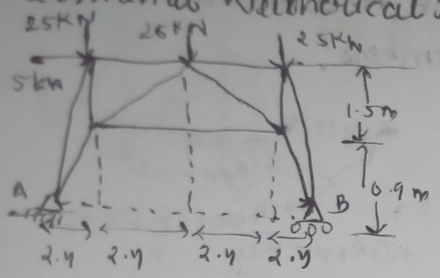
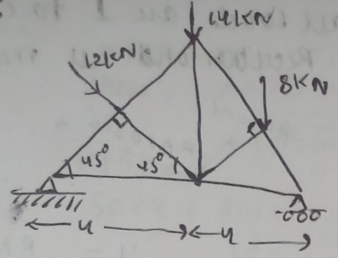
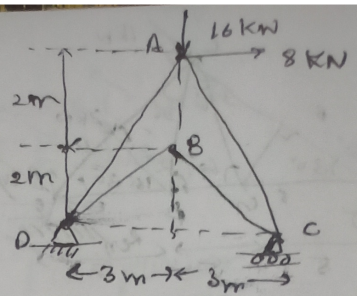
• Sessional Numerical:

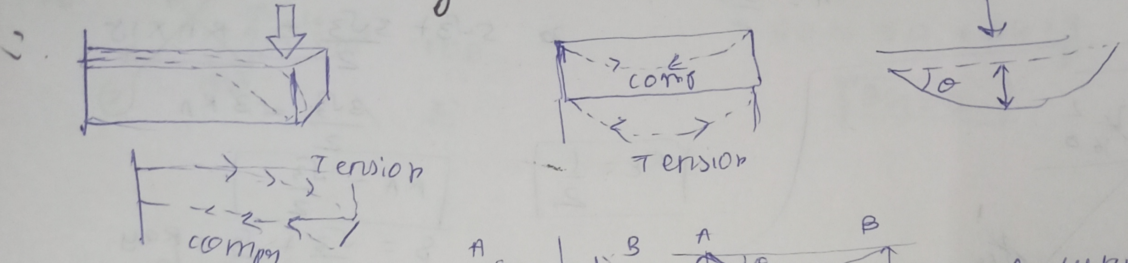




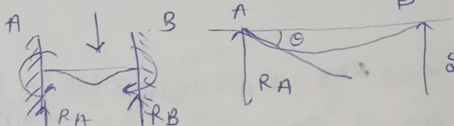


CHAPTER: 6 SHEAR FORCE AND BENDING MOMENT

: Shear and Bending force:



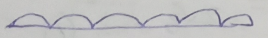
: Different supports:

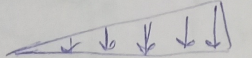


simple support

No rotation

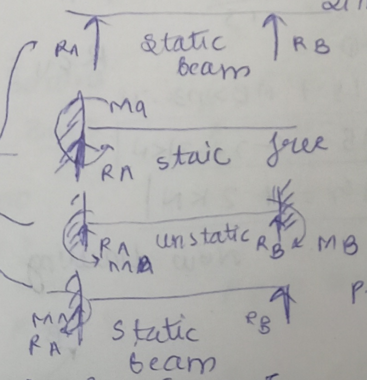
becoz hinges balance torques

: Symbol:  → uniform load throughout the length.

:  → varrying load throughout the length.

: Types of Support: Simple supported beam

Exactly 2/1 Support

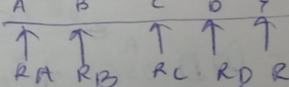


cantilever beam

Fixed beam

Propped cantilever beam.

more than 2 support

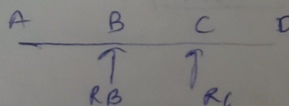


continuous beam

Unstatic beam

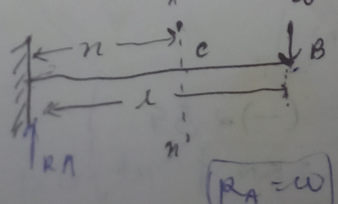
: Static beam → total Renⁿ + Moment ≤ 3

: unstatic beam → total Renⁿ + Moment > 3



overhanging beams.

Que:



$\boxed{R_A = W}$

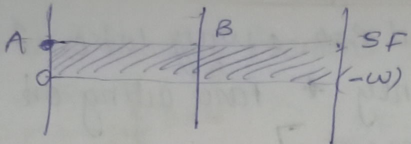
SF at B = −W

SF at C = −W [W is constant throughout length]

SF just right of A = −W

SF at A = 0 [+W−W]

Shear diagram:



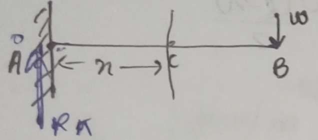
: Shear force:

: Algebric sum of all forces either taking right or left from the section should be equal and opposite.

: Bending moment:

: Algebric sum of all moments either taking right or left from the section should be equal and opposite.

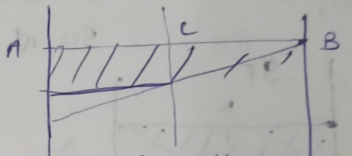
Que: Find BM and draw BM diagram:



BM at B = 0

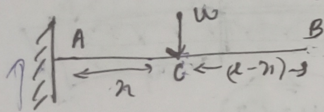
at C = $-w(l-x)$

at A = $-wl$



BM diagram

Que: Find SF and BM also draw digram?



SF at B = ~~ω~~ 0

C = ω

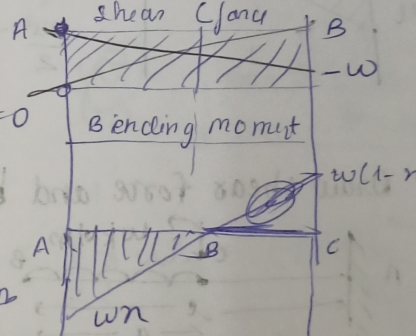
~~A = B~~ ~~A = ω~~

BM at B = ~~ω(l−x)~~ 0

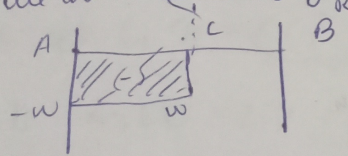
A = 0

at C = 0

at A = $-wx$



* if we are calculating from R to L



if we are moving from Right to left

consider section on B ∴ No force is there on right hence SF = 0.

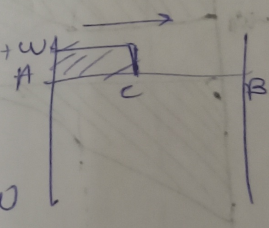
[NOTE: for calculating SF we need to consider from direction]

* if we are calculating from L to R: The SF at A = 0

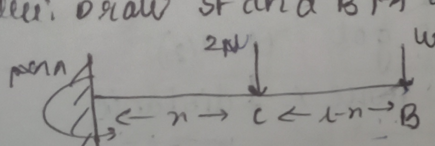
B = 0

C = 0

just right of a = +ω



Que: Draw SF and BM diagram!



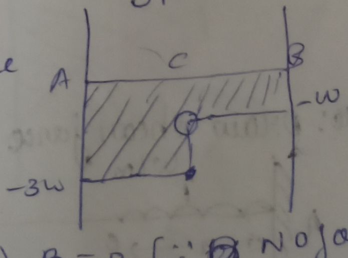
RA = 3ω ↑

∴ when consider RHS side

SF at B = −ω

SF at C = −3ω

SF at A = 0



BM at B = ~~2(l−x) − 3(l)~~ B = 0 [∵ No force on right side)

~~at B = (−l − 2x)ω~~

BM at A = ~~2ω(x)~~ + (l−x)ω − ω(l−x)

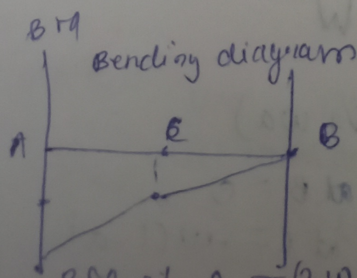
~~A = −(ωx + ωl)~~ ~~ωl − 2ωx~~

c = −ωl + ωx

~~BM~~ at A = ~~−3xω~~ ~~ω(l−x)~~

= ~~−3ωx − ωl + ωx~~

~~BM at A = −2ωx − ωl~~



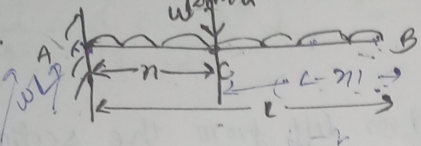
BM at A = $-(2\omega x) - \omega(l-x)$

A = $-\omega l - 2\omega x$

[NOTE : for calculating SF and BM alway take 1 side and calculate all forces on that side only + Force acting on that point. This also apply for Bending Moment.]

Que: Find the Shear force and Bending moment diagram ~~i.e. pt~~ : w will be divided uniformly

Ans:



per m

SF at B = 0

SF at C = −w(L−x)

SF at A = −wL

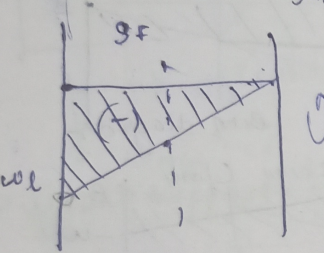
w kN/m

Bending moment:

BM at B = 0

BM at C = $-w(l-x) \times \frac{w(l-x)}{2} = -\frac{w(l-x)^2}{2}$

BM at A = $-\frac{wl^2}{2}$



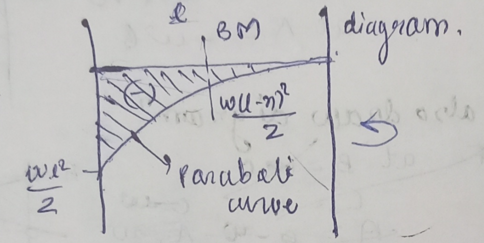
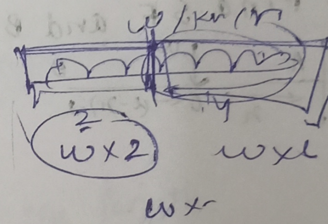
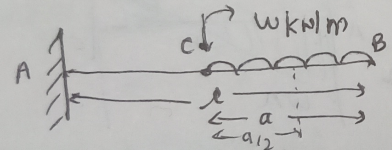


diagram.



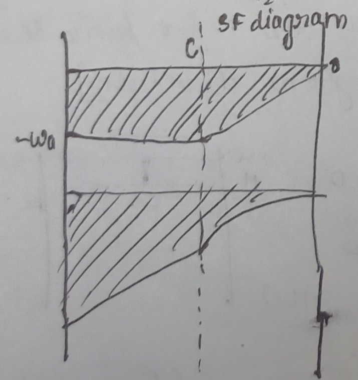
Que: Draw shear force and bending moment diagram:



SF at B = 0

SF at C = −wa

SF at A = −wa



BM at B = 0

BM at C = $-wa \cdot \frac{a}{2}$ [Since w will act at a/2 distance]

$= -\frac{wa^2}{2}$

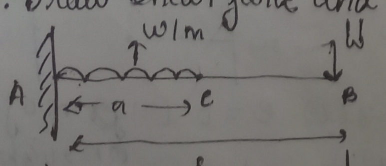
BM at A = $(l - a/2) - wa$

[⊥ distance of force CB is $(l-a) + \frac{a}{2}$

∴ we got $(l - a/2)$

hence force × ⊥ distance

Que: Draw shear force and bending moment diagram:

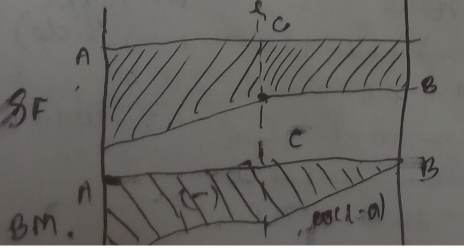


Shear force:

SF at B = −W

SF C = −W

SF at A = −(W + wa)

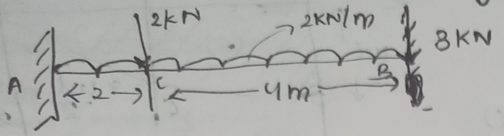


Bending moment: BM at B = 0

BM at C = −W(l−a)

BM at A = $-Wl - \frac{wa^2}{2}$

Que: Find the shear and Bending Moment digram for the following :



SF : at B = -3 KN

SF right at C = (-2)(4) - 3

SF at A = -3 - 2×6 - 2

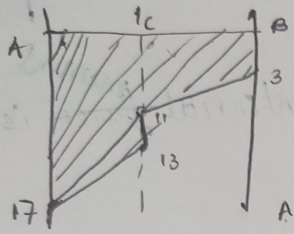
SF at C = (-2(4) - 3) - 2

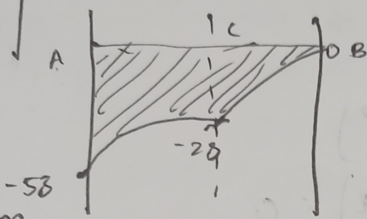
BM : at B = 0

right at C = -(3)(4) - (2)(2)×(4)

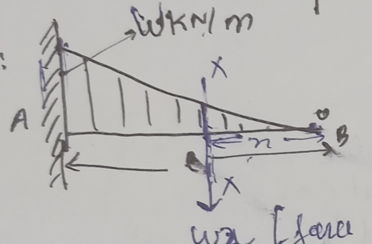
BM at A = -(2)(2) - (2)(6)(3) - (3)(6)

= -58





Que:



SF : at B = 0

at A =

w_x [force acting on section xx']

$\frac{W}{l} = \frac{w_x}{x}$

$w_x = \frac{w}{L} x$

SF at B = 0

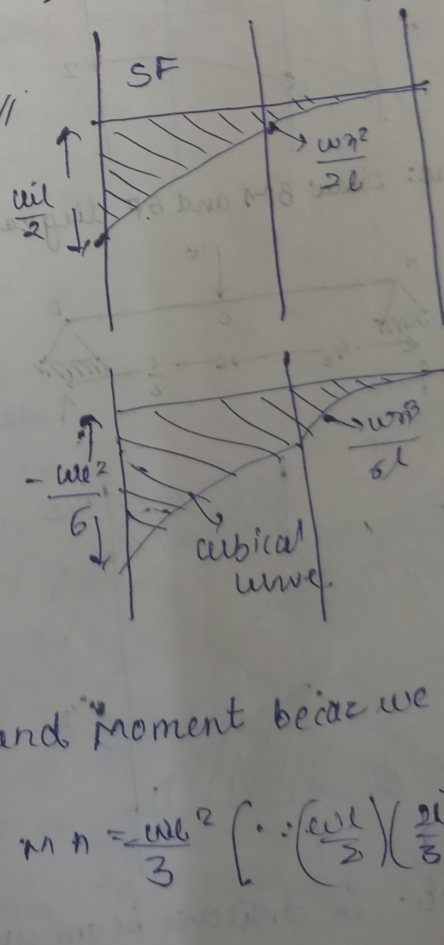
SF at C, $x = -\frac{w}{2}$ = area = $\frac{1}{2} x w_x = (-1)\frac{w x^2}{2l}$

SF at A, $x = l$ = $\frac{1}{2} w \times l = -\frac{1}{2} w_x l = -\frac{1}{2} wL$//

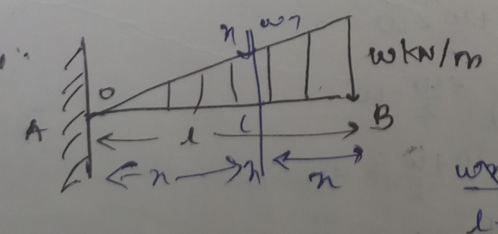
BM at B = 0

BM at C = $(-)\left(\frac{w x^2}{2l}\right)\frac{x}{3}$

BM at A = $(-)\left(\frac{wL}{2}\right)\left(\frac{L}{3}\right) = -\frac{wL^2}{6}$



Que:



$\frac{w_x}{l-x} = \frac{W}{L}$

$w_x = \frac{w}{L}(l-x)$

~~SF at B~~ = we will consider Reaⁿ at A and moment becaz we will consider left handside

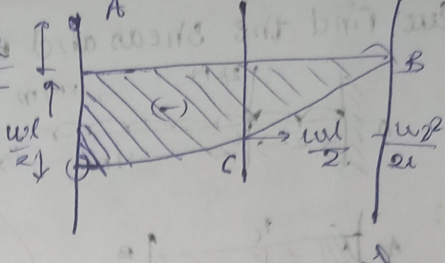
$\therefore R_A = \frac{wl}{2}$ $[\frac{1}{2} \times B \times h]$

$M_A = \frac{wl^2}{3}$ $\left[\because \left(\frac{wl}{2}\right)\left(\frac{2l}{3}\right)\right]$

SF at $A = +\frac{wl}{2}$

SF at $C = +\frac{wl}{2} - \frac{wx^2}{2l}$

SF at $B = \frac{wl}{2} - \frac{1}{2}wl = 0$



BM at A =

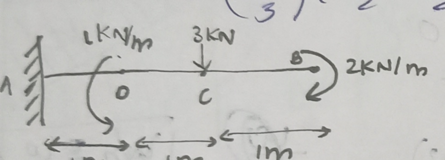
* at hinge point the moment is always zero. until external ~~force~~ moment is applied on ~~force~~ end.

~~BM~~ at $A = \frac{wl^2}{3}$

BM at $C = \left(\frac{2x}{3}\right)\left(\frac{wl}{2} - \frac{wx^2}{2l}\right)$

BM at $B = \left(\frac{2l}{3}\right)\left(\frac{wl}{2} - \frac{1}{2}wl\right) = 0$.

Que:



Draw BM and SF diagram:

Shear force:

SF at B = 0

SF at C = -3

SF at D = -3 . SF at right (A) = -3

bending moment:

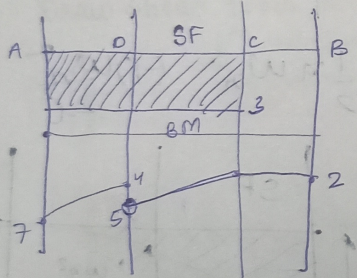
BM at B = -2

BM at C = -2

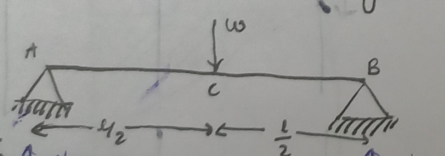
BM at D (right) = -2 - 3 × 1 = -5

BM at A = 2 × -3 - ~~2~~ + 1 = -7

BM at D = -1 ∓ 3 = -4 kN



Que: Draw BM and SF diagram:



due to symmetry R_A & $R_B = w/2$

SF at $B = +w/2$

SF at $C = +\frac{w}{2} - w$

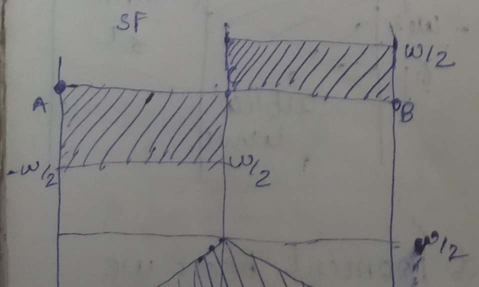
SF at A (right of A) $= +\frac{w}{2} - w$

SF at $A = \frac{w}{2} + \frac{w}{2} - w = 0$

BM at B = 0

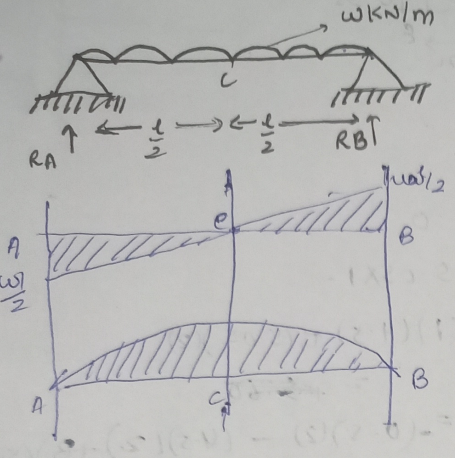
BM at $C = \frac{w}{2} \times \frac{l}{2} = +\frac{wl}{4}$

BM at $A = \frac{w}{2} \times l - \frac{wl}{2} = 0$



[NOTE: in cantilever beam we get BM (-) becau ... but here we get ∴ BM = +]

Que: Draw BM and SF diagram of this system:



go down

$R_A + R_B = wl$ and by symmetry

$R_A = R_B = \frac{wL}{2}$

SF at $B = \frac{wl}{2}$

SF at $C = \frac{wL}{2} + \frac{wl}{2} = 0$.

SF at $A = -wl + \frac{wl}{2} = -\frac{wl}{2}$

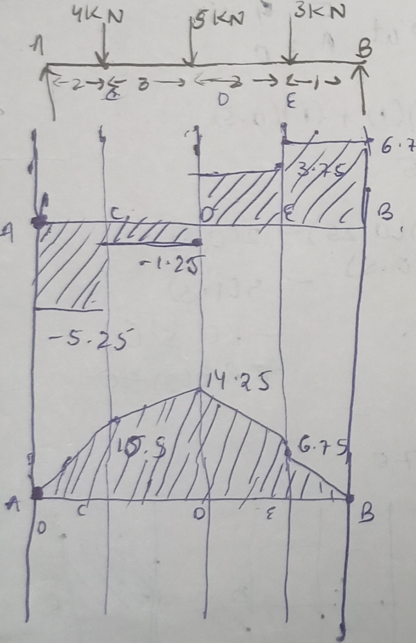
BM at $B = 0$

BM at $C = +\frac{wl}{2} \times \frac{l}{2} - \frac{wL}{2} \times \frac{l}{4} = \frac{wl^2}{4} - \frac{wl^2}{8} = \frac{wL^2}{8}$

BM at right of $A = +\frac{wl^2}{8}$ BM at $A = 0$.

[NOTE: the point where shear force is 0 or changing its sign from + to -(ve) maximum BM occurs]

Que: Draw BM and SF diagram of this system:



$\because R_A + R_B = 12$ $(\Sigma V = 0)$

$\Sigma M_A = 0$: $\therefore (2)(-4) + (5)(-5) + (7)(-3) + R_B \times 8 = 0$

$= +8 + 25 + 21 = R_B \times 8$

$R_B = \frac{54}{8}$ $R_B = 6.75$

$R_A = 5.25$ $R_A = 5.25$

SF at $B = +6.75 \uparrow$

SF at $E = 3.75 \uparrow$

SF at $E = -1.25$

SF at $C = -5.25$

SF at right $= -5.25$

SF at $A = 0$.

BM at $B = 0$

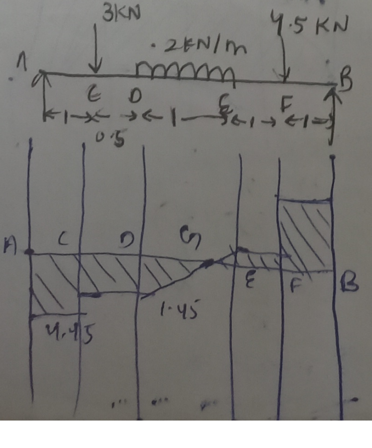
BM at $E = 6.75 \times 1$

BM at $D = 2(-3) + (6.75)(3) = 14.25 \uparrow$

BM at $C = 10.5$

BM at $A = 0$

Que: Calculate and draw the shear force diagram for following system:



$\Sigma V = 0$; $R_A + R_B = 3 + 4.5 + 2$

$R_A + R_B = 9.5$

$\Sigma M_A = 0$: $(-3 \times 1) + (4.5)(3.5) - 2(2) + R_B(4.5) = 0$

SF at $B = 5.05$ kN

SF at $F = 0.55$ kN $R_B = 5.05$ kN

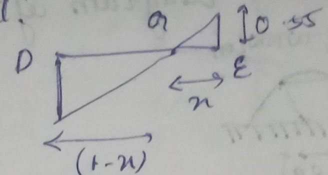
SF at $E = 0.55$ kN $R_A = 4.45$ kN

SF at $D = -1.45$ kN

SF at $C = -3.45$ kN

SF at $A = -4.45$ kN

to calculate length of GE we get:

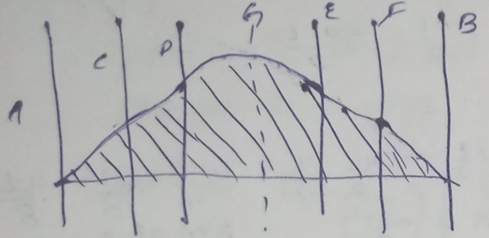


$\therefore \frac{x}{0.55} = \frac{1-x}{1.45}$

$\boxed{x = 0.275}$

$\therefore EG = 0.275$

Now we will calculate



BM at B = 0

BM at F = 5.05X1

BM at E = -(1)(4.5) + (5.05)(2)

= ~~5.60~~

BM at D = -(0.5)(2) - (4.5)(2) + 3)(5.05)

= ~~10.75~~ 6.075

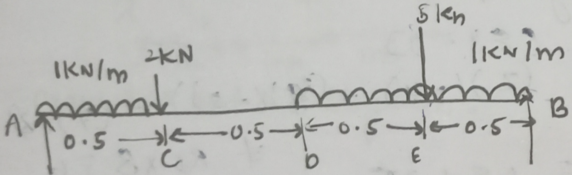
BM at G = 10.75

BM at C = (1)(-2) + (-2.5)(4.5) + (3.5)(5.05)

= 9.05

BM at A = 0.

Que: Find SF and BM:



$R_A + R_B = 7 + (1)(1) + (1)(0.5)$

$R_A + R_B = 8.5$

$\Sigma M_A = 0$: $-(1)(0.25) - 2(0.5)(0.5) - 5(1.5) - 1(1.5)(1) + R_B(2) = 0$

$\boxed{R_B = 5.0625}$

$\boxed{\cancel{R_A = 3.375}}$ $\boxed{R_A = 3.4375\ N}$

SF at B = 5.0625 ↑

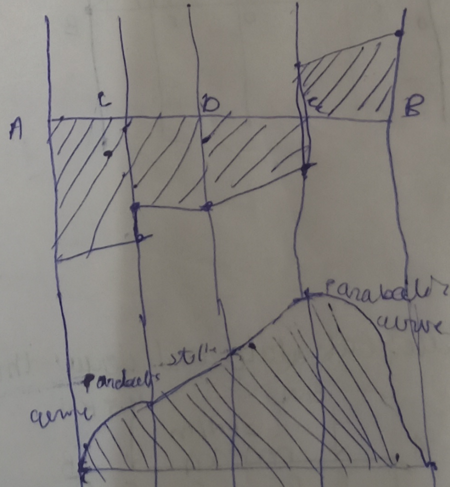
SF at E = ~~0.0625~~ 5.0625 - 5 = 1(0.5) = -0.4375

SF at D = -6 + 5.0625 = -0.9375 ↓

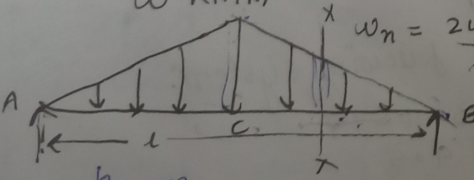
SF at C = -2.4375

SF at A = 0.

SF at right of A = -3.4375



Que: Find SF and BM:



$w_x = \frac{2wx}{l}$

$\frac{x}{w_x} = \frac{l/2}{w}$

by similar triangle

$\boxed{w_x = \frac{2wx}{l}}$

$R_A + R_B$ = Area of Δ

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

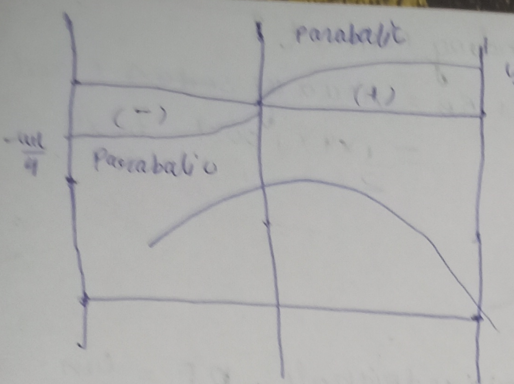
$\boxed{R_A = \frac{wl}{4}}$

SF at B = wl/4

SF at section x = $\frac{1}{2}\frac{wx}{l} \cdot x = \frac{1}{2}\frac{wx^2}{l} + \frac{1}{4}wL$

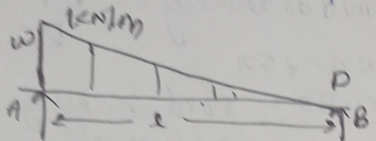
SF at C = $\frac{1}{8}wL + \frac{1}{4}wL = \frac{3}{8}wL$ $\frac{3}{8}wL$ 0.

$x = \frac{l}{2}$



BM at C $= +\frac{wl}{4} \times \frac{l}{2} - \left[\frac{wl}{2} \cdot \frac{l}{2}\right] \times \perp$ distn $= \frac{wl^2}{12}$

Que: Find shearforce and Bending moment ?



Sol.

$R_A + R_B = \frac{1}{2} L W$

$\Sigma M_A = 0$

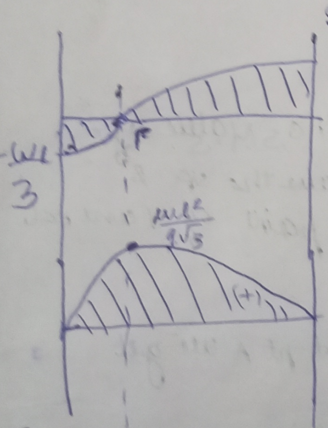
$R_B \times l - \frac{Wl}{2} \times \frac{l}{3} = 0 \quad R_B = \frac{wl}{6}$ & from eqn (1) $R_A = \frac{wl}{3}$

w_x is the load at section x-x.

∴ SF at B $= +\frac{wl}{6}$ by similar triangle, we get $w_x = \frac{Wx}{L}$

SF at x-section $= \frac{wl}{6} - \frac{w_x \cdot x}{2} = \frac{wl}{6} - \frac{Wx^2}{2l}$

SF at A (just right) $= -\frac{wl}{3}$



to find F point SF = 0

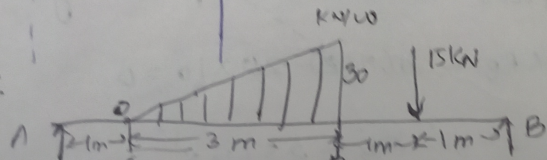
∴ $\frac{wx^2}{2l} = \frac{wl}{6}$ ∴ $x = \frac{l}{\sqrt{3}}$

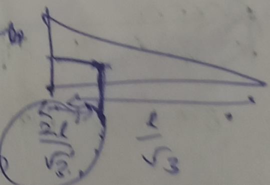
hence BF $= \frac{l}{\sqrt{3}}$

~~BM at C where SF is zero. so~~ w

BM at C $= \frac{wl^2}{9\sqrt{3}}$

Que: :





$\frac{1}{2} \frac{l}{\sqrt{3}} \times w$

$\frac{wl}{\sqrt{3}} \times \frac{1}{2\sqrt{3}}$

$R_A + R_B = 15 + 30 \times \frac{1}{2} \times 3$

$= 15 + 45 = 60$

$R_A + R_B = 60$

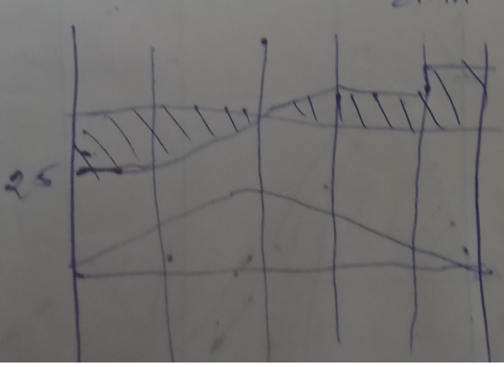
$\frac{wl}{\sqrt{3} \times 2\sqrt{3}} \times \frac{2l}{\sqrt{3}}$

∴ ~~SF at B =~~ $\Sigma M_A = 0$: $2 \times 60 = B \times 6$

$+ 15 \times 5$

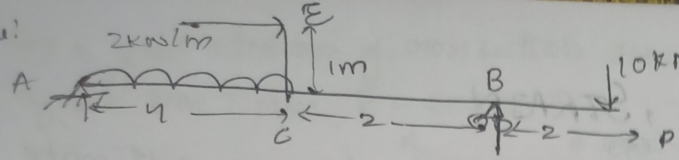
$\frac{w}{3}$

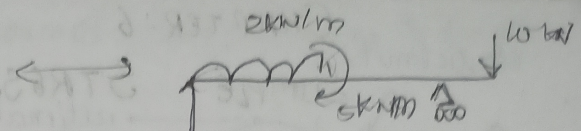
$20 + \quad = B$



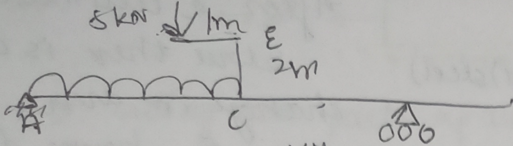
$\frac{2l}{\sqrt{3}}$

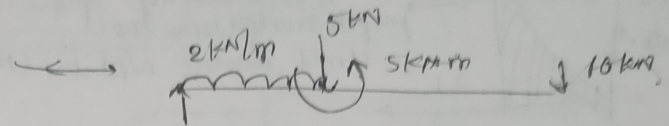
Que:



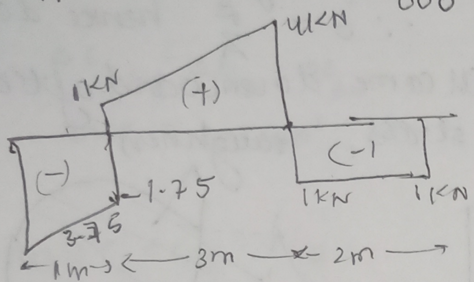


Que:





Que:



From rightmost to left, value of w is constant hence a point load of 1kN at rightmost.

then at varying load whose $w = \frac{4-1}{3} = 1$kN.

At another point $1 - W = -1.75$

$W = 2.75$

and then varying load.