R.C.Patel College Of Engineering & Polytechnic, Shirpur
Department of Civil Engineering

Course Title- Strength of Material

Programme Name -Civil Engineering

Course Code -313308

Semester-Third

Unit	Title	COs	Learning hours	R Level	U Level	A Level	Total Marks
III	Shear Force & Bending Moment	CO3	14	2	4	10	16

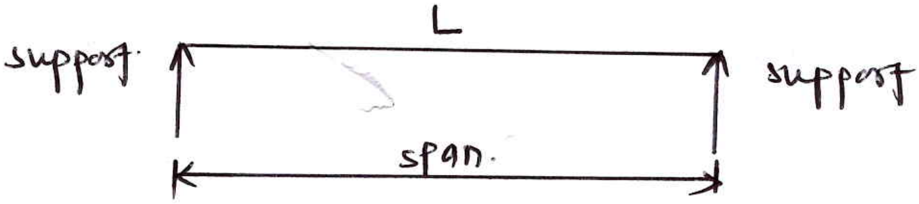
Subject Teacher

Mr.R.B.Patil

BEAM :-

It is a Horizontal or inclined. structural member having a span betn one or more supports carrying a vertical loads across it's longitudinal axis.

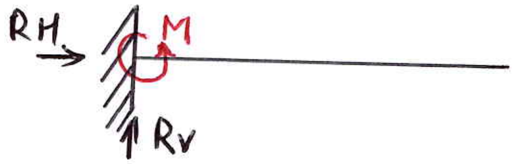
SPAN :- It is the distance betn two intermidiate supports of a structure.



TYPES OF SUPPORTS :-

1. FIXED SUPPORT :-

- It is most rigid type of support against rotation in any direction.
- It is used for cantilever beam. because it has more stability than other supports.



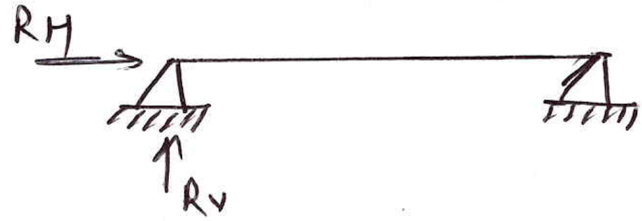
2. ROLLER SUPPORT :-

Roller support is place against the vertical force and which is rest on rollers.

Fixity code vertical.

3. PINNED SUPPORT :-

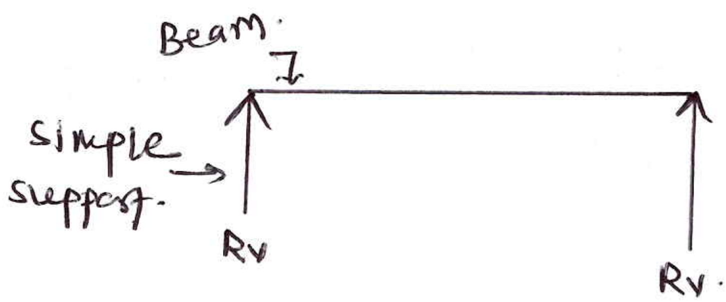
- This support is very common in use.
- it resist both vertical and horizontal Force
- generally it is used in trusses.
- It is also called hinged support.



Fixity code
Horizontal and vertical.

4. SIMPLE SUPPORT :-

- This support is similar to roller support. Where the member rests on external structure

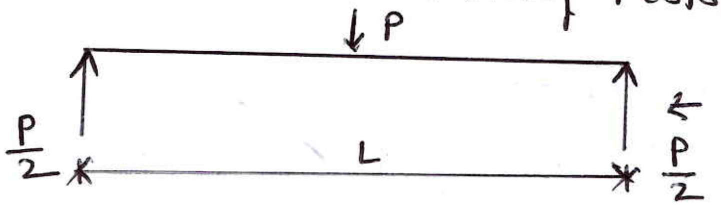


Fixity code
vertical.

★ TYPES OF BEAM :–

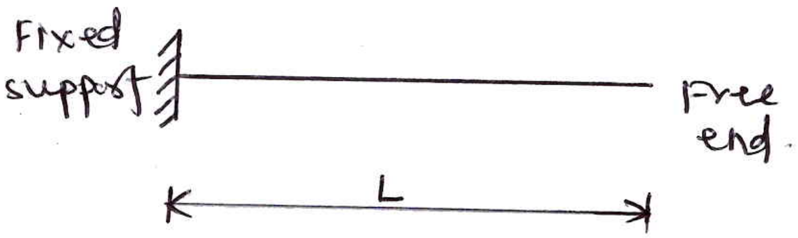
1. SIMPLY SUPPORTED BEAM :–

- simply supported beam has two supports at it's either end.
- Bending moment at supports is zero.
- It has NO bending resistance.



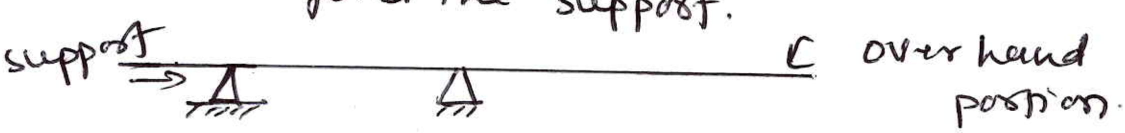
2. CANTILEVER BEAM :–

- In cantilever beam it's one end is fixed and other end is Free
- in this beam maximum bending moment occures at fixed end.
- maximum deflection occures at free end.



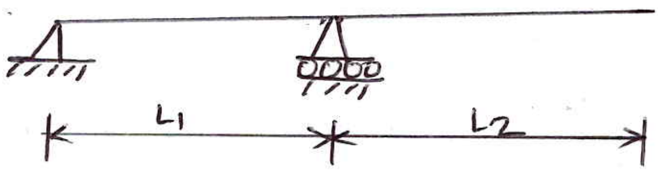
3. OVERHANG BEAM :–

- In this beam some portion of beam extends beyond the support.



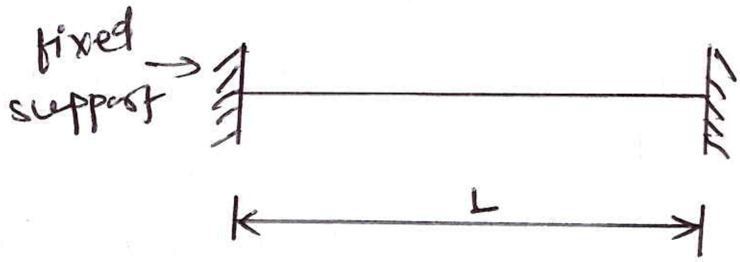
4. Contineous Beam :-

- This beam have no. of support having Multiple span.



5. FIXED BEAM :-

- It's both ends are fixed.
- it is widely used to resist deflection at mid span due to fixed support.



SHEAR FORCE:-

It is unbalanced vertical force, therefore it tends to slide one portion of beam, upwards or downwards with respect to other

BENDING MOMENT:-

It is the algebric sum of moments of force, to the right or left of the section. is called as B.M.

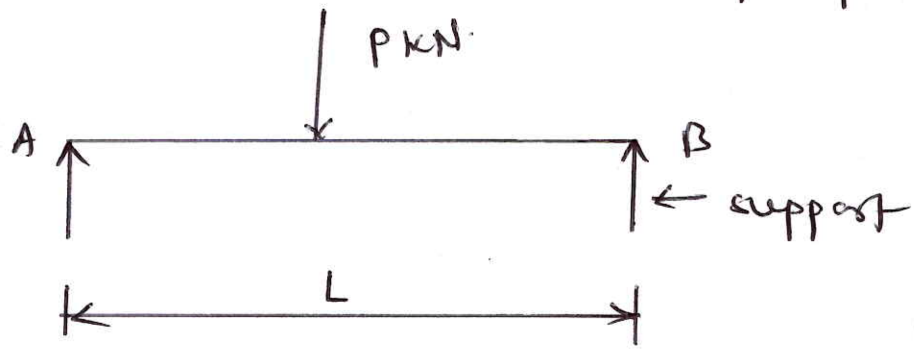
RELATION BETWEEN S.F and B.M:-

1. Point load acts at section then S.F changes suddenly But the B.M remains the same.
2. If there is no force betn two points, then S.F. does not change, But B.M changes linearly.
3. UDL is acts betn two points. then shear force change linearly But the B.M. changes according to the parabolic law.
4.

TYPES OF LOAD :-

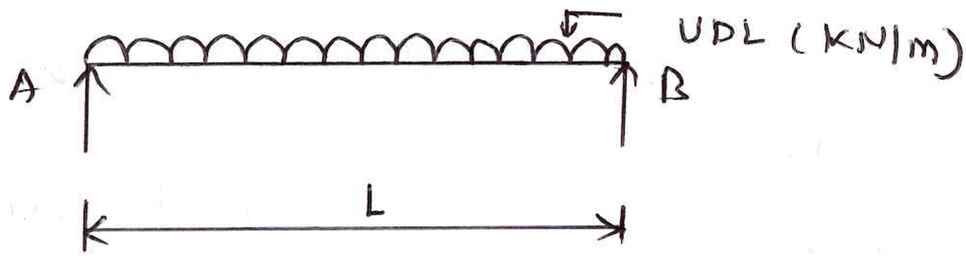
1. CONCENTRATED OR POINT LOAD :-

- A concentrated point load act on a beam.
- It is considered to act at a single point.



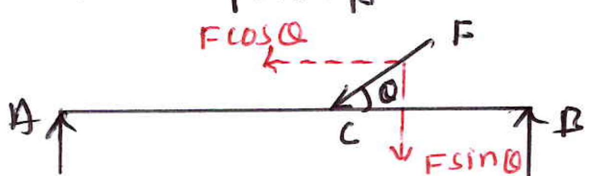
2. UNIFORM DISTRIBUTED LOAD :-

It is a load which is distributed (uniformly) across the overall span of a beam.

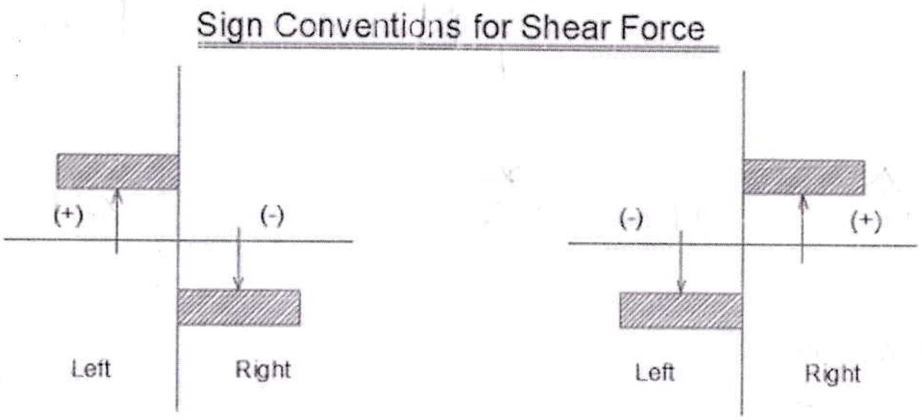


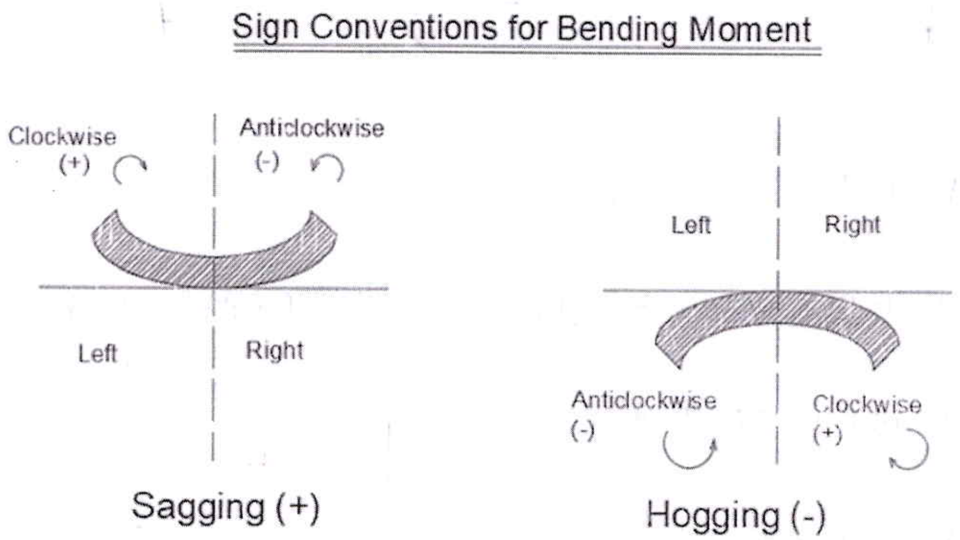
3. INCLINED POINT LOAD :-

The load in which it acts at inclined i.e it's line of action makes some angle with the axis of beam. it is resolve in vertical and Horizontal components.



Sign Conventions for Beams



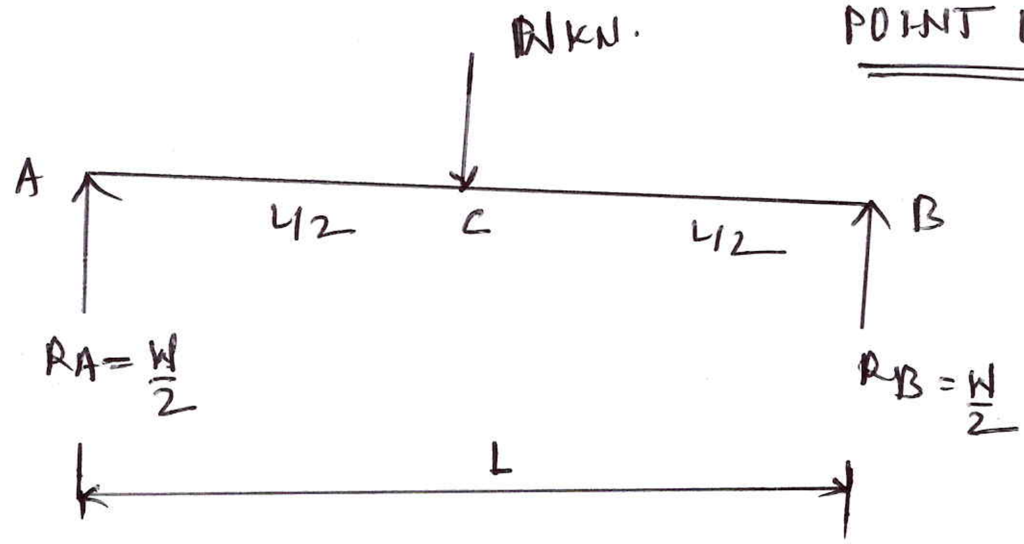


Shear Force:

If the force is upwards to the left of the section, then it is positive shear force. Similarly, if the force is downwards to the right side of the section, then it is negative shear force, as illustrated in above figure.

SFD AND BMD FOR SIMPLY SUPPORTED BEAM :—

POINT LOAD



REACTIONS CALCULATION :—

$R_A + R_B = W$ —— (i)

Take moment @ A.

$\therefore M_A = W \times \frac{L}{2} - R_B \times L = 0$

$\therefore \frac{WL}{2} = R_B \times L$

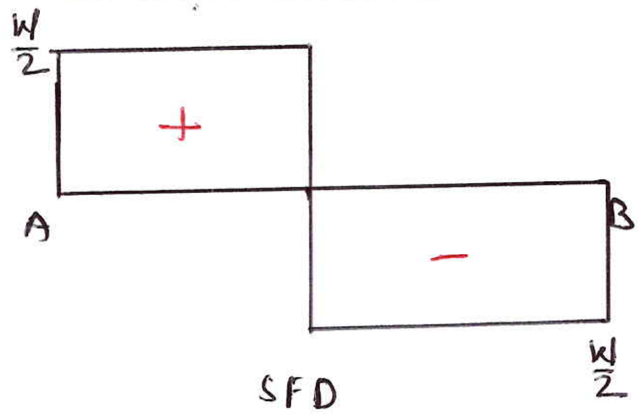
$\therefore R_B = \frac{WL}{2L}$

$\therefore \boxed{R_B = \frac{W}{2}}$

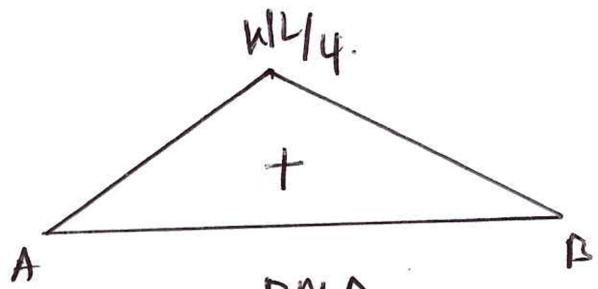
Put in eq^n (i).

$\therefore \boxed{R_A = \frac{W}{2}}$

TO DRAW SFD and BMD :—



SFD

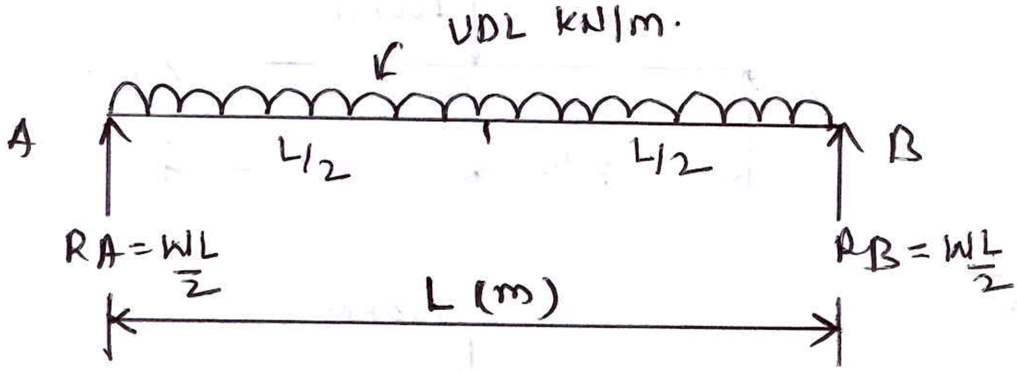


BMD

$B_{max} = \frac{W}{2} \times \frac{L}{2} = \frac{WL}{4}$

SFD AND BMD FOR SIMPLY SUPPORTED BEAM.

[UDL]



REACTIONS :-

$R_A + R_B = WL$ —①

B.M. at A and B are zero.

$\therefore M_A = 0, \quad M_B = 0.$

i.e. B.M is Max. at middle of span.

$M_A = WL \times \frac{L}{2} - R_B \times L = 0.$

$\therefore \frac{WL^2}{2} = R_B \times L$

$\therefore R_B = \frac{WL}{2}$

put in eqn ①

$R_A = \frac{WL}{2}$

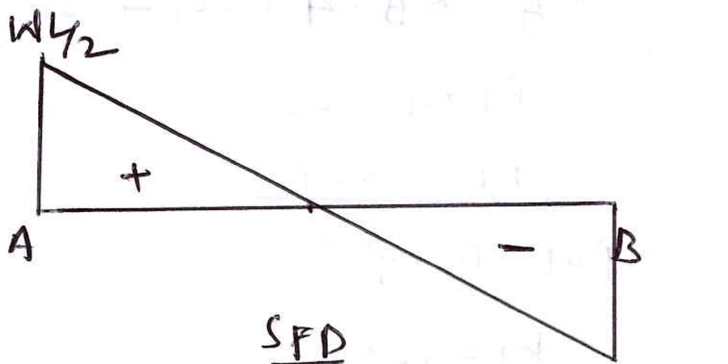
B.M. CALCULATIONS :-

$M_A = 0, \quad M_B = 0.$

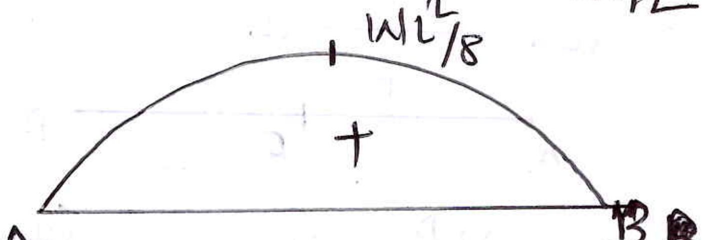
$B_{max} = \frac{WL}{2} \times \frac{L}{2} - \frac{W}{2} \times \left(\frac{L}{2}\right)^2$

$= \frac{WL^2}{4} - \frac{WL^2}{8}$

$B_{max} = \frac{WL^2}{8}$

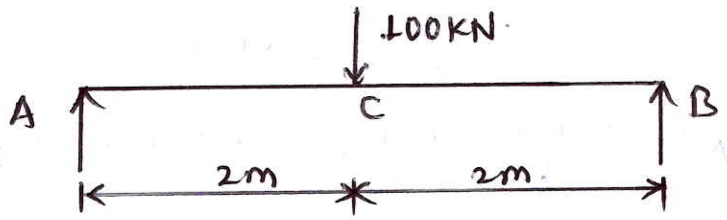


SFD

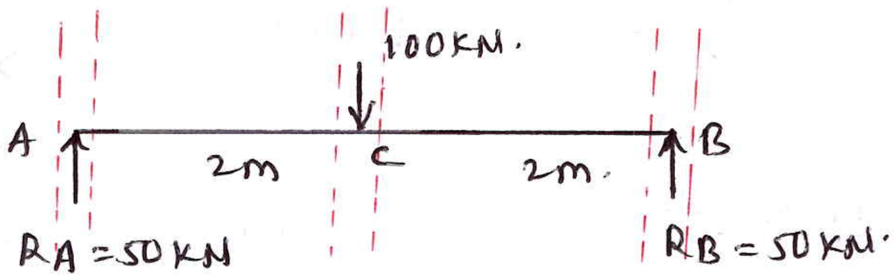


NUMERICALS :-

1. Draw SFD and BMD for given SSB.



Ans :-



To Find Reactions :-

$R_A + R_B = 100$ —— (1).

Now,

$M_A = M_B = 0$

Taking moment at point A

$\therefore M_A = -R_B \times 4 + 100 \times 2 = 0$

$\therefore R_B \times 4 = 200$

$R_B = 50\ KN$.

Put in eq^n (1)

$\therefore R_B = 50\ KN$.

To Find Moment :-

~~Max Bending moment @ point C.~~

$\therefore$ ~~$M_C = 50 \times 2$~~

$M_C = 50 \times 2$

$M_C = 100\ KN\text{-}m$.

S.F. calculations :-

SF @ left of A = 0 KN.

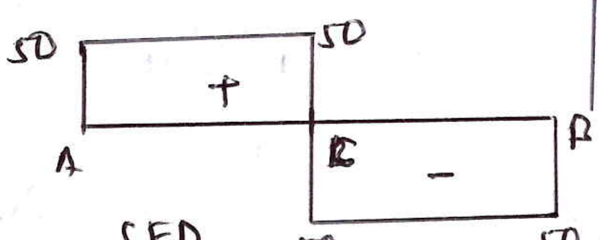
SF @ Right of A = 50 KN.

SF @ left of C = 50 KN.

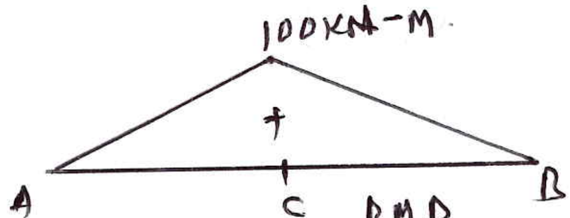
SF @ Right of C = 50 − 100 = −50 KN.

SF @ left of B = −50 KN.

SF @ Right of B = −50 + 50 = 0 KN



SFD



BMD

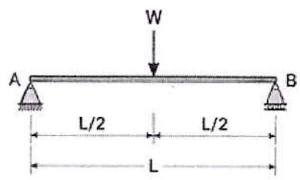
SFD & BMD OF SIMPLY SUPPORTED, CANTILEVER & OVERHANGING BEAMS

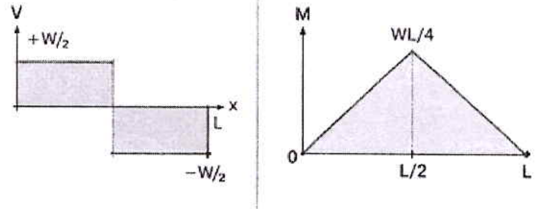
DIAGRAMS AND FORMULAS

1. SIMPLY SUPPORTED BEAM

TYPE OF LOADING | BEAM DIAGRAM | SHEAR FORCE DIAGRAM (SFD) | BENDING MOMENT DIAGRAM (BMD) | FORMULAS

(a) POINT LOAD (W) AT MID-SPAN





Reactions:

$R_A = R_B = W/2$

SFD:

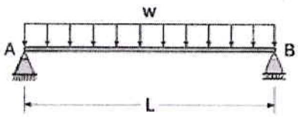
$$V(x) = \begin{cases} +W/2 & 0 < x < L/2 \\ -W/2 & L/2 < x < L \end{cases}$$

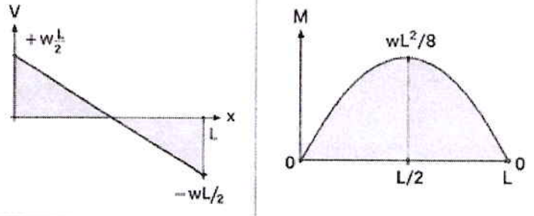
BMD:

$$M(x) = \begin{cases} (W/2)\,x & 0 \le x \le L/2 \\ (W/2)(L - x) & L/2 \le x \le L \end{cases}$$

$M_{max} = \frac{WL}{4}$ at $x = L/2$

(b) UNIFORMLY DISTRIBUTED LOAD (w) OVER ENTIRE SPAN





Reactions:

$R_A = R_B = wL/2$

SFD:

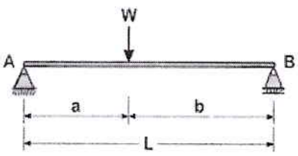
$V(x) = w\left(\frac{L}{2} - x\right) \quad 0 \le x \le L$

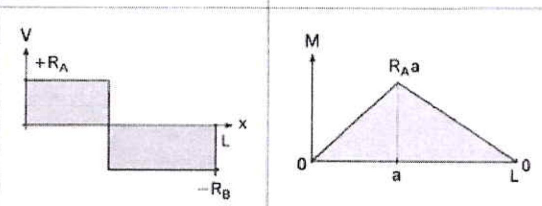
BMD:

$M(x) = \frac{w\,x\,(L - x)}{2} \quad 0 \le x \le L$

$M_{max} = \frac{wL^2}{8}$ at $x = L/2$

(c) POINT LOAD (W) AT DISTANCE 'a' FROM LEFT SUPPORT (b = L − a)





Reactions:

$R_A = \frac{Wb}{L}, \quad R_B = \frac{Wa}{L}$

SFD:

$$V(x) = \begin{cases} R_A & 0 < x < a \\ -R_B & a < x < L \end{cases}$$

BMD:

$$M(x) = \begin{cases} R_A x & 0 \le x \le a \\ R_A x - W(x - a) & a \le x \le L \end{cases}$$

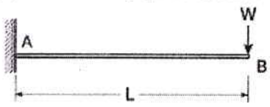
$M_{max} = R_A a = \frac{Wab}{L}$ at $x = a$

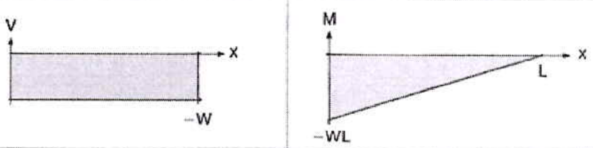
Note: In simply supported beams, BM is zero at supports and maximum at the point where shear force is zero.

2. CANTILEVER BEAM (FIXED AT ONE END, FREE AT THE OTHER)

TYPE OF LOADING | BEAM DIAGRAM | BMD | FORMULAS

(a) POINT LOAD (W) AT FREE END





SFD:

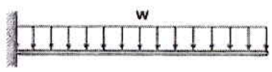
$V(x) = -W$ (constant)

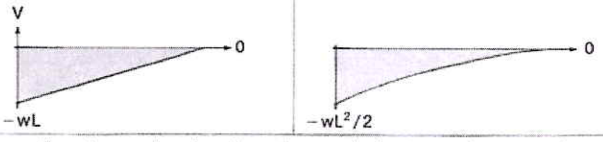
BMD:

$M(x) = -W(L - x) \quad 0 \le x \le L$

$M_{max} = -WL$ at $x = 0$ (fixed end)

(b) UNIFORMLY DISTRIBUTED LOAD (w) OVER ENTIRE LENGTH





SFD:

$V(x) = -w(L - x)$

BMD:

$M(x) = -w(L - x)^2 / 2$

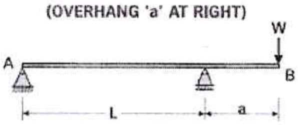
$M_{max} = -\frac{wL^2}{2}$ at $x = 0$ (fixed end)

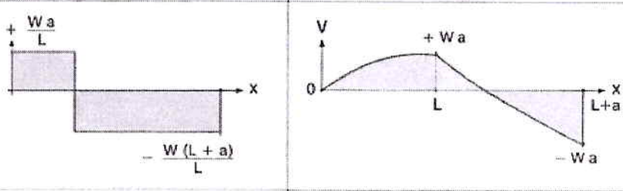
Note: In cantilever beams, shear force is maximum at the fixed end and zero at the free end. Bending moment is maximum (hogging) at the fixed end and zero at the free end.

3. OVERHANGING BEAM

TYPE OF LOADING | BEAM DIAGRAM | BMD | FORMULAS

(a) POINT LOAD (W) AT FREE END (OVERHANG 'a' AT RIGHT)





Reactions:

$R_A = \frac{w\,a}{L}, \quad R_B = \frac{W(L + a)}{L}$

SFD:

$$V(x) = \begin{cases} R_A & 0 < x < L \\ -R_B & L < x \le L + a \end{cases}$$

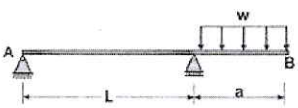
BMD:

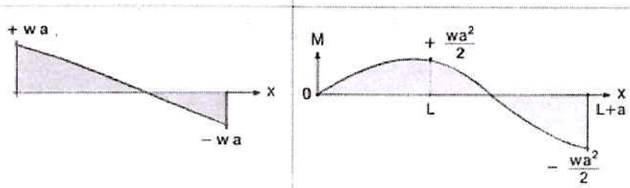
$$M(x) = \begin{cases} R_A x & 0 \le x \le L \\ R_A x - W(x - L) & L \le x \le L + a \end{cases}$$

M_{max} (positive) $= Wa$ at $x = L$

M_{max} (negative) $= -Wa$ at $x = L + a$

(b) UNIFORMLY DISTRIBUTED LOAD (w) OVER OVERHANG 'a' AT RIGHT





Reactions:

$R_A = \frac{w\,a}{2}, \quad R_B = \frac{w\,a}{2}$

SFD:

$$V(x) = \begin{cases} R_A & 0 < x < L \\ R_A - w(x - L) & L \le x \le L + a \end{cases}$$

BMD:

$$M(x) = \begin{cases} R_A x & 0 \le x \le L \\ R_A x - w(x - L)^2/2 & L \le x \le L + a \end{cases}$$

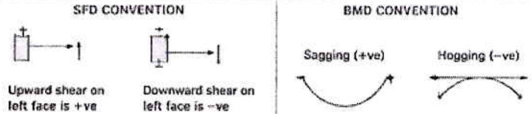
M_{max} (positive) $= wa^2$ at $x = L$

M_{max} (negative) $= -wa^2/2$ at $x = L + a$

GENERAL RELATIONSHIPS

- $\frac{dV}{dx} = -w(x)$ (Rate of change of shear force equals intensity of tod faght)
- $\frac{dM}{dx} = V(x)$ (Slope of BMD equals SFD)
- At supports (simple): $M = 0$
- Maximum / minimum BM occurs where SFD = 0

CONVENTIONS



NOTES

- SFD is linear for UDL and constant for point loads.
- BMD is parabolic for UDL and linear for point loads.
- Check the sign of BM: above the axis (+) sagging, below (−) hogging.

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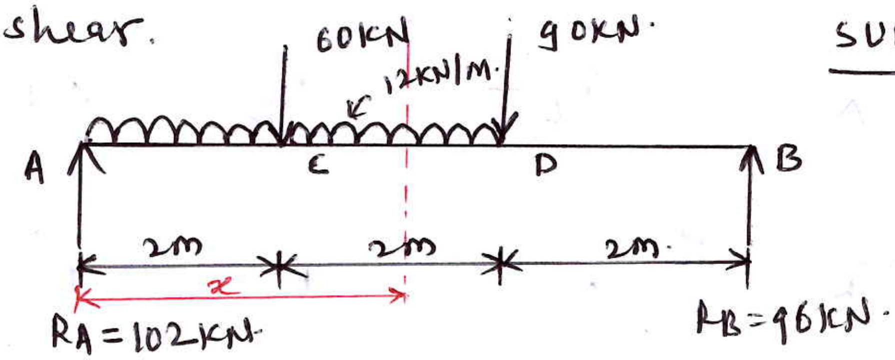
2. Draw SFD and BMD for SSB, also find maximum shear force and bending moment locate the point of zero shear.

SUMMER-26



Ans:-

To find reactions:-

$R_A + R_B = 60 + 90 + 48$

$R_A + R_B = 198\ KN$

$M_A = 0$

$M_A = (60\times2) + (90\times4) + (12\times4\times\frac{4}{2}) - R_B\times6 = 0$

$\frac{576}{6} = R_B$

$\therefore R_B = 96KN$

$\therefore R_A = 102KN$

Shear force calculation:-

S.F at left of A = 0

SF at Right of A = 102KN.

SF at left of C = 102 − 24 = 78KN.

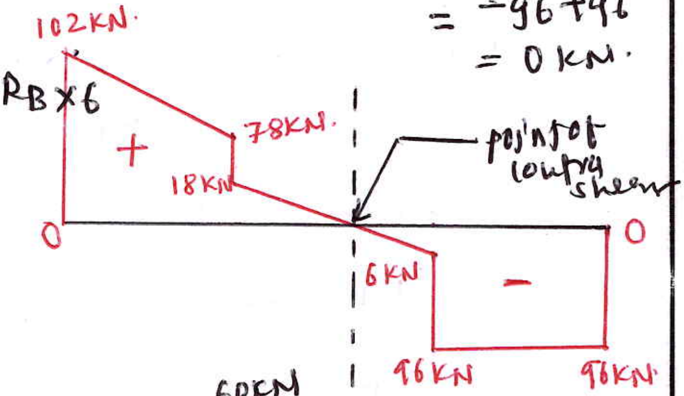
SF at Right of C = 102 − 24 − 60 = 18KN.

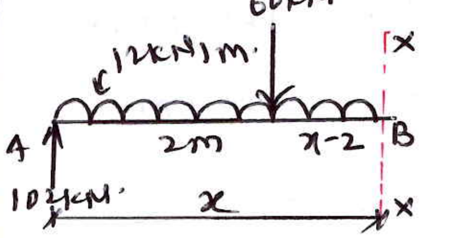
S.F at left of D = ~~18 − 24 = 6KN~~ 102 − 60 − ~~90~~ − 48 = −06KN.

S.F. at Right of D = ~~96 − 90~~ −6 − 90 = ~~6 84KN~~ = −96KN.

S.F at left of B = ~~84KN~~ 96KN.

SF at Right of B = ~~−84 + 96~~ = −96 + 96 = 0KN.





$\therefore B.M_{xx} = (102\times x) - [60\times(x-2)] - 12\times x\times\frac{x}{2}$

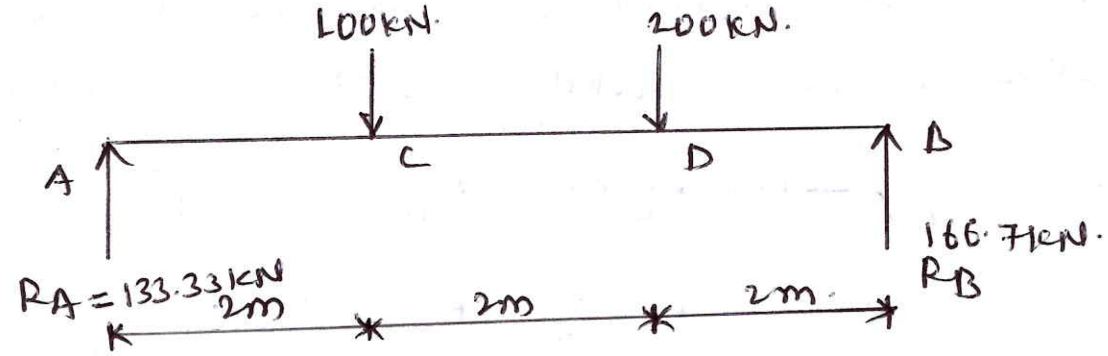
$102x - 60x - 120 - \frac{12x^2}{2}$

$42x - 120 - 6x^2$

i.e. $-6x^2 + 42x - 120$

$\therefore x = 3.5\ m.$

③ Draw SFD and BMD for SSB [WINTER-24]



Ans: Reaction calculation

$R_A + R_B = 100 + 200$

$= 300 KN.$

Now,

$M_A = (100 \times 2) + (200 \times 4) - R_B \times 6 = 0.$

$200 + 800 = R_B \times 6$

$\therefore R_B = \frac{1000}{6}$

$R_B = 166.7 KN.$

$\therefore R_A = 133.33 KN.$

S.F. Calculations:-

S.F @ left of A = 0

S.F @ Right of A = 133.33 KN.

SF @ left of C = 133.33 KN.

SF @ Right of C = 133.33 - 100

= 33.33 KN.

S.F. @ left of D = 33.33 KN.

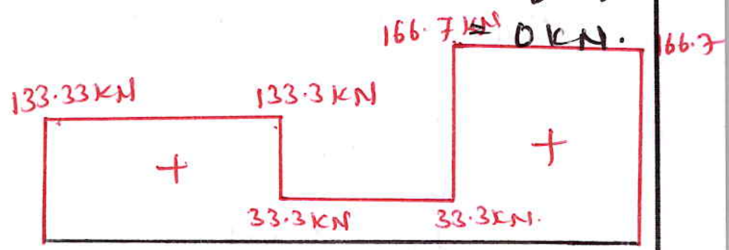
S.F @ Right of D = 33.33 - 200

= 166.7 KN

S.F @ left of B = 166.7 KN.

S.F @ Right of B = 166.7 - 166.7

0 KN.



SFD.

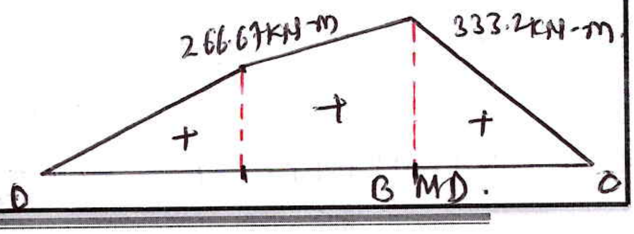
B.M. calculations:-

$M_A = M_B = 0$

$M_C = 133.33 \times 2 = 266.6 KN\text{-}m$

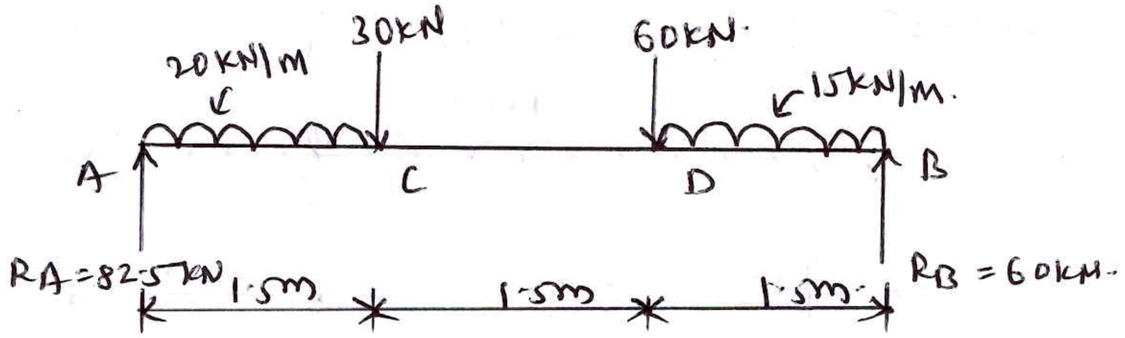
$M_D = (133.33 \times 4) - (100 \times 2)$

$= 333.2 KN\text{-}m.$



BMD.

(4) Draw SFD and BMD. WINTER-2024



Ans:-

To find reactions:-

$R_A + R_B = (20\times1.5) + 30 + 60 + (15\times1.5)$

$= 30 + 30 + 60 + 22.5$

$R_A + R_B = 142.5$ —— (1)

$M_A = 0$

$= \left[20\times1.5\times\frac{1.5}{2}\right] + [30\times1.5] + [60\times3] + [15\times1.5] - R_B\times4.5$

$0 = 270 - R_B\times4.5$

$\therefore R_B = 60KN$

$R_A = 82.5KN$

S.F. calculations:-

S.F at left of A = 0

S.F at Right of A = 82.5KN.

S.F. at left of C = 82.5 − (20×1.5)

= 52.5 KN.

S.F at Right of C = 52.5 − 30 = 22.5KN.

S.F. at left of D = 22.5KN.

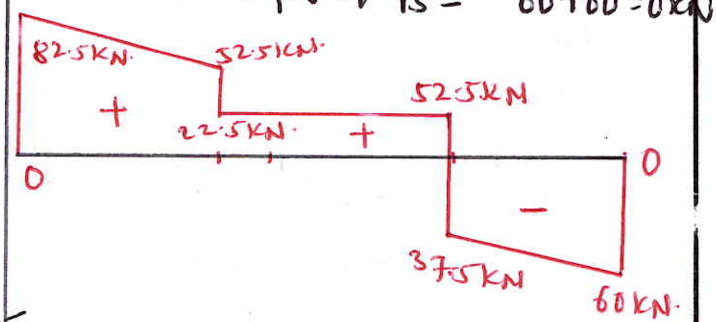
S.F at Right of D = 22.5 − 60

= −37.5KN.

S.F at left of B = −37.5 − 22.5

= −60KN.

S.F at Right of B = −60 + 60 = 0KN



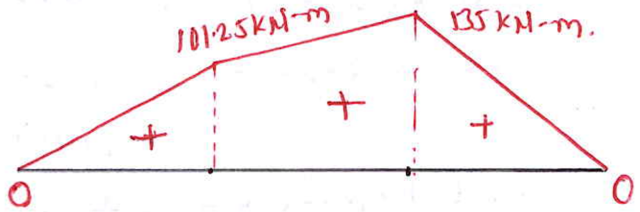
B.M. calculations:-

$M_A = 0, M_B = 0$

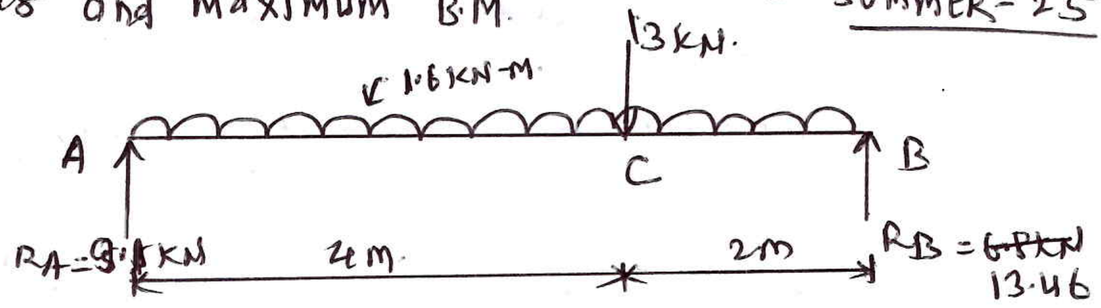
$M_C = (82.5\times1.5) - \left[20\times1.5\times\frac{1.5}{2}\right] = 101.25KN\text{-}m.$

$M_D = (82.5\times3) - (20\times1.5\times2.25) - (30\times1.5)$

$= 135KN\text{-}m.$



(5) Draw SFD and BMD, Also find point of zero shear and maximum B.M. — SUMMER-25



Ans :-

Reaction calculation :-

$R_A + R_B = (1.6 \times 6) + 3$

$= 9.6 + 13$

$R_A + R_B = 22.6\ KN$ —— (1)

Now,

$M_A = 0$

$\left[1.6 \times 6 \times \frac{6}{2}\right] + [3 \times 4] - R_B \times 6 = 0$

$80.8 = R_B \times 6$

$= R_B$

i.e. $R_B =$ ~~6.8 KN~~ $13.46\ KN$

∴ put in eqn (1)

$R_A = 9.1\ KN$

S.F. calculations :-

S.F @ left of A = 0

S.F @ Right of A = ~~5.5 KN~~ ~~22.6 KN~~ 9.1 KN.

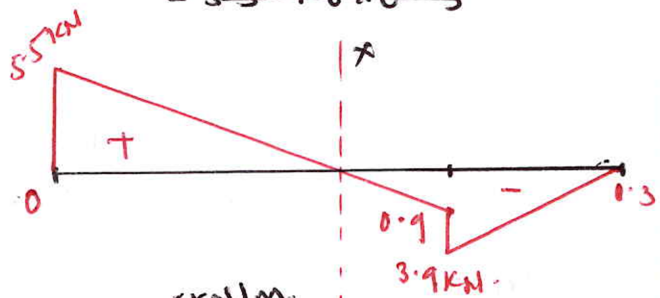
S.F @ left of C = ~~5.5 − (1.6×4)~~

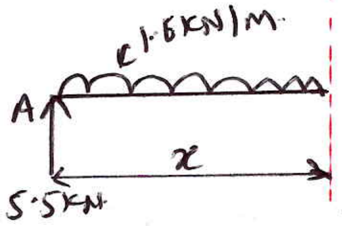
= ~~−0.9 KN~~ 7.46 KN

S.F @ Right of C = −0.9 − 3 = ~~−3.9 KN~~ 4.46 KN.

S.F @ left of B = 5.5 − (1.6×6) − 3 = −0.3 KN

= ~~5.5 − 1.6×6 − 3~~





$M_x = (5.5 \times x) - \left(1.6 \times x \times \frac{x}{2}\right)$

$5.5x - 0.8x^2$

∴ x =

POINT OF CONTRASHEAR :- (point of zero shear)

It is the point at which SFD changes the sign from positive to negative or vice-versa w.r.to base line is called point of contra shear

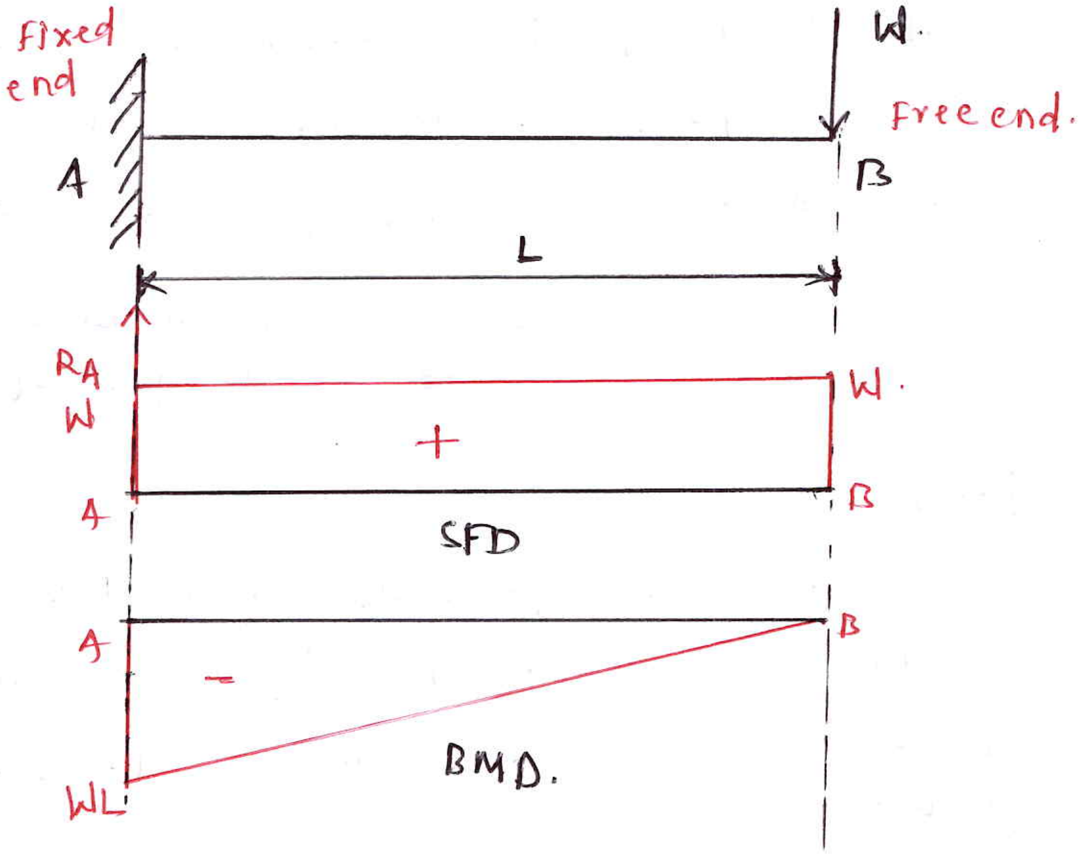
S.F. will be zero at point of contrashear

point of contraflexure :-

It is the point at which BMD changes the sign from positive to Negative or vice versa w.r.to base line is called as point of contra-flexure.

B.M. will be zero at point of contraflexure

* CANTILEVER BEAM SUBJECTED TO POINT LOAD :-



To Find Reactions:-

$\Sigma F_Y = 0$

$\therefore \quad R_A - W = 0$

$\boxed{R_A = W}$

To Find shear force:-

S.F. at A = W.

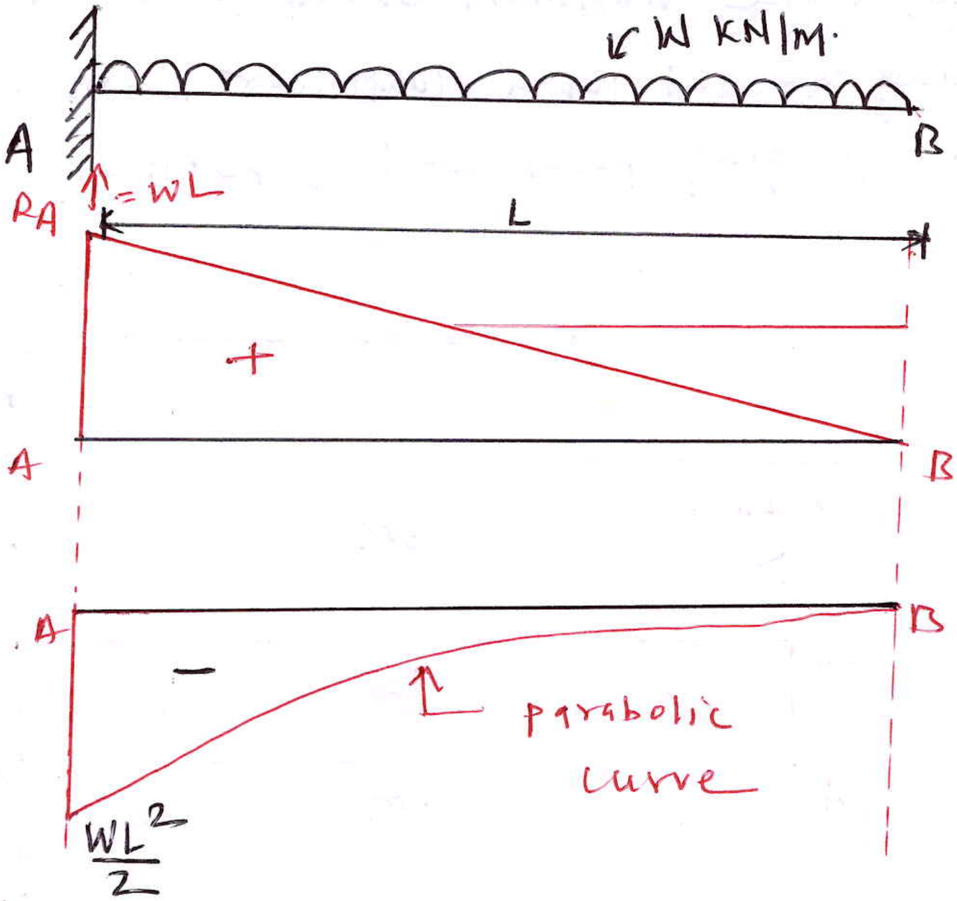
S.F. at B = 0

~~B.M.~~ To Find B.M. calculations:-

B.M. at A = $-WL$ —— (Hogging)

B.M. at B = 0

★ CANTILEVER BEAM SUBJECTED TO UDL :-



To find Reactions :-

$R_A - wL = 0$

$\therefore R_A = wL$

To find S.Force :-

S.F at left of A = 0

S.F. at Right of A = wL

S.F at left of B = wL − wL = 0

S.F. at right of B = 0

To find B.M :-

B.M at B = 0

$\therefore M_B = 0$ kN-m

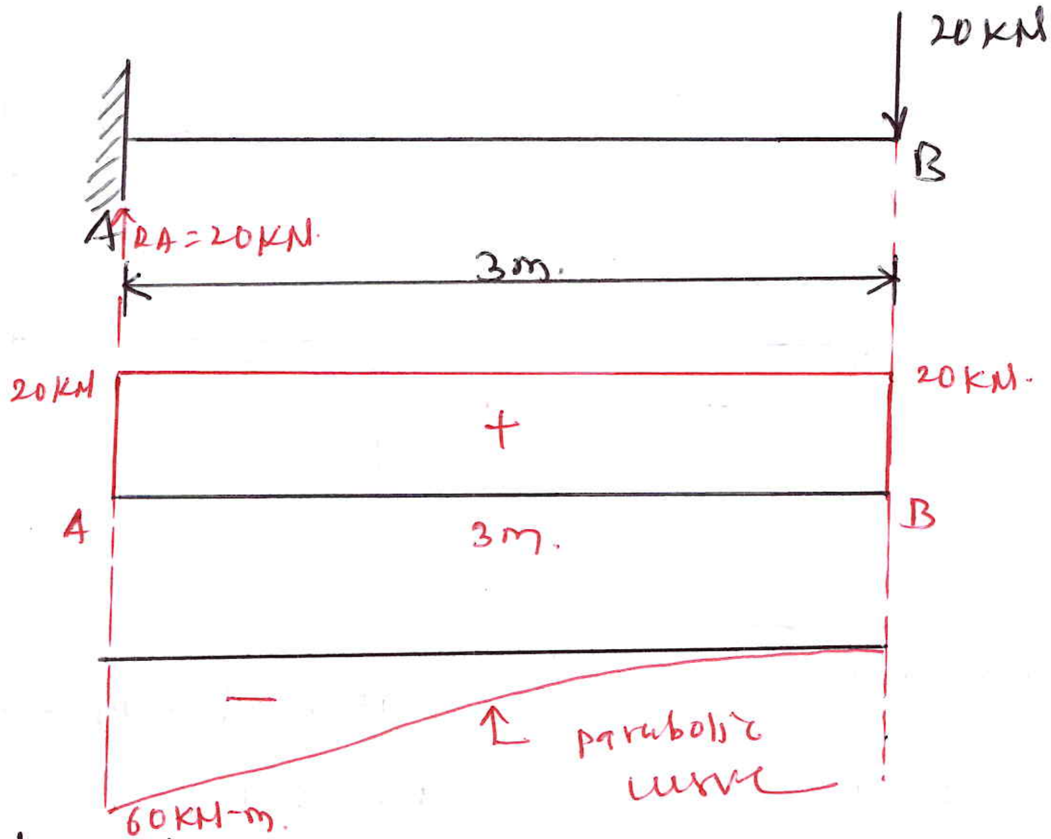
$M_A = w \times L \times \frac{L}{2}$

$M_A = \frac{wL^2}{2}$ — (Hogging) −ve.

NUMERICALS ON CANTILEVER BEAM :—

1. Determine maximum shear force and maximum bending moment for a cantilever beam having 3.0 m span carrying point load of 20 KN at free end.

Ans :—



To Find Reactions :—

$R_A - 20 = 0$

$R_A = 20$ KN

To Find shear force

S.F. at left of A = 0

S.F. at right of A = 20 KN.

S.F. at left of B = 20 KN.

S.F. at Right of B = 0

To Find B.M.

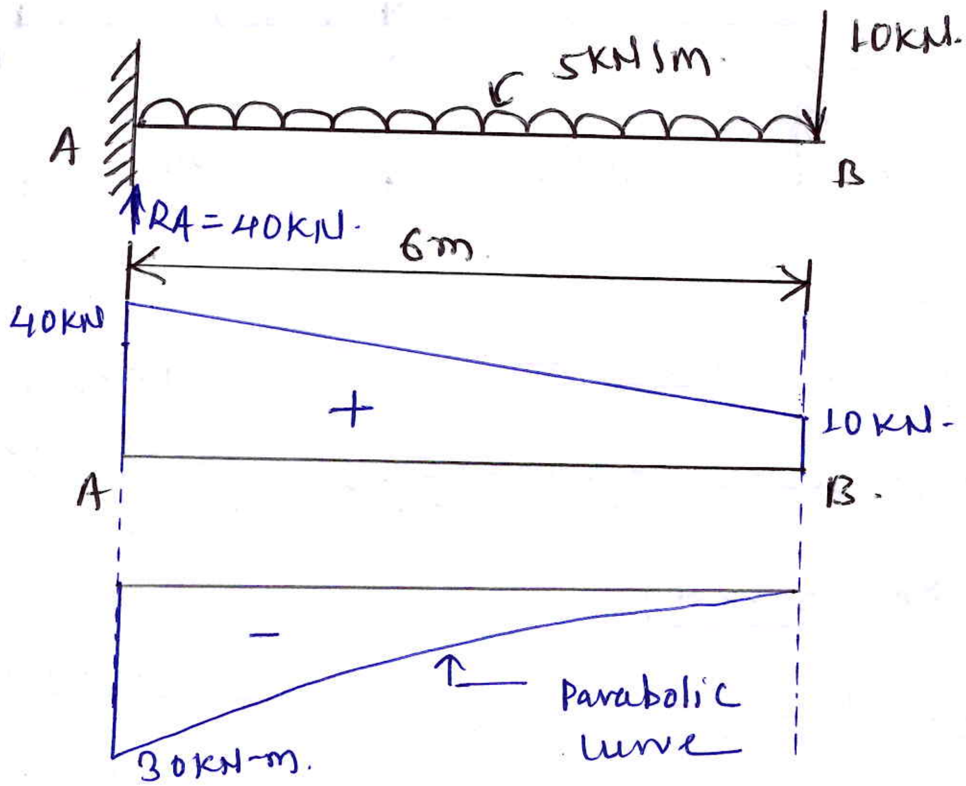
$M_B = 0$ KN-M.

$M_A = -20 \times 3$

$= -60$ KN-m. — (Hogging)

② Draw SFD and BMD for cantilever beam of 6m length fixed at point A and free at B. It carries a point load of 10KN at free end and UDL of 5KN/m over entire span of beam. — SUMMER-2026

Ans:—



To Find Reactions:—

$R_A - (5\times6) - 10 = 0$

$R_A - 30 - 10 = 0$

$R_A = 40KN$

To Find S.F.

S.F. at left of A = 0

S.F. at Right of A = 40KN

S.F. at left of B = 40 − (5×6) = 10KN.

S.F. at Right of B = 40 − (5×6) − 10 = 0KN.

B.M. Calculations:—

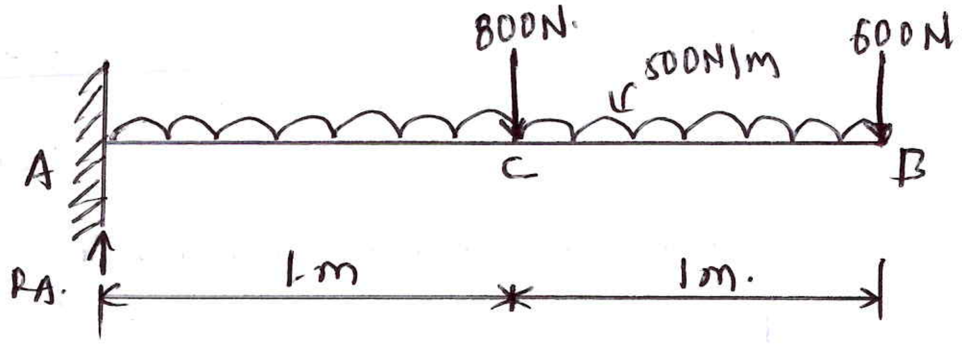
$M_B = 0$ KN-m.

$M_A = -\left[5\times6\times\frac{6}{2}\right] - 10\times6$

$= 90 - 60$

$M_A = -30$ KN-m. — Max.

③ A cantilever fixed at left end is 2m long and carries an UDL of 500 N/m, A point load of 800 N and 600 N act at 1m and 2m from fixed end respectively. Draw SFD and BMD. [W-24]



Ans:-

To Find Reactions:-

$R_A - 800 - 600 - [500 \times 2 \times \frac{2}{2}] = 0$

$\therefore$ $\boxed{R_A = 2400\,N}$

To Find S.F.:-

S.F. at left of A = 0 N.

S.F at Right of A = 2400N

S.F at left of C = 2400 − 500×1×~~1~~

= ~~2450~~ 1900 N

S.F at Right of C = 2400 − 500×1×~~1~~ − 800

= ~~1350~~ 1100 N

S.F. at left of B = ~~1350 − 500×2×2/2~~

= ~~350 N.~~

2400 − (500×2×~~1~~) − 800 = 600N.

~~S.F Right of B = 350 − 600~~

S.F. at Right of B = 2400 − 800 − 600 − [500×2×2/2]

= 0 N.

To Find B.M:-

$B.M_A$ = 800×1 + 600×2 + [500×2×2/2]

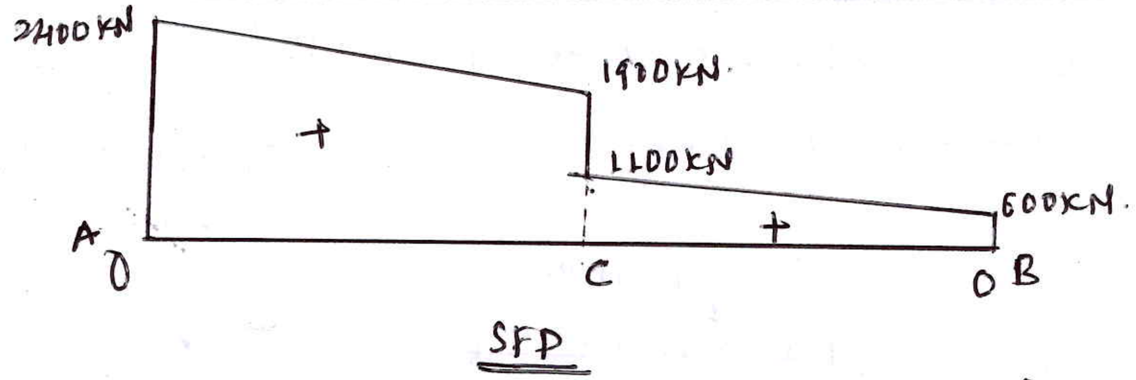
= −3000 N-m.

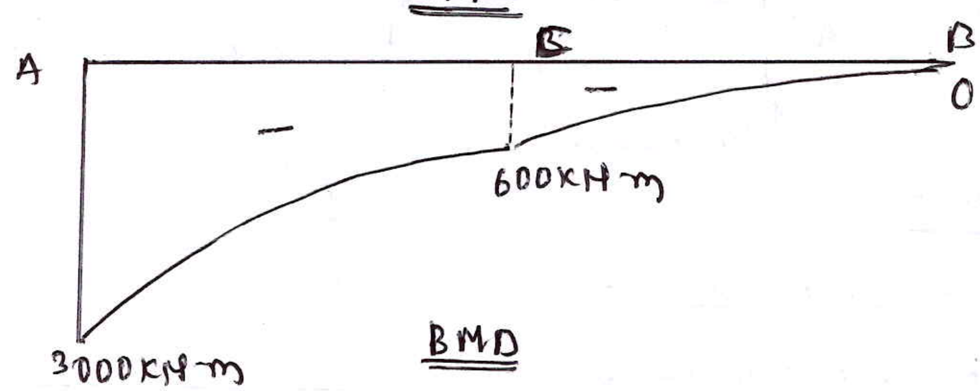
M_C = ~~2400×1 − 500×1×0.5~~

= ~~2450 N-m~~ − 600×1 = −600 KN-m.

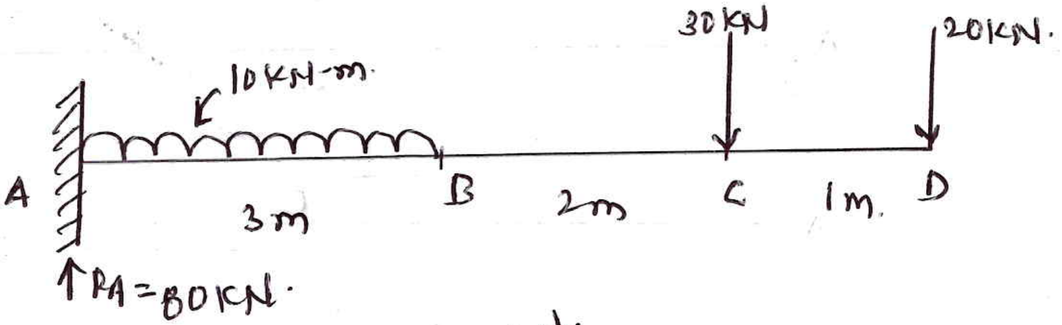
M_B = ~~[2400×2] + [500×2×1] + [800×1]~~

= 0 KN m.


2400 KN
1900 KN.
1100 KN
600 KN.
+
+
A
0
C
0 B
SFD


A
B
0
600 KN-m
3000 KN-m
BMD

(4) A cantilever beam is loaded as shown in fig. Draw SFD and BMD. — [SUMMER-26]



Ans:—

To Find Reaction:—

$R_A - 10\times3 - 30 - 20 = 0$

$R_A = 80\,KN$

To Find S.F.

S.F at left of A = 0

S.F. at Right of A = 80 KN.

S.F. at left of B = 80 − 10×3 = 50 KN.

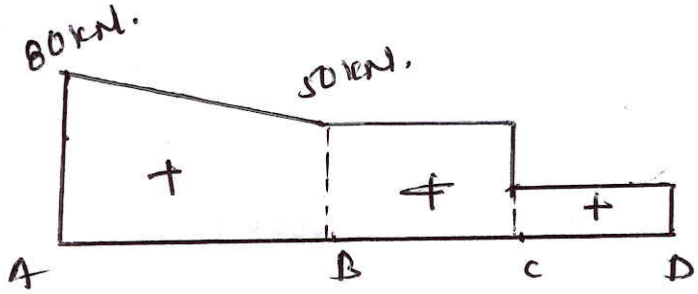
S.F at Right of B = 50 KN.

S.F at left of C = 50 KN.

S.F at Right of C = 50 − 30 = 20 KN.

S.F at left of D = 20 KN.

S.F. at Right of D = 20 − 20 = 0 KN.



SFD

To Find B.M:—

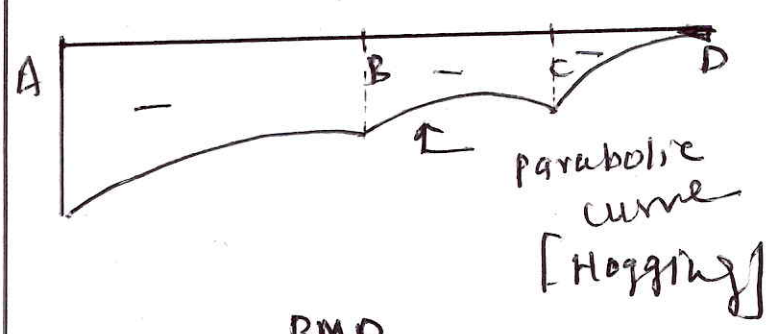
$M_A = -\left[10\times3\times\frac{3}{2}\right] - [30\times5] - [20\times6]$

$= -315$ KN-m.

$M_B = -30\times2 - 20\times3$

$= -60 - 60 = -120$ KN-m.

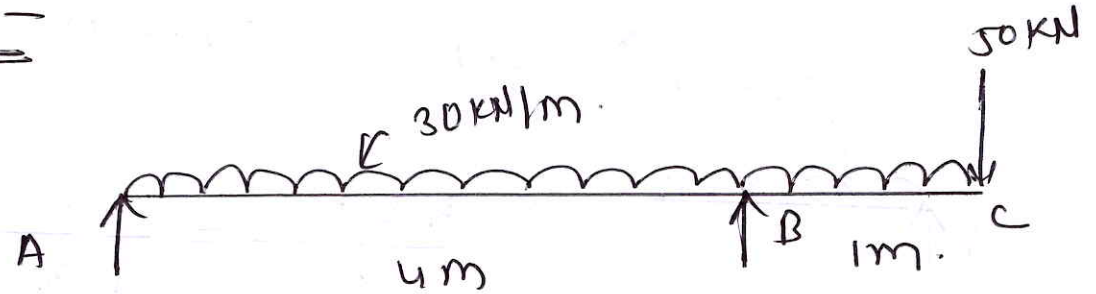
$M_C = -20\times1 = -20$ KN-m.



BMD

* An overhanging beam ABC, such that AB = 4 m, BC = 1 m. It is supported at 'A' and 'B', the Beam ABC subjected to UDL of ~~30~~ 30 kN/m over entire length it is subjected to point load of 50 kN at the free end C, Draw SFD & BMD, also locate point of contraflexure.

Ans:-



RA = 43.75 kN. RB = 156.25 kN.

To find Reactions:-

$R_A + R_B = 150 + 50$

$= 200$ kN.

$M_A = 30 \times 5 \times \frac{5}{2} - R_B \times 4 + 50 \times 5$

$R_B = 156.25$ kN.

$R_A = 43.75$ kN.

To find S.F.

S.F at left of A = 0

S.F. at Right of A = 43.75 kN.

S.F. at left of B = 43.75 − 120.

= −76.25 kN.

S.F. at Right of B = −76.25 + 156.25

= ~~232.5~~ 80 kN.

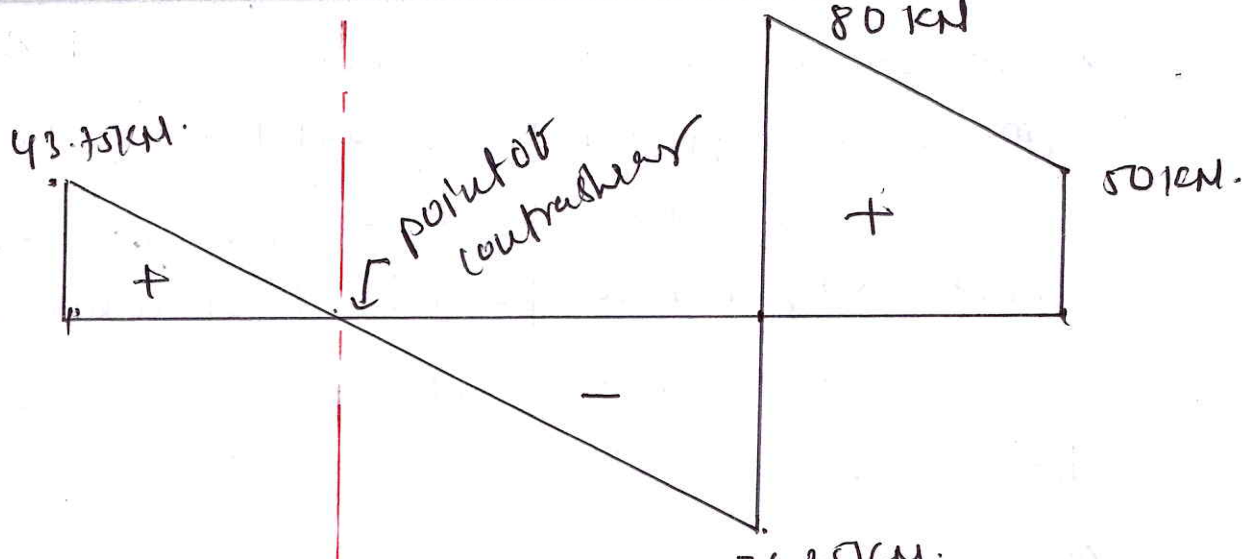
S.F. at left of C = 43.75 − 150 + 156.25 = ~~262.5~~ 50 kN.

S.F. at Right of C

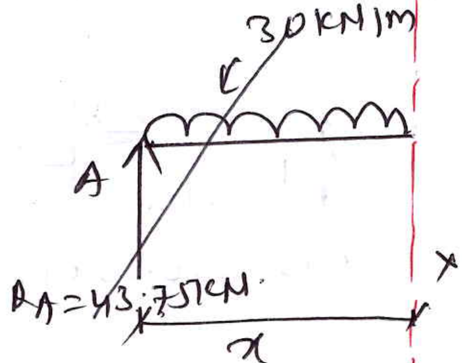
= − ~~265.5~~

50 − 50

= 0 kN.



SFD.



$$\therefore \frac{43.75}{x} = \frac{76.25}{4-x}$$

$$43.75(4-x) = 76.25x$$

$$175 - 43.75x - 76.25x = 0$$

$$175 = 120x$$

$$x = 1.46\,m \text{ from A}$$

$$M_{xx} = (43.75 \times x) - \left(30 \times x \times \frac{x}{2}\right)$$

$$= 43.75x - \frac{30x^2}{2}$$

$$0 = 43.75x - 15x^2$$

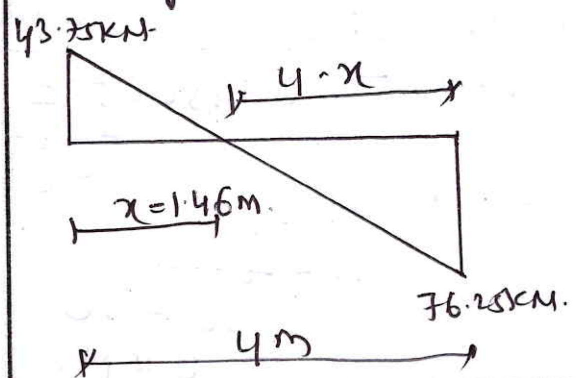
B.M. calculations:

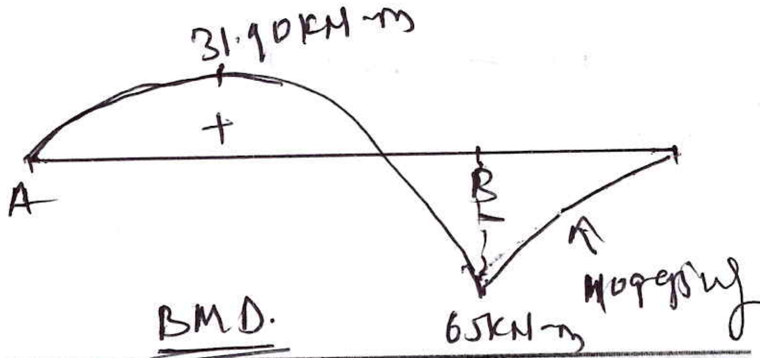
$$M_A = M_C = 0.$$

$$M_B = (-50 \times 1) - (30 \times 1 \times 1/2)$$

$$= -65\,KN\text{-}m.$$

using similar Δ

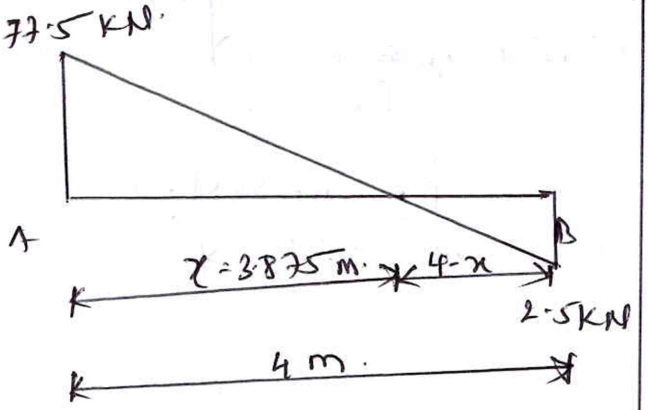




BMD.

To locate point of contrashear :-

using simillar Δ



$$\therefore \frac{77.5}{x} = \frac{2.5}{4-x}$$

$$77.5(4-x) = 2.5x$$

$$310 - 77.5x - 2.5x = 0$$

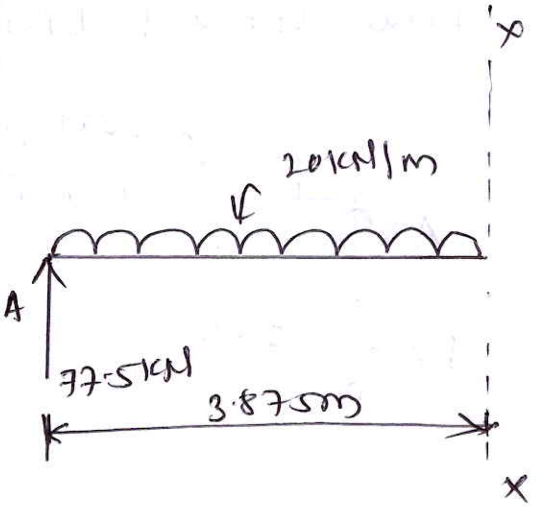
$$310 - 80x = 0$$

$$\therefore x = \frac{310}{80}$$

$$x = 3.875\,m$$

i.e. point of contrashear is 3.875 m away from point A.

∴ As we know that B.M. will max. at point of contrashear.



$$M_{xx} = M_{max}$$

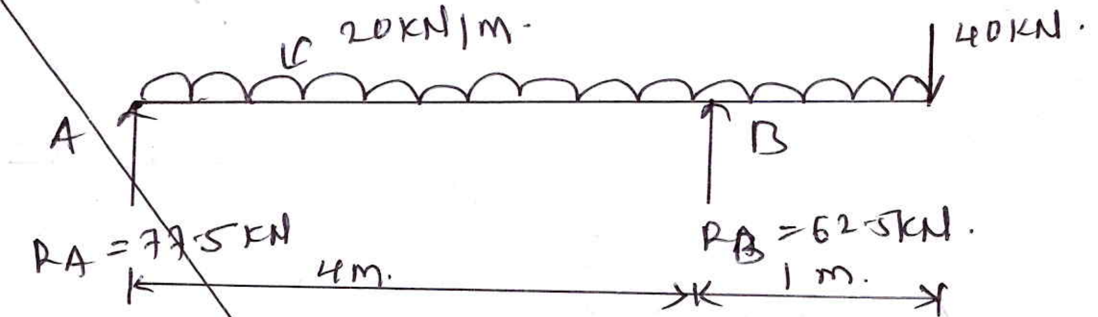
$$= (77.5 \times 3.875) - \left[20 \times 3.875 \times \frac{3.875}{2}\right]$$

$$\boxed{M_{xx} = 150.15\,KN\text{-}m}$$

OVERHANG BEAM :-

Winter - 24

1. Draw SFD and BMD for overhanging beam



Ans :-

To Find Reactions :-

$M_A = 20 \times 5 \times \frac{5}{2} - R_B \times 4 - 40 \times 5 = 0$

$R_B = 62.5 KN$

$R_A = 77.5 KN$

To Find S.F.

S.F at left of A = 0

S.F. at Right of A = 77.5KN.

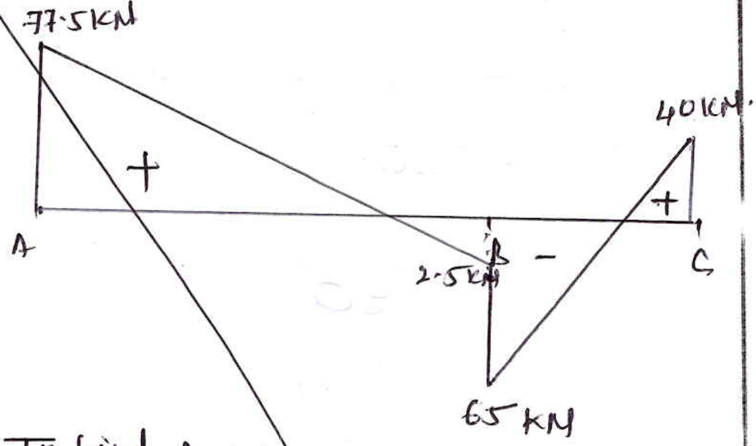
S.F at left of B = 77.5 − 80 = −2.5KN.

S.F. at Right of B = 77.5 − 80 − 62.5 = −65KN.

S.F. at left of C = 77.5 − 100 + 62.5 = 40KN.

S.F at Right of C

77.5 − 100 + 62.5 − 40 = 0KN.

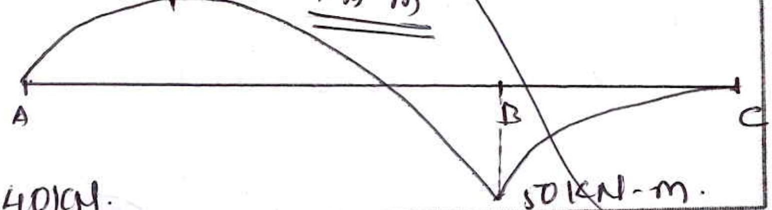


To Find B.M :-

$M_A = M_C = 0$

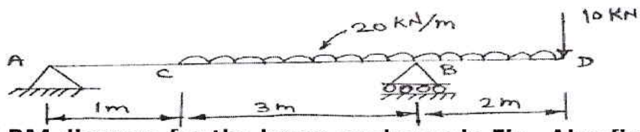
$M_B = -40 \times 1 - 20 \times 1 \times \frac{1}{2} = -50 KN\text{-}m.$

BMax = 150.15 KN·m

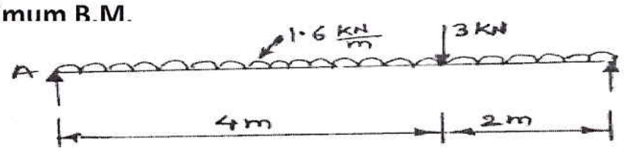


Unit - III
Shear Force & Bending Moment
Question Bank

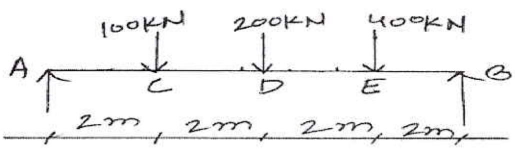
1. State relation between shear force and bending moment.
2. Define axial load and eccentric load
3. Define – i) Point of Contra-Flexure ii) Point of Contra-shear
4. Define shear force and bending moment.
5. A simply supported beam of span 9.75 m is carrying full span u.d.l. of 10 kN/m. What is the magnitude and position of maximum bending moment developed?
6. A simply supported beam of span 6 m carries a u.d.l. of 3 kN/m spread over 2 m from left support and a point load of 6 kN at 4 m from left support. Draw S.F.D. and B.M.D
7. A simply supported beam of span 7 m carries a udl. of 2 kN/m over 4 m length from the left support and a point load of 5 kN at 2 m from the right support. Draw S.F. and B.M. diagrams.
8. A simply supported beam of span 7m carries an u.d.l. of 2kN/m over 4m length from left hand support and a point load of 5kN at 2m from right hand support. Draw S.F. and B.M. diagram.
9. Draw shear force and bending moment diagram for the beam as shown in Fig.



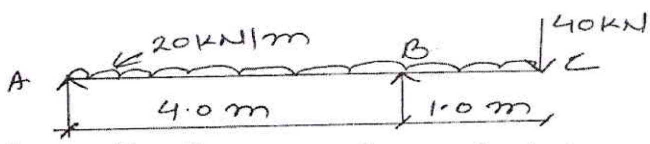
10. Draw SF and BM diagram for the beam as shown in Fig. Also find point of zero shear and maximum B.M.



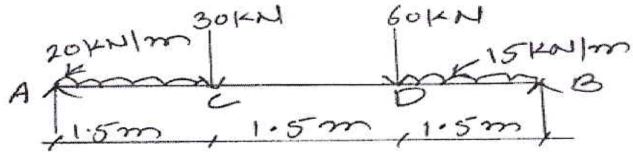
11. Draw S.F.D. and B.M.D. for a simply supported beam as shown in Figure



12. Draw SF and B.M. diagram for the overhanging beam as shown in Figure



13. Draw the shear force and bending moment diagrams for the beam as shown in Figure



14. A cantilever fixed at left end is 2 m. long and carries an UDL of 500 N/m. A point load of 800 N and 600 N act at 1 m and 2 m from fixed end respectively. Draw SF and B.M. diagrams.

15. Draw SF and BM diagrams for the beam shown Also locate the point of contraflexure.