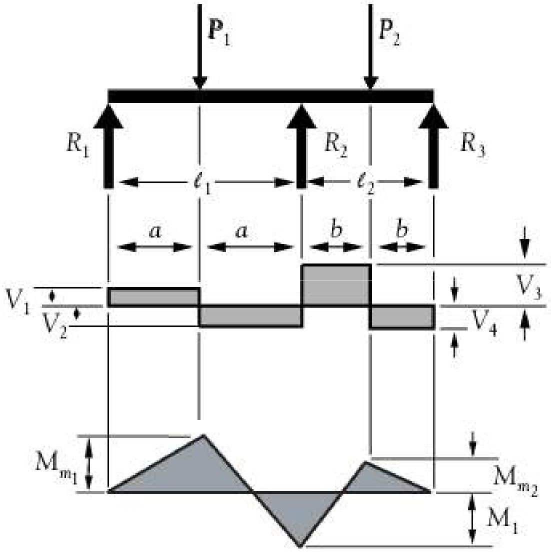
$$V_4 \ldots\ldots = R_3$$

$$M_1 \ldots\ldots = -\frac{w\ell_2^{\,3} + w\ell_1^{\,3}}{8(\ell_1 + \ell_2)}$$

$$M_{x_1}\left(\text{when } x_1 = \frac{R_1}{w}\right) \ldots\ldots = R_1 x_1 - \frac{wx_1^{\,2}}{2}$$

$$M_{x_2}\left(\text{when } x_2 = \frac{R_3}{w}\right) \ldots\ldots = R_3 x_2 - \frac{wx_2^{\,2}}{2}$$

## Figure 15 Continuous Beam–Two Unequal Spans–Concentrated Load on Each Span Symmetrically Placed



$R_1$ . . . . . . . . . . . . . . . . . $= \frac{M_1}{\ell_1} + \frac{P_1}{2}$

$R_2$ . . . . . . . . . . . . . . . . . $= P_1 + P_2 - R_1 - R_3$

$R_3$ . . . . . . . . . . . . . . . . . $= \frac{M_1}{\ell_2} + \frac{P_2}{2}$

$V_1$ . . . . . . . . . . . . . . . . . $= R_1$

$V_2$ . . . . . . . . . . . . . . . . . $= P_1 - R_1$

$V_3$ . . . . . . . . . . . . . . . . . $= P_2 - R_3$

$V_4$ . . . . . . . . . . . . . . . . . $= R_3$

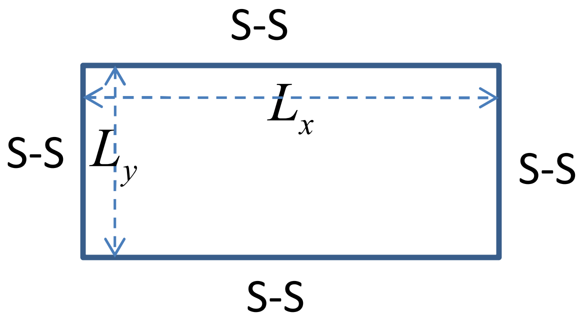
$M_1$ . . . . . . . . . . . . . . . . . $= -\frac{3}{16}\left(\frac{P_1\ell_1^{2} + P_2\ell_2^{2}}{\ell_1 + \ell_2}\right)$

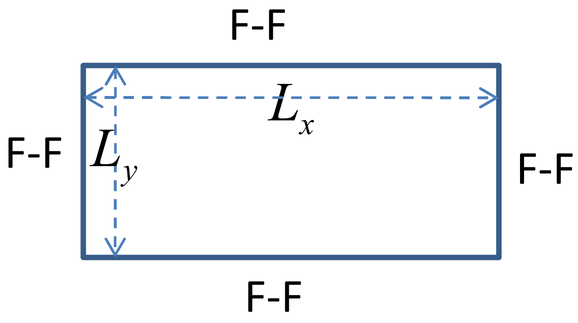
$M_{m_1}$ . . . . . . . . . . . . . . . $= R_1 a$

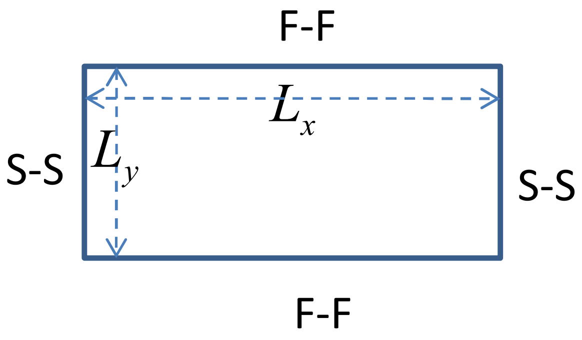
$M_{m_2}$ . . . . . . . . . . . . . . . $= R_3 b$

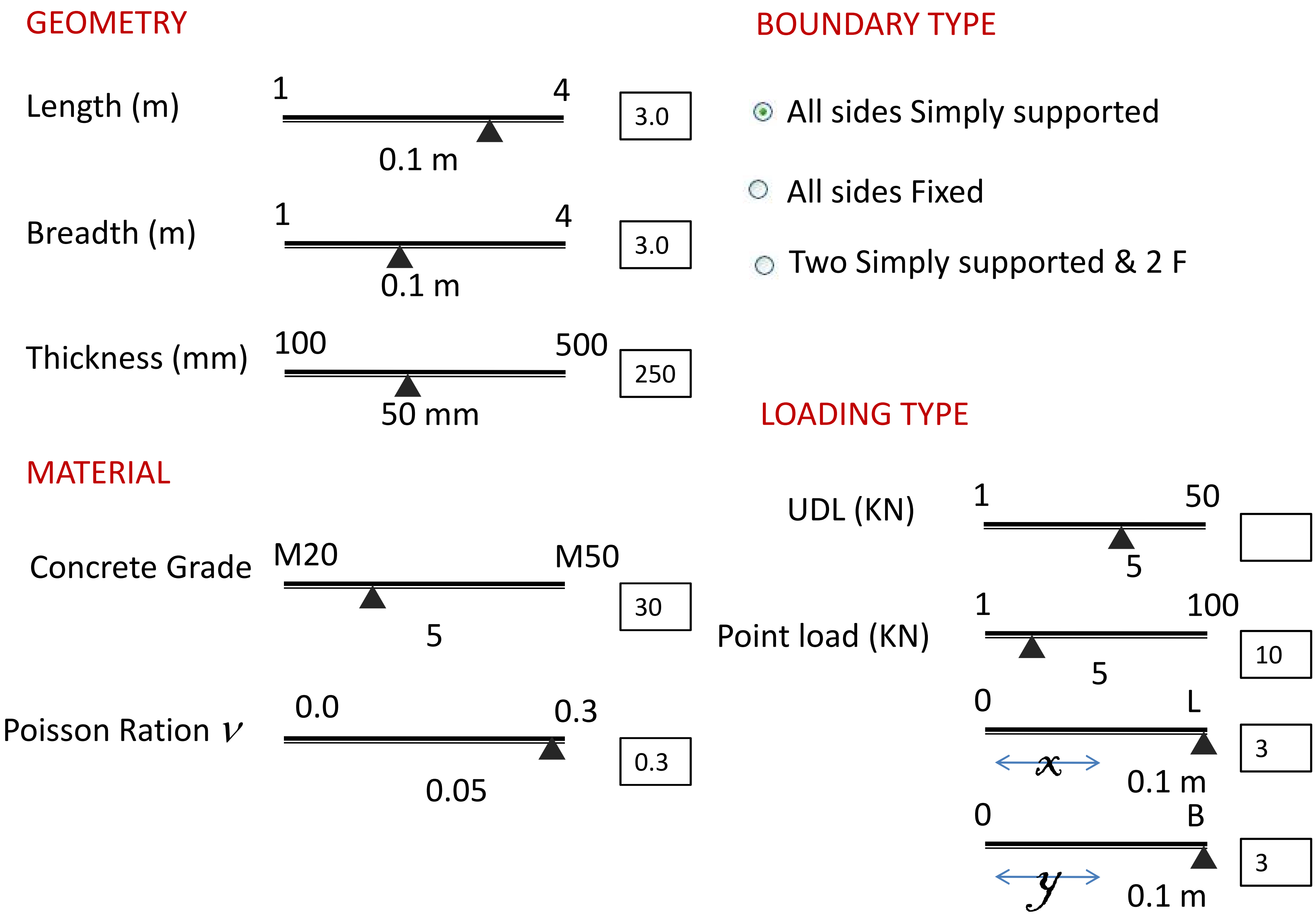
# PLATES

CASE 1: All sides simply supported with UDL
: All sides simply supported with Point load
CASE 2: All sides fixed with UDL
: All sides fixed with point load









## GEOMETRY

Length (m)
1
4
0.1 m
3.0

Breadth (m)
1
4
0.1 m
3.0

Thickness (mm)
100
500
50 mm
250

## MATERIAL

Concrete Grade
M20
M50
5
30

Poisson Ration $\nu$
0.0
0.3
0.05
0.3

## BOUNDARY TYPE

● All sides Simply supported

○ All sides Fixed

○ Two Simply supported & 2 F

## LOADING TYPE

UDL (KN)
1
50
5

Point load (KN)
1
100
5
10

0
L
$x$
0.1 m
3

0
B
$y$
0.1 m
3

PLATE CALCULATIONS

To compute the displacement of a simply-supported rectangular plate under a uniform load.

Input Data

Geometry

Width $L_x$
Length $L_y$
Thickness T

Material

Youngs Modulus
E = 5000 x sqrt(30)
$\nu$ = 0.3

Loading

UDL (P)

Deflection at any point (x,y)

$$D=\frac{ET^3}{12(1-\nu)}$$

$$w(x,y)=\frac{16p}{\pi^6 D}\sum_{m=1,3,5}^{\infty}\sum_{n=1,3,5}^{\infty}\frac{\sin\left(\frac{m\pi x}{L_x}\right)\sin\left(\frac{n\pi y}{L_y}\right)}{mn\left[\left(\frac{m}{L_x}\right)^2+\left(\frac{n}{L_y}\right)^2\right]^2}$$

PLATE CALCULATIONS

To compute the displacement of a simply-supported rectangular plate under a Point distributed load.

## Input Data

### Geometry

Width $L_x$
Length $L_y$
Thickness T

### Material

Youngs Modulus
E = 5000 x sqrt(30)
$\nu$ = 0.3

### Loading

Point load

### Point load position

X coordinate ‘a’
Y coordinate ‘b’

### Deflection at any point (x,y)

$$D = \frac{ET^3}{12(1-\nu)}$$

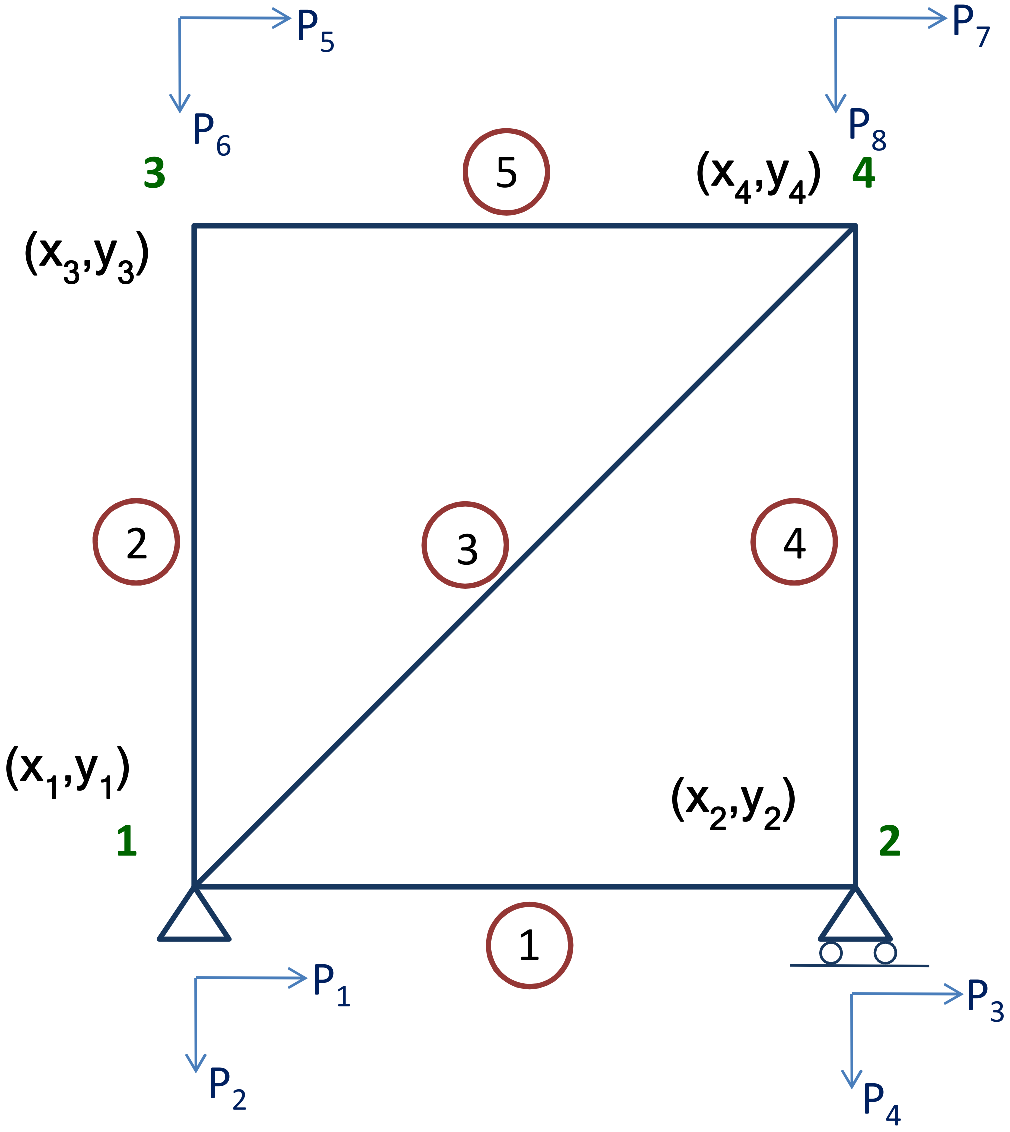
$$w(x,y) = \frac{4p}{\pi^4 D L_x L_y} \sum_{m=1,3,5}^{\infty} \sum_{n=1,3,5}^{\infty} \frac{\sin\left(\frac{m\pi a}{L_x}\right)\sin\left(\frac{n\pi b}{L_y}\right)\sin\left(\frac{m\pi x}{L_x}\right)\sin\left(\frac{n\pi y}{L_y}\right)}{\left[\left(\frac{m}{L_x}\right)^2 + \left(\frac{n}{L_y}\right)^2\right]^2}$$

PLATE CALCULATIONS

To compute the displacement of a two simply-supported and two fixed rectangular plate under a Point distributed load.

Need Update

# TRUSS FORMULATION



# TRUSS

## STEP-1

Nodal Coordinates

ND

| Node Number | x | y |
|---|---|---|
| 1 | $x_1$ | $y_1$ |
| 2 | $x_2$ | $y_2$ |
| 3 | $x_3$ | $y_3$ |
| 4 | $x_4$ | $y_4$ |

## STEP-3

Element connectivity

EL

| Element | N1 | N2 | **E** | **A** |
|---|---|---|---|---|
| 1 | 1 | 2 | | |
| 2 | 1 | 3 | | |
| 3 | 1 | 4 | | |
| 4 | 2 | 4 | | |
| 5 | 3 | 4 | | |

## STEP-2

Element Lengths

$$\ell_e = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$$

$$\ell = (x_2 - x_1)/l_e$$

$$m = (y_2 - y_1)/l_e$$

E - elastic modulus

A - cross section area

## STEP-4

Element Stiffness Matrix

$$k_{ele} = \frac{E_e A_e}{l_e} \begin{bmatrix} l^2 & lm & -l^2 & -lm \\ lm & m^2 & -lm & -m^2 \\ -l^2 & -lm & l^2 & lm \\ -lm & -m^2 & lm & m^2 \end{bmatrix}$$

# STEP-5 Global Stiffness Matrix

```
For  i=1:size( EL,1)  % iterating through all elements ------------------------

      node1 =  EL(i,2);
      node2 =  EL(i,3);

       E1= EL(i,4);
       A1 =  EL(i,5);

        % Calculation of K_ele -   (step -2 then  step - 4 )


      t1 = node1*2; t2 = node2*2;

      % global K
      Kgl((t1 -1):t1,(t1 -1):t1) = Kgl( (t1 -1):t1,(t1 -1):t1) + Klc(1:2,1:2);
      Kgl((t1 -1):t1,(t2 -1):t2) = Kgl( (t1 -1):t1,(t2 -1):t2) + Klc(1:2,3:4);
      Kgl((t2 -1):t2,(t1 -1):t1) = Kgl( (t2 -1):t2,(t1 -1):t1) + Klc(3:4,1:2);
      Kgl((t2 -1):t2,(t2 -1):t2) = Kgl( (t2 -1):t2,(t2 -1):t2) + Klc(3:4,3:4);

   end;
```

## STEP-6

Boundary Conditions and Forces

CON = [ Node number, X-constraint , Y-Constraint ] →

Fixed – 0
Free - 1

LOAD = [ Node number, X-force , Y-force ]

```
C=max(max(kgl))*10000

for i=1:size(CON)
        if(CON(i,2)==0)
         kgl((CON(i,1)*2)-1,(CON(i,1)*2)-1)=C;
        end

         if(CON(i,3)==0)
           kgl((CON(i,1)*2),(CON(i,1)*2))=C;
         end
end

 f(1:dof,1)=0
f or i=1:size(LOAD)
   f(2*LOAD(i,1)-1)=LOAD(i,2);
   f(2*LOAD(i,1))=LOAD(i,3);
End
```

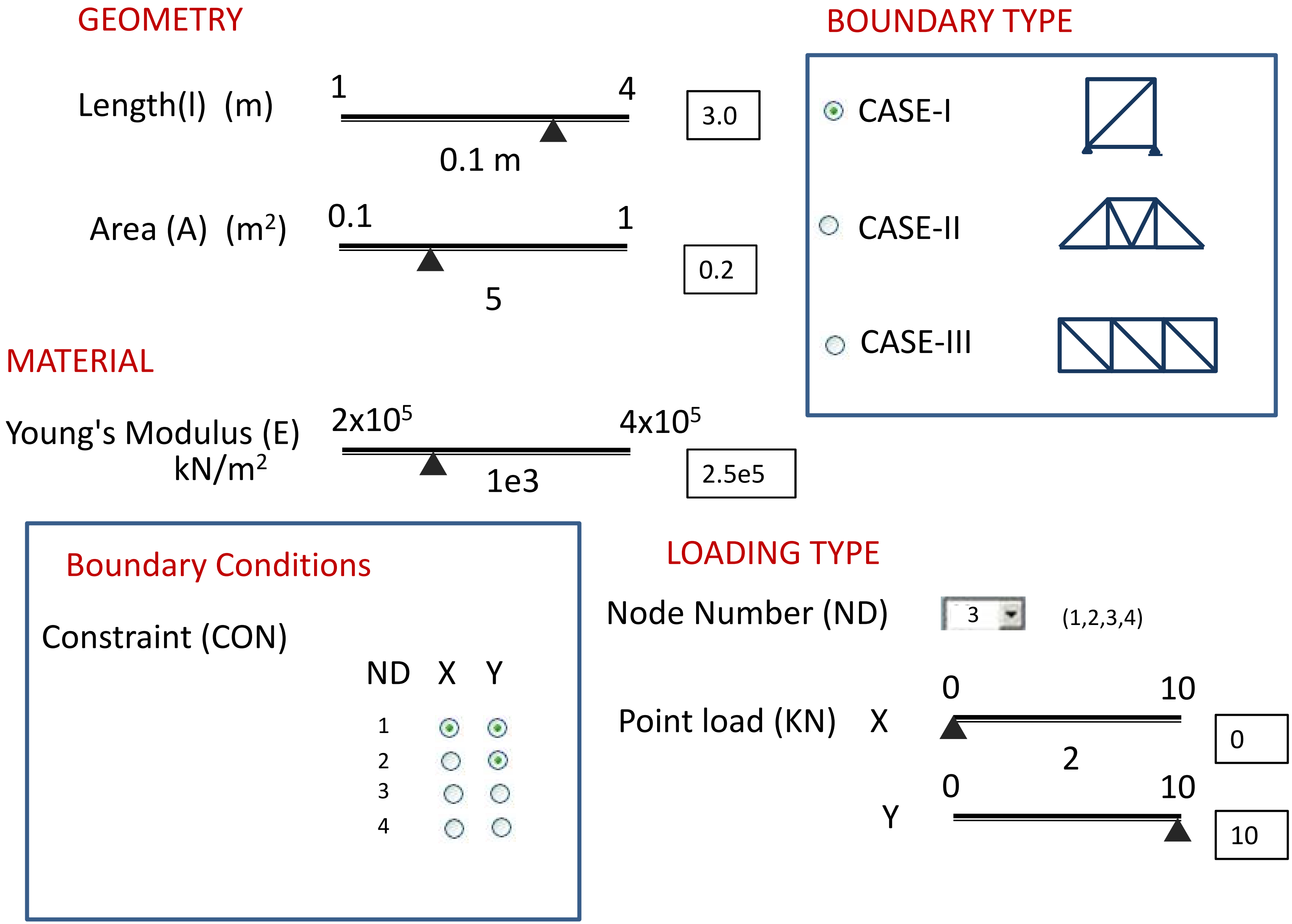
```
CON = [  1  0  0  ;
         2  1  0
         4  0   0];

LOAD = [  2  10  0  ;
          3  10  10  ];
```

## STEP-7

Final Displacements

```
displacements = inv(kgl)*f
```

PART-II



## GEOMETRY

Length(l) (m) 1 4 0.1 m 3.0

Area (A) ($m^2$) 0.1 1 5 0.2

## MATERIAL

Young's Modulus (E) $kN/m^2$ $2x10^5$ $4x10^5$ 1e3 2.5e5

## BOUNDARY TYPE

● CASE-I

○ CASE-II

○ CASE-III

## Boundary Conditions

Constraint (CON)

| ND | X | Y |
|---|---|---|
| 1 | ● | ● |
| 2 | ○ | ● |
| 3 | ○ | ○ |
| 4 | ○ | ○ |

## LOADING TYPE

Node Number (ND) 3 (1,2,3,4)

Point load (KN) X 0 10 2 0

Y 0 10 10

## FINAL OUTPUT:

The final out put should be the nodal displacements.