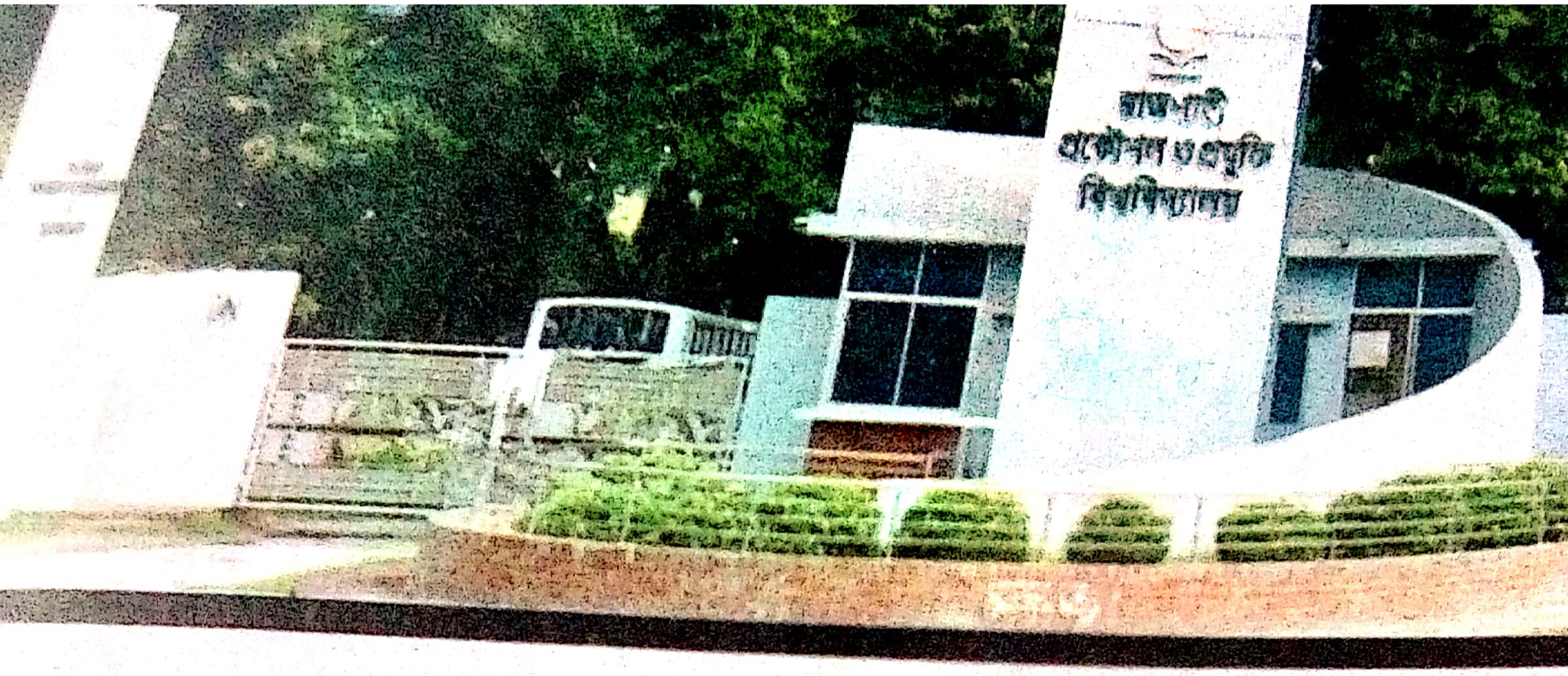


Name: Noushin Tabassum Tasnim

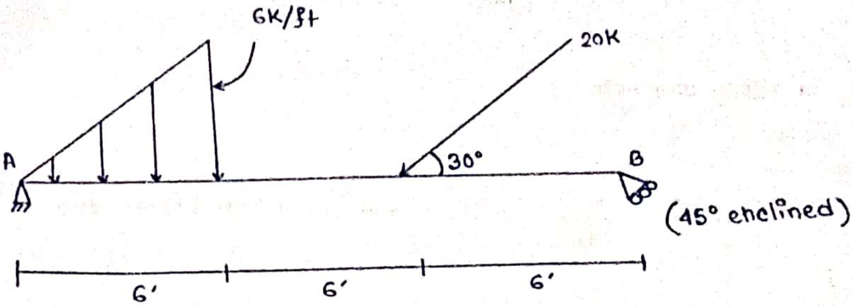
Roll: 1800130

CE – 2111

19/01/2020

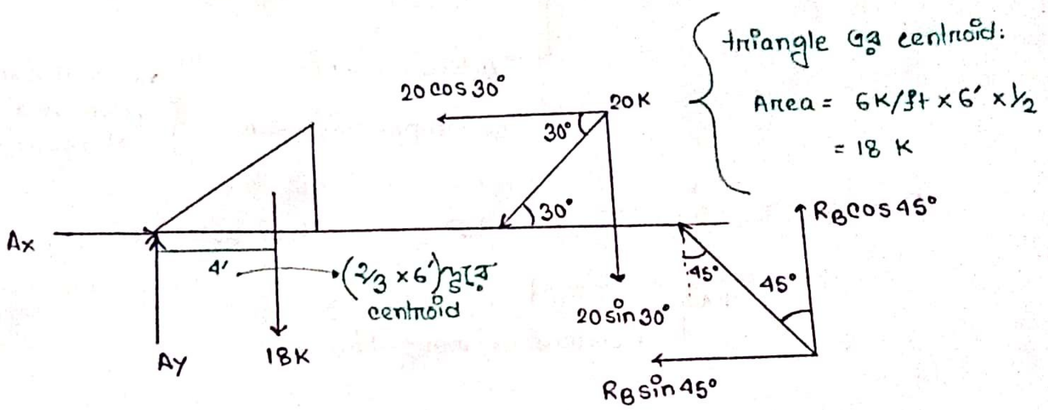
Mechanics of Materials – I

#:



Calculations at A and B ?

⇒



$\Sigma M_A = 0$

$\Rightarrow 18 \times 4 + 20 \sin 30° - R_B \cos 45° \times 18 = 0$

$\Rightarrow R_B = ?$

$\Sigma F_x = 0$

$\Rightarrow A_x - 20 \cos 30° - R_B \sin 45° = 0$

$\Rightarrow A_x = ?$

$\Sigma F_y = 0$

$\Rightarrow A_y - 20 \sin 30° + R_B \cos 45° - 18 = 0$

$\Rightarrow A_y = ?$

22/01/20

Stress and Strain

Stress = $\frac{\text{Resisting force}}{\text{Area}}$, $\boxed{\sigma = \frac{P}{A}}$

* steel, concrete

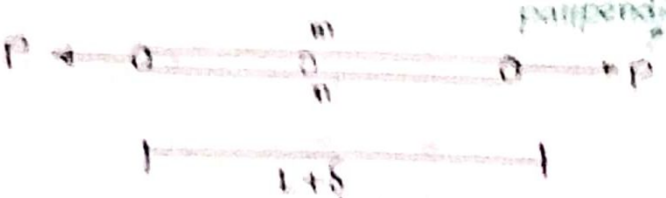
→ original bar before loading

A (cross sectional area) pulling away

→ free body diagram of a load (tension) segment of the bar

→ (i) tension stress
(ii) compressive stress } normal stress (perpendicular) of cross section

perpendicular to the plane



→ bar after loading

shearing stress → parallel

$l+\delta$ → extension/elongation

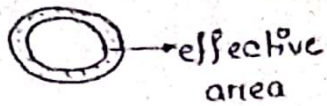
← P (contraction → deformation)

Strain, $\boxed{\varepsilon = \frac{\delta}{l}}$ → [illegible]

A hollo circular alluminium column is supporting 26 kips compressive load. Inner diameter = 4 inch, Outer diameter = 4.5 inch. Length of the column 16 inch. Calculate develop stress.

⇒ compressive load, $P = 26$ kips

$= 26 \times 1000$ lb



Effective Area $= \frac{\pi}{4}(4.5)^2 - \frac{\pi}{4}(4)^2$

$= 3.338$ inch^2

Stress, $\sigma = \frac{P}{A}$

$= \frac{26000 \text{ lb}}{3.338 \text{ inch}^2}$

$= 7790$ psi (pound per squre unit)

Ksf   1K = 1000lb
Ksi
psf $N/m^2 \longrightarrow$ Pa, KPa, MPa

$1 N/mm^2 = 1$ MPa

145 Psi = 1 MPa

Modulas of plasticity of steel:

SI and FPS unit

Deformation = 0·012 inch

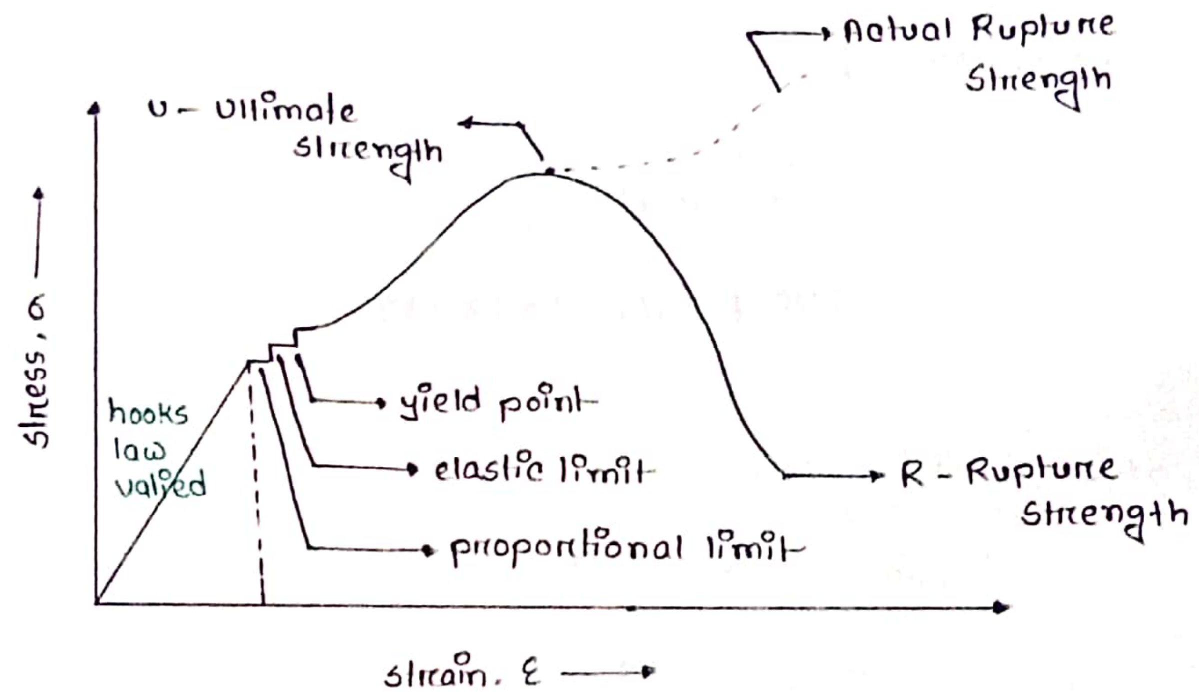
Strain = ?

$\hookrightarrow \quad \varepsilon = \frac{\delta}{L}$

$= \frac{0.012}{16}$

$= 7.5 \times 10^{-4}$ inch/inch

Stress/ strain Diagram:

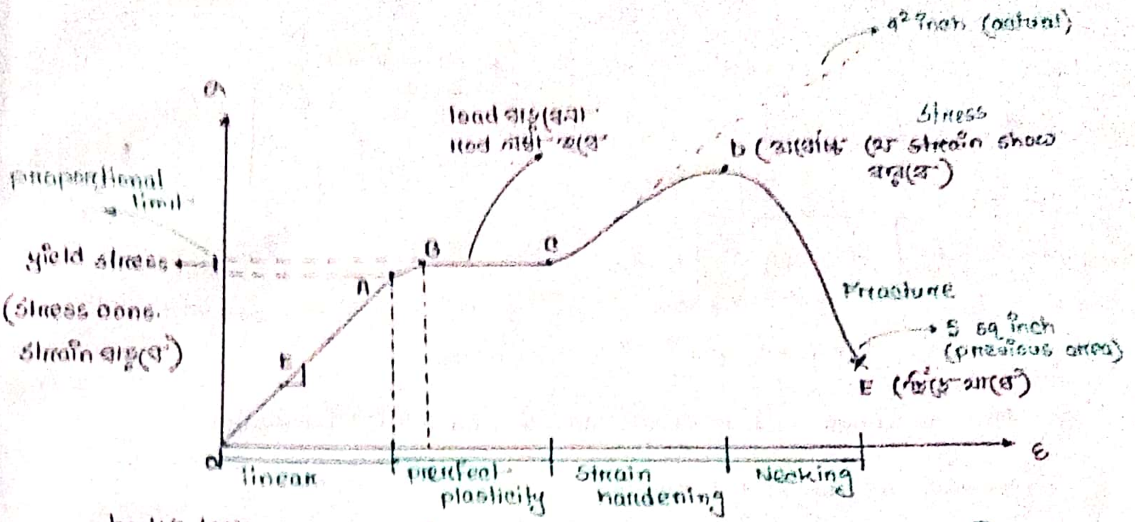


* plastic deformation = permanent deformation.

proportional limit ⟶ stress ∝ strain যত অংশ পর্যন্ত

elastic limit ⟶ যে limit পর্যন্ত load apply করলে আগের জায়গায় ফিরে আসে

ultimate strength ⟶ যে পর্যন্ত load resistance করতে পারে। (max stress)

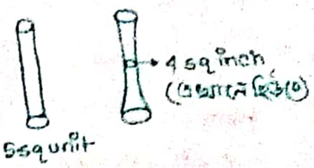


hook's law: $\sigma \propto \varepsilon$

$\Rightarrow \sigma = k\varepsilon$

↓

proportionality cons



$\boxed{\sigma = E\varepsilon}$ → yung's modulas / modulas of elasticity

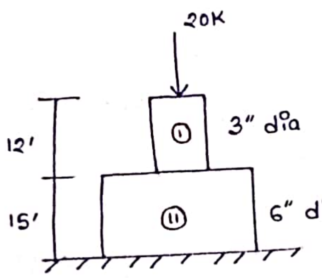
* steel E

$\sigma = \frac{P}{A} = k\frac{\delta}{L} = E\frac{\delta}{L}$

$\Rightarrow \boxed{\delta = \frac{PL}{AE}}$ → deformation

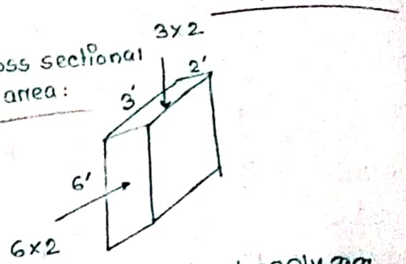
25/01/2020

#



$E = 29 \times 10^6$ psi

cross sectional area :

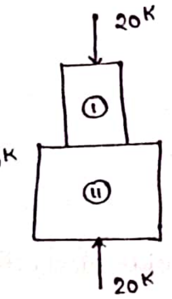


যেখানে load apply করা হবে, সেখানের area

Find maximum and minimum stress and total deformation.

(Neglect weight of the bars)

→



$$\varepsilon = \frac{\Delta}{L}$$

here,

$P = P_1 = P_2 = 20^K$

$$A = \frac{\pi}{4} d^2$$

$$\sigma_1 = \frac{P_1}{A_1} = \frac{20 \times 1000 \text{ lb}}{\frac{\pi}{4} \times (3)^2} = 2.83 \text{ ksi}$$

$$\sigma_2 = \frac{P_2}{A_2} = 0.71 \text{ ksi}$$

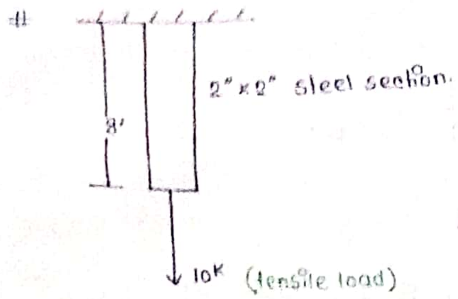
here,

$$\Delta_1 = \frac{PL_1}{A_1 E} = \frac{20 \times 1000 \times 12 \times 12}{\frac{\pi}{4} \times 3^2 \times 29 \times 10^6}$$

$$\Delta_2 = \frac{PL_2}{A_2 E} = \frac{20 \times 1000 \times 15 \times 12}{\frac{\pi}{4} \times 6^2 \times 29 \times 10^6}$$

$$\Delta = \Delta_1 + \Delta_2 =$$

#



$\boxed{1\ MPa = 145\ psi}$

Find stress and strain in the steel section.

$\rightarrow \quad \sigma = \frac{P}{A}$

$= \frac{10 \times 1000\ lb}{2 \times 2\ inch^2}$

$= 2500\ psi$

$E_s = 200$ ~~gpa~~ GPa

$= 200 \times 145$ ~~psi~~ ksi

$= 2.9 \times 10^4$ psi

$= 2.9 \times 10^4 \times 1000$ psi

$= 2.9 \times 10^7$ psi

ave strain, $\varepsilon = \frac{\Delta}{L}$

$= \frac{8.28 \times 10^{-3}}{(8 \times 12)''}$

$= 8.6 \times 10^{-5}$

here,

$\Delta = \frac{PL}{AE_s}$

$= \frac{10 \times 1000 \times (8 \times 12)''}{2 \times 2 \times 2.9 \times 10^{7}}$

$= 8.28 \times 10^{-3}$ inch (elongation)

or, $\quad \sigma = E\varepsilon$

$\Rightarrow \varepsilon = \frac{\sigma}{E} = 8.6 \times 10^{-5}$

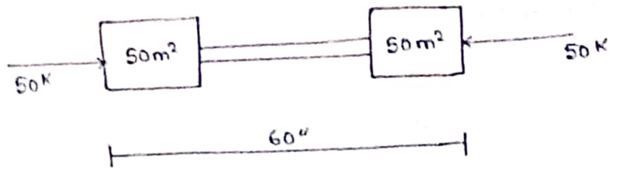
yield stress of steel

$* f_y = 500\ MPa = \frac{500 \times 145}{1000}\ ksi = 72.5\ ksi$

$\varepsilon_y = \frac{f_y}{E} = \frac{72.5}{2.9 \times 10^7}$

yield stress

#:



Find the area of the middle portion if the stress is limited to 20 ksi.

→

Applied load = 50^K

$$\sigma = \frac{P}{A}$$

$$\Rightarrow A = \frac{P}{\sigma}$$

$$= \frac{50^K}{20 \text{ Ksi}}$$

$$= 2.5 \text{ inch}^2$$

Factor of safety:

ঐ metal যতটুকু stress নিতে পারে

$$\text{Factor of safety} = \frac{\text{yield or ultimate stress}}{\text{Allowable strength}}$$

যতটুকু আমি allow করব

Calculate the length of the middle porsion in the total elongation is 0.001 inch.

length of the middle porsion $= l_1$

length of other porsion $= l_2 = 60 - l_1$

Total deformation, $\Delta = \Delta_1 + \Delta_2$

$$= \frac{P_1 L_1}{A_1 E_1} + \frac{P_2 L_2}{A_2 E_2}$$

here,

$P_1 = P_2$

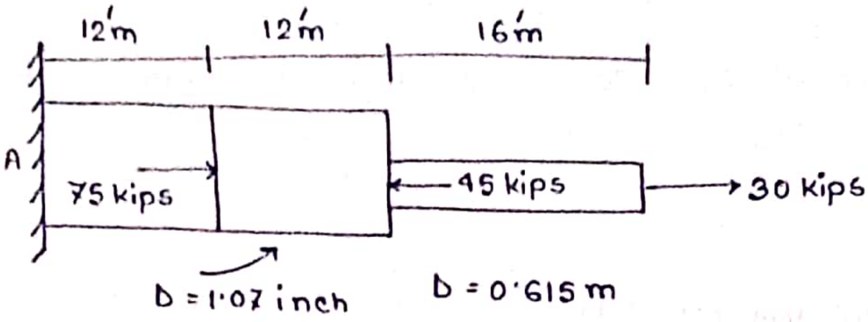
$E_1 = E_2$

$$\therefore \Delta = \frac{P}{E}\left(\frac{L_1}{A_1} + \frac{L_2}{A_2}\right)$$

$$\Rightarrow 0.001 = \frac{P}{E}\left(\frac{L_1}{A_1} + \frac{60 - L_1}{A_2}\right)$$

$$= \frac{50 \times 10^3}{2.9 \times 10^7}\left(\frac{L_1}{2.5} + \frac{60 - L_1}{50}\right)$$

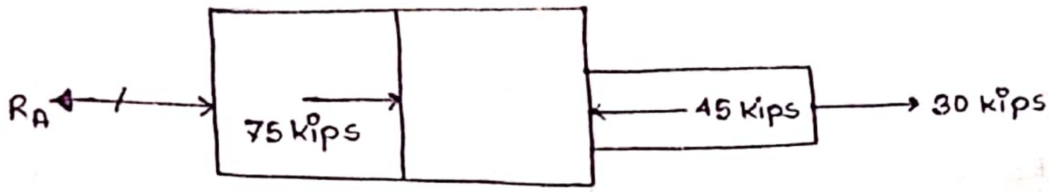
#



$E = 30 \times 10^6$ psi

Calculate max stress and total deformation.

⇒ Segment ① →



$\Sigma F_y = 0$

$\Sigma M_A = 0$

$A_1 = \frac{\pi}{4} d^2$

$= \frac{\pi}{4} (1{\cdot}07)^2$

Axial load of member,

$\Sigma F_x = 0$

$\Rightarrow R_A = 60$ kips $= P_1$ (let) → tensail

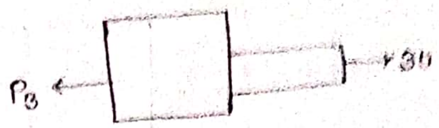
Steps:

① Divide the member into components at the load application points.

⑪ Apply a free body analysis. on each component to determine the internal force.

Segment (II) →

Segment (III) →



$\Sigma F_x = 0$

$\Rightarrow 45K - 30K + P_2 = 0$

$\Rightarrow P_2 = -15K$ (compression)

towards right.

(resisting force এর দেওয়ার জন্য)

$\Sigma F_x = 0$

$\Rightarrow P_3 = 30K$ (T)

$A_2 = \pi/4\,(1.07)^2$

$A_3 = \pi/4\,(0.618)^2$

$\sigma_1 = \frac{P_1}{A_1}$

$\sigma_2 = \frac{P_2}{A_2}$

$\sigma_3 = \frac{P_3}{A_3}$

$$\Delta = \Delta_1 - \Delta_2 + \Delta_2$$

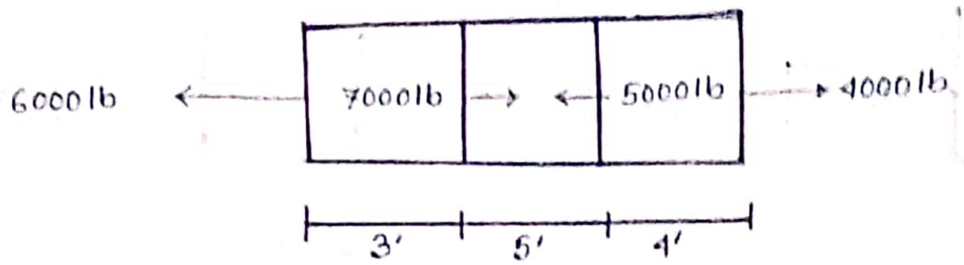
$$= \sum_{1} \frac{P_i L_i}{A_i E_i} = \frac{1}{E}\left(\frac{P_1 L_1}{A_1} - \frac{P_2 L_2}{A_2} + \frac{P_3 L_3}{A_3}\right)$$

$$= \frac{1}{30\times10^6}\left[\frac{(60\times10^3)\,12}{0.9} - \frac{(15\times10^3)\,12}{0.9} + \frac{(30\times10^3)\,16}{0.3}\right]$$

$$= 73.37\times10^{-3} \text{ inch.}$$

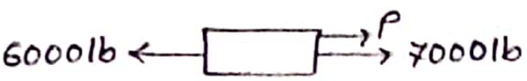
Scanned by CamScanner

#:



An aluminium bar carries the axial loads applied as shown in Fig. Compute the total change in length of the bar if $E = 10 \times 10^6$ psi and cross sectional area of $0.5\ in^2$.

⇒ Segment ① →



$\sum F_x = 0$

$\Rightarrow 7000 + P - 6000 = 0$

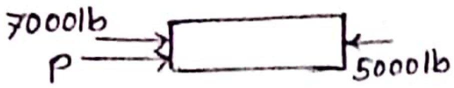
$\Rightarrow P = -1000\ lb$

$$\delta_1 = \frac{PL}{AE}$$

$$= \frac{1000 \times 3}{0.5 \times 10 \times 10^6}$$

$$= 6 \times 10^{-4}$$

Segment ⑪ →



$\sum F_x = 0$

$\Rightarrow P + 7000 - 5000 = 0$

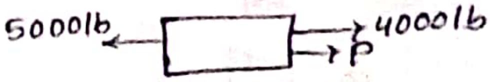
$\Rightarrow P = -2000$

$$\delta_2 = \frac{PL}{AE}$$

$$= \frac{2000 \times 6}{0.5 \times 10 \times 10^6}$$

$$= 2 \times 10^{-3}$$

Segment ⑪ →



$\sum F_x = 0$

$\Rightarrow P = 1000 lb$

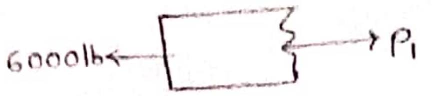
$$\delta_3 = \frac{PL}{AE}$$

$$= \frac{1000 \times 4}{0.5 \times 10 \times 10^6}$$

$$= 8 \times 10^{-4}$$

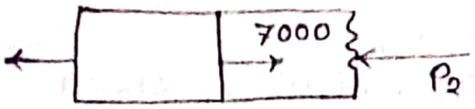
$$\delta = -\delta_1 - \delta_2 + \delta_3$$

$$= -1.8 \times 10^{-3}$$

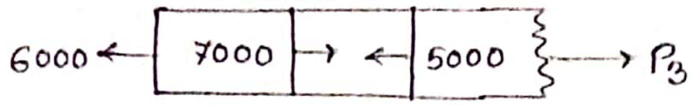


$\delta = \delta_1 - \delta_2 + \delta_3$

$P_1 = 6000\,lb\ (T)$

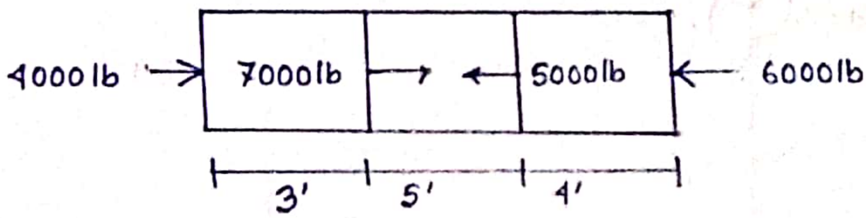


$P_2 = 1000\ (C)$

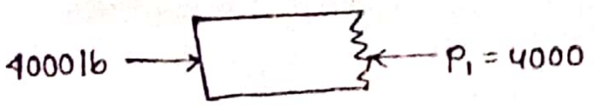


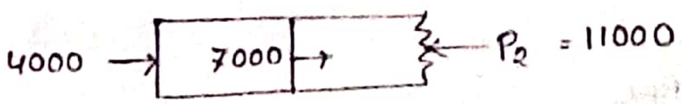
$P_3 = 4000\ (T)$

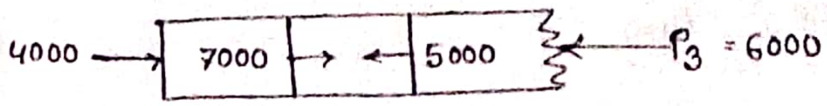
#



⇒







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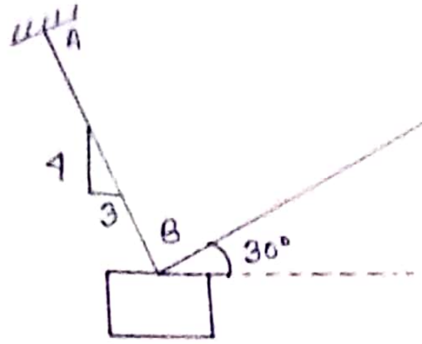
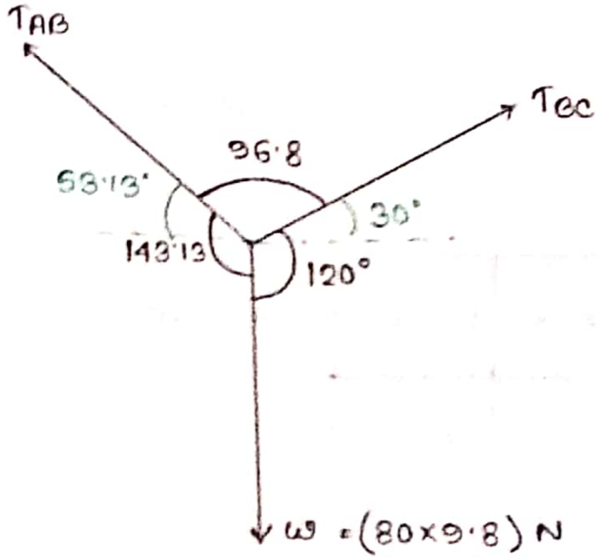


The 80 kg lamp is supported by two rods AB and BC as shown in the figure. If AB has a diameter of 10 mm and BC has a diameter of 8 mm. Determine the average normal stress in each rod.

⇒



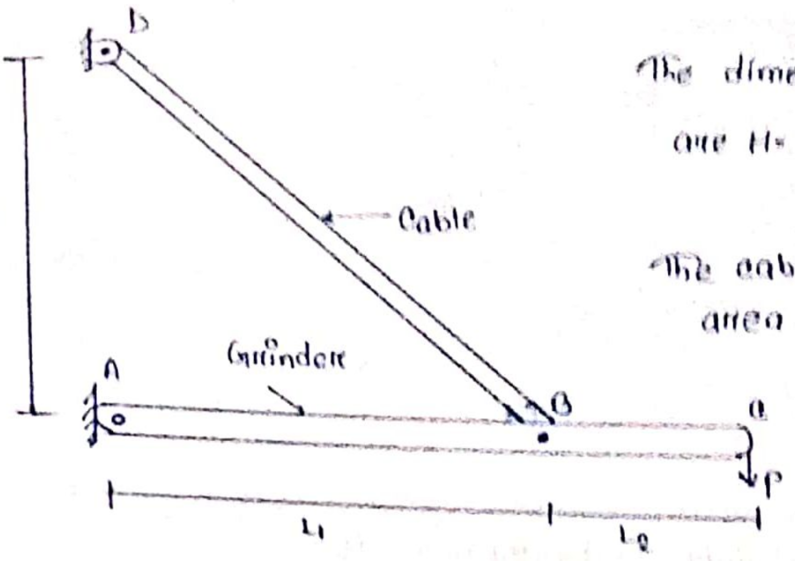
$$\frac{w}{\sin 96{\cdot}8} = \frac{T_{BC}}{\sin 143{\cdot}13} = \frac{T_{AB}}{\sin 120^\circ}$$

⇒ $T_{AB} = ?$ $\qquad \sigma_{AB} = \dfrac{T_{AB}}{A_{AB}}$

⇒ $T_{BC} = ?$ $\qquad \sigma_{BC} = \dfrac{T_{BC}}{A_{BC}}$

* Cable always take tension.

#1:

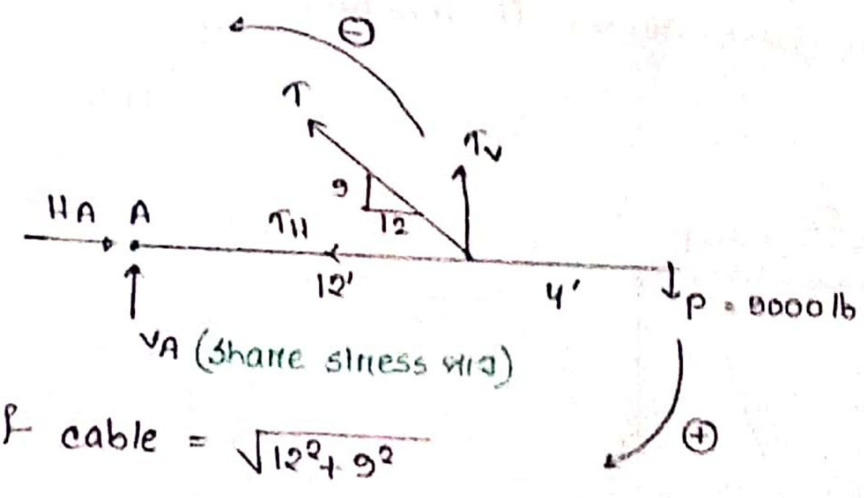


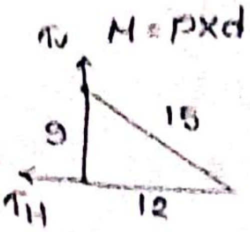
The dimensions of the crane are $H = 9ft$, $L_1 = 12ft$, $L_2 = 4ft$.

The cable has a cross-sectional area $A = 0.471\ in^2$.

(a) If the load $P = 9000\,lb$, what is the stress in the cable?

(b) If the cable stretches by 0.382 in. what is the strain?





$M = p \times d$

$\theta = \sin^{-1} 9/15$

$\Rightarrow T_v = T \sin\theta$

$\Rightarrow T_v = T\ 9/15$

$\Rightarrow T = 15/9\ T_v$

length of cable $= \sqrt{12^2 + 9^2}$

$= 15'$

$\Sigma M_A = 0$

$\Rightarrow 9000 \times 16 - T_v \times 12 = 0$

$\Rightarrow T_v =$

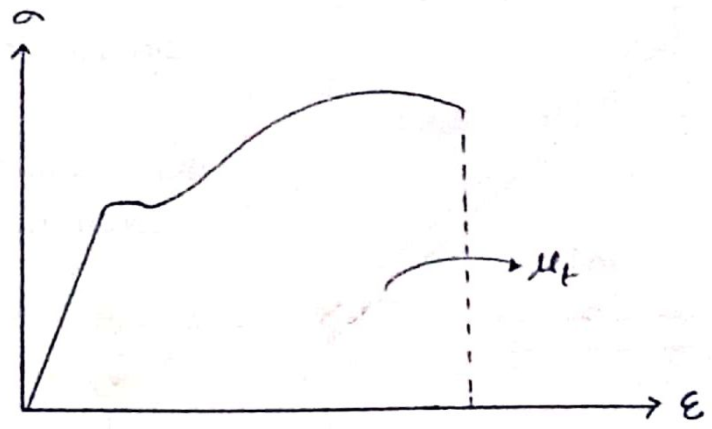
$\Rightarrow T = 20000\ lb$

$\sigma = \frac{T}{A}$

$\varepsilon = \frac{\delta}{L}$

$\Rightarrow \varepsilon = \frac{0.382}{15 \times 12\ in}$

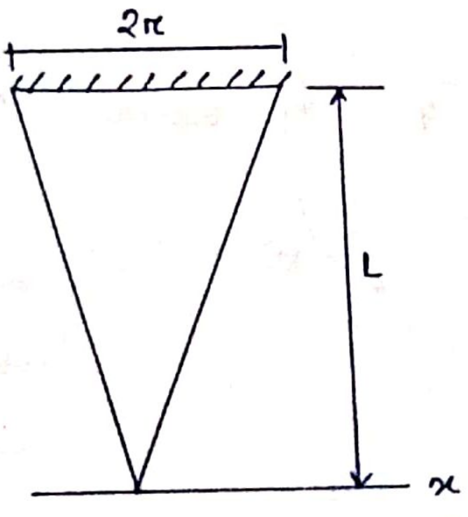
Modulas of toughness:



Modulas of tougheness μ_t

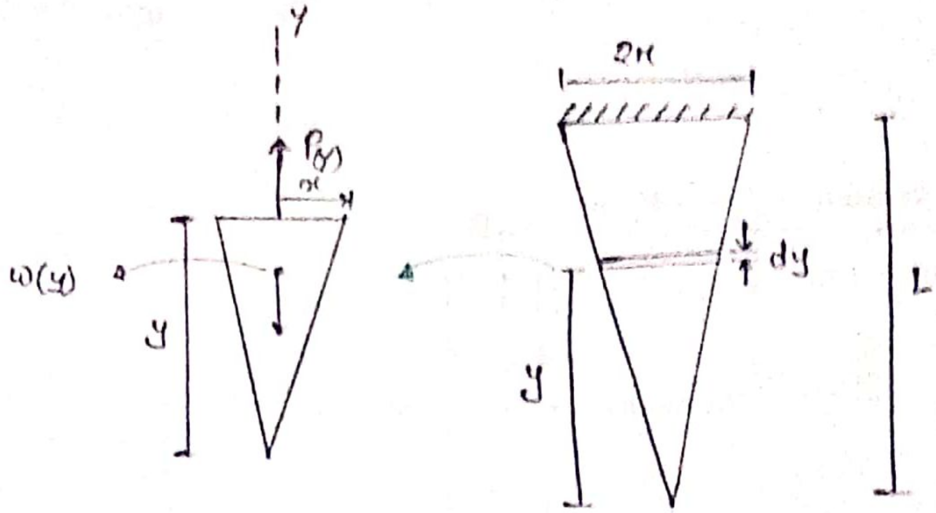
It represents the entire area under the stress-strain diagram. It indicates the strain energy density of the material just before it fractures.

#



A solid conical bar is suspended as shown in figure. Determine the elongation due to its own weight.

⇒



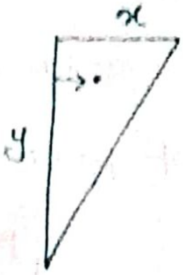
$x/y = r/L$

$\Rightarrow x = \frac{ry}{L}$

γ = density

$V = \frac{1}{3}\pi x^2 y$

$= \frac{\pi r^2}{3L^2} y^3$ [x এর মান বসিয়ে]



$A = \frac{xy}{2}$

$\bar{x} = x/3$

$\theta = 2\pi$

$A\bar{x}\theta = \frac{xy}{2} \times \frac{x}{3} \times 2\pi$

$= \frac{1}{3} x^2 y \pi$

$W = V\gamma$ ↳ density

$P(y) = \gamma \frac{\pi r^2}{3L^2} y^3$

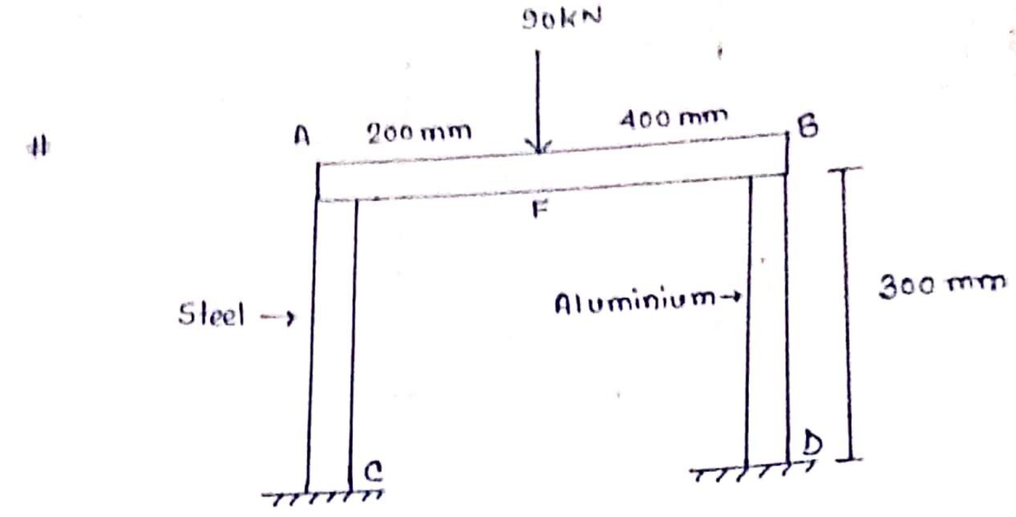
$A(y) = \pi x^2 = \frac{\pi r^2}{L^2} y^2$ $\left[x = \frac{ry}{L}\right]$

$$\delta = \int_0^L \frac{P(y)\,dy}{A(y)E}$$

$$= \frac{\gamma}{3E}\int_0^L y\,dy$$

$$\delta = \frac{\gamma L^2}{6E}$$

#



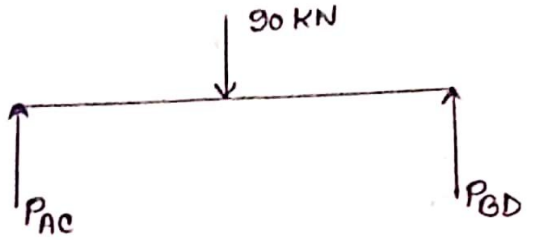
$E_{st} = 200$ GPa

$E_{Al} = 70$ GPa

$\phi = 40$ mm

A beam supports a 90 KN load as shown in figure. Determine the displacement at point F and the middle of the beam.

⇒



$$\Delta_{AC} = \frac{P_A L}{AE}$$

$\Sigma M_A = 0$

$\Rightarrow P_{BD} \times 600 - 90 \times 200 = 0$

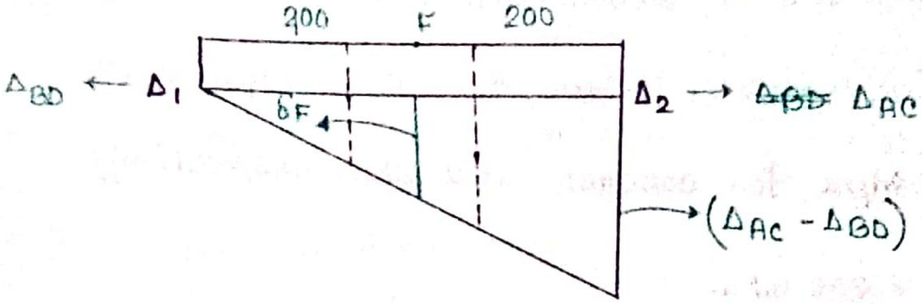
$\Rightarrow P_{BD} = \frac{90 \times 200}{600}$

$= 30$ KN

$\Sigma F_y = 0$

$\Rightarrow P_{AC} = 60$ KN

যদি $\Delta_2 > \Delta_1$ হয় →



$$\Delta_{AC} = \frac{300\times 60\times 10^3}{\frac{\pi\times 20^2}{4\times 1m^2}\times 200\times 10^9}$$

$$= 0{\cdot}286\ mm$$

$$\Delta_{BD} = 0{\cdot}172\ mm \longrightarrow \frac{PL}{AE} = \frac{30\times 10^3\times 300}{\pi\times (20)^2\times 70\times 10^9}$$

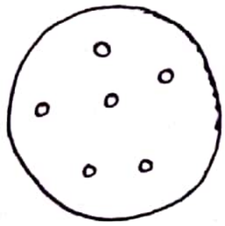
$$\Delta_{AC} - \Delta_{BD} = ?$$

↳ y বের করে F point এ $\delta F = \Delta_{BD} + y$

A reinforce concrete column 200 mm in diameter is designed to carry a compressive load of 300 KN. Determine the required area of the reinforcing steel if the allowable stresses are 6 Mpa and 120 Mpa for concrete and steel respectively.

$E_c = 14$ GPa , $E_{st} = 200$ GPa.

$\Rightarrow$



$f_c = 6$ MPa $\quad E_c = 14$ GPa

$f_s = 120$ MPa $\quad E_{st} = 200$ GPa

strain ~~ভিন্ন~~ same হবে. stress ~~same~~ ভিন্ন হবে।

load apply হবে perpendicular.

$$\delta_c = \delta_s$$

$$\Rightarrow \frac{P_c L}{A_c E_c} = \frac{P_s L}{A_s E_s}$$

$$\Rightarrow \frac{\sigma_c}{E_c} = \frac{\sigma_s}{E_s}$$

$$\Rightarrow \frac{\sigma_s}{\sigma_c} = \frac{E_s}{E_c} = n$$ → plasticity ratio / Modular ratio.

$$\Rightarrow \sigma_s = n\sigma_c$$

Working stress,

$$\text{Factor of safety} = \frac{\text{Ultimate strength}}{\text{Allowable strength}}$$

- When $\sigma_s = 120$ MPa, so then $\sigma_c = \frac{\sigma_s}{n} = 8.4$ MPa

  it is greater than 6 MPa [not OK]

- When $\sigma_c = 6$ MPa, then $\sigma_s = 85.8$ MPa.

এখন steel maximum stress-এ আছে তখন concrete allowable stress এ নেই, তাই we didn't acept it. Concrete is used in maximum stress, then $\sigma_s < 120$. so it is acceptable.

$$P = P_c + P_s$$

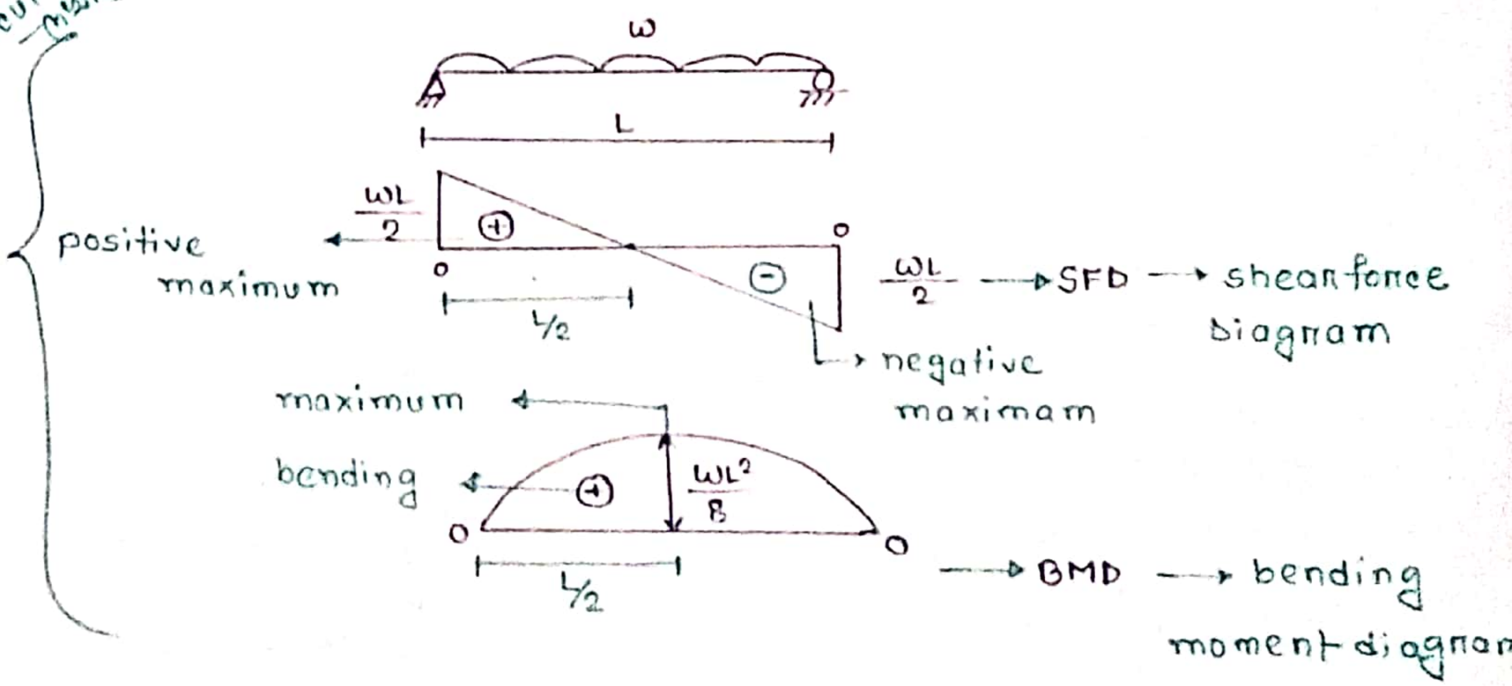
$$= \sigma_c A_c + \sigma_s A_s \qquad [A_c = A - A_s]$$

(ii) Shear force and bending moment diagram:

Shear Force: The algebric sum of the verticle forces at any section of a beam to the right or left of the section is known as shear force.

Bending Moment: The algebric sum of the moments of all forces acting to the right or left of the section is known as bending moment.

calculation শিখতে হবে



A SFD is one which shows the variation of the shear force along the length of the beam.

A BMD is one which shows the variation of the bending moment along the length of the beam.

Rules for SFD and BMD:

(i) Consider the left or right portion of the section.

(ii) Add the process normal to the beam in one of the portions.

For right portion of the section, downward loads are positive.
" left " " " " , negative

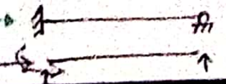
(iii) SFD will increase or decrease suddenly by a verticle straigth line at section where there is a verticle point load.

(iv) Shear force betn two verticle point loads will be constant and hence, SFD betn two point loads will be horizontal.

(v) Bending moment at the two supports of a simply supported beam and at the free end of a cantilever will be zero.

propt cantilever beam →

এই beam হয়েছে hinge এ করা যায় (অস্থি determinent structure)



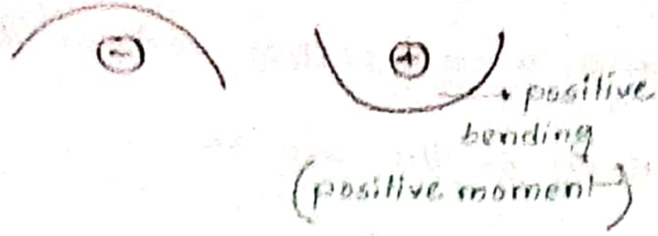
Determinant Structure: It is one, which can be analysied using the eqn s of static equllibrium.

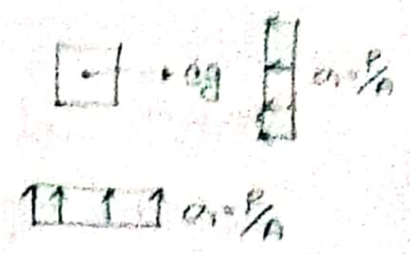
$$(\Sigma F_x = 0,\ \Sigma F_y = 0,\ \Sigma M = 0)$$

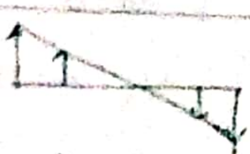
Indeterminent structure:

* concrete → very strong in compression
→ " weak " tension

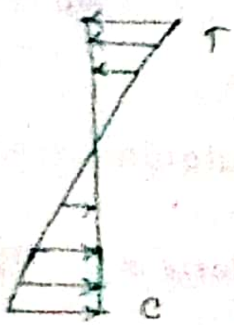
Sign convention for bending moment:

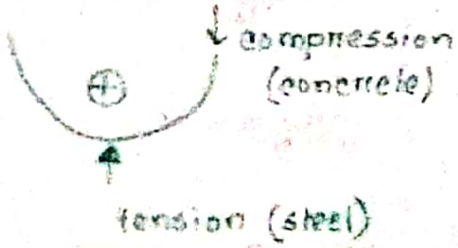






একই সাথে com, ten থাকতে পারবে;

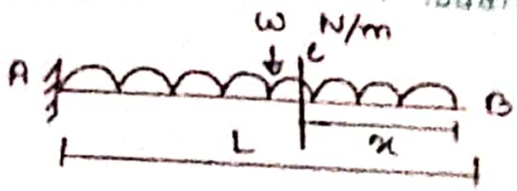




simple supported beam
- tension - নাই
- bending moment → ⊕

* shear stress
- bending stress
  - sign important
    - ⊕ → tension নাই তাহলে ফাটবে
      → reinforce নাই দিব

bending moment → sum of all moments
normal moment → sum of loading moments



$\Sigma F_y = 0$

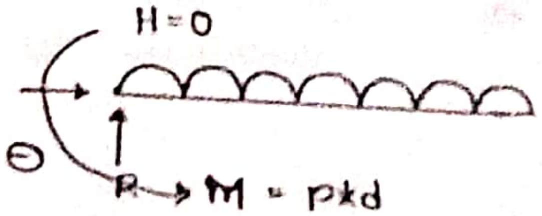
$\Rightarrow R - \omega L = 0$

$\Rightarrow R = \omega L$

$\Sigma M_A = 0$

$\Rightarrow -M + \omega L \times L/2 = 0$

$\Rightarrow M = \dfrac{\omega L^2}{2}$



$M = p \times d$

① Calculation of shear force:

consider any section C, at a distance x from B.

Consider right portion of the section.

Idal ver. $V_x = \omega * x$

At B,

$x = 0$

$V_B = \omega * 0 = 0$

At A,

$x = L$

$V_A = \omega * L = \omega L$

Shear force and bending moment diagram draw

② Calculation of bending moment:

Consider right portion.

Magnitude ⟶

$M_x = -\omega * x * x/2$

Sign ⟶

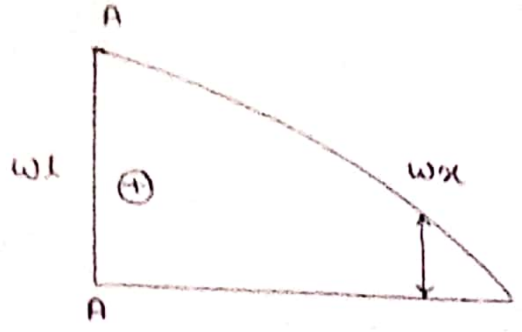
$= ⊖ \omega x^2/2$

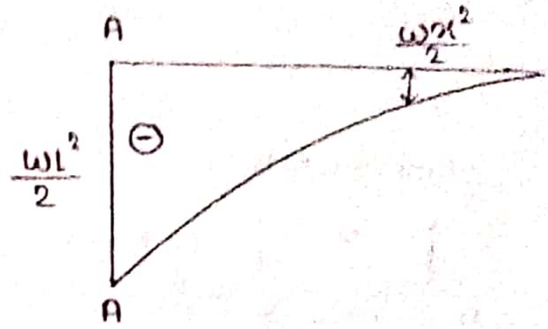
(tension upper side)
cantilever ⟶ ⊖

At B, $x = 0$, $M_B = 0$

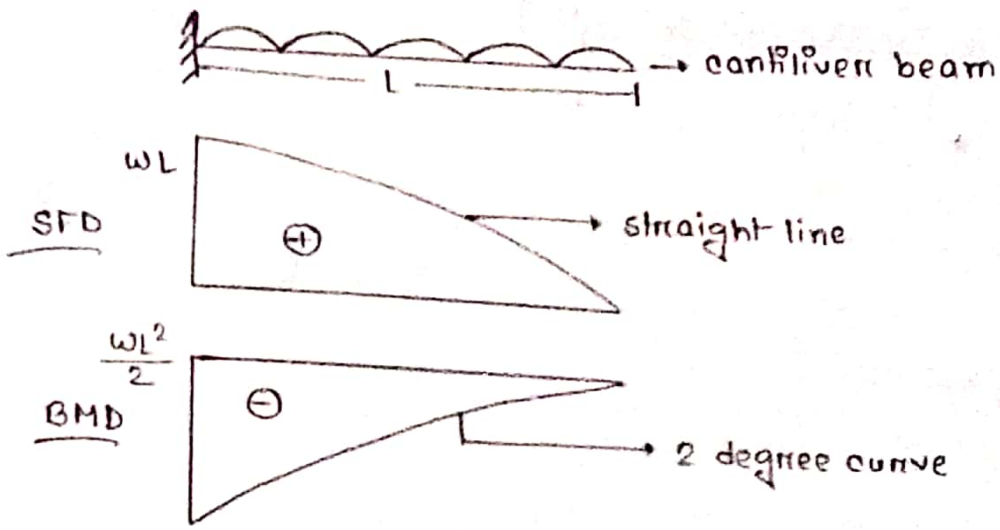
At A, $x = L$, $M_A = -\dfrac{\omega L^2}{2}$

SFD and BMD:





(ii)



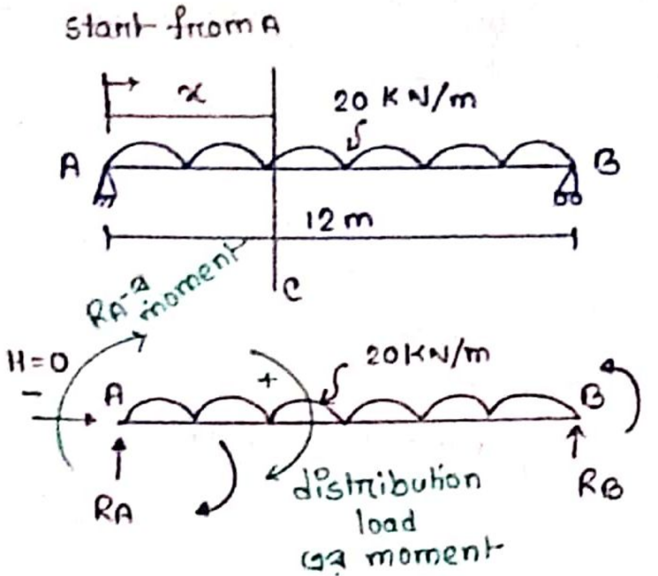
$M_x = \frac{wx^2}{2}$

$V_x = wx$

Mithun Sir

Draw SFD and BMD for the simply supported beam shown in Fig.

⇒



BMD

$\Sigma M_A = 0$

$\Rightarrow 20 \times 12 \times \frac{12}{2} - R_B \times 12 = 0$

$\Rightarrow R_B = 120\ KN$

$\Sigma F_y = 0$

$\Rightarrow R_A + R_B - 240 = 0$

$\Rightarrow R_A = 120\ KN.$

Consider any section C at distance x from A.

Consider left porsion.

Shear force $\begin{cases} \text{For left portion} \longrightarrow \text{upward} \longrightarrow (+) \\ \text{For right "} \longrightarrow \text{"} \longrightarrow (-) \end{cases}$

Shear force :

$V_x = R_A - \omega x$

$\Rightarrow V_x = 120 - 20 * x$

At A, $x = 0 \longrightarrow V_A = 120 - 20 * 0 = 120$ KN

At B, $x = 12 \longrightarrow V_B = 120 - 20 * 12 = -120$ KN

Location of 0 shear force;

$V_B = 0 = 120 - 20 * x$

$\Rightarrow x = \frac{120}{20}$

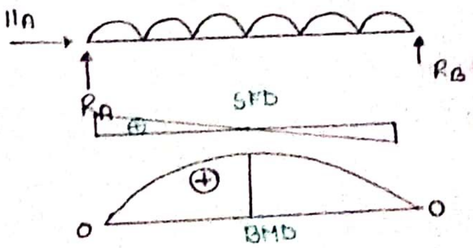
$= 6$ m

Bending Moment:

$M_x = R_A * x - (\omega * x) * x/2$

$x = 0 \longrightarrow M_A = 0$

$x = 12 \longrightarrow M_B = 120 * 12 - (20 * 12) * 12/2 = 0$ $\left\{ M_x = R_A x - \frac{\omega x^2}{2} \right\}$



where shear force is zero, bending moment is maximum.

At $x = 6$, $V = 0$, $M = M_{max} = 360$ KN-m.

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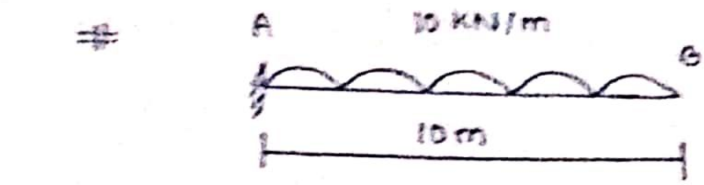
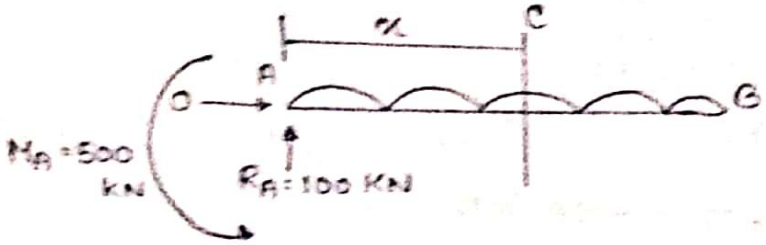
cantilever এ generally right থেকে শুরু করতে সুবিধা
(কারণ বামদিকের load কম থাকে, ডানদিকের থেকে শুরু করলে সুবিধা)





SFD:

Consider any section C at a distance x from point A
Consider left portion.

$$\therefore V_x = R_A - \omega x$$

$$= 100 - 10 * x$$

At A, $x = 0 \longrightarrow V_A = 100$ KN

At B, $x = 10 = L \longrightarrow V_B = 0$ KN

BMD:

point load হওয়ায় x এর উপর vary করবে না

$$M_x = -500 + 100 * x - \frac{\omega x^2}{2}$$

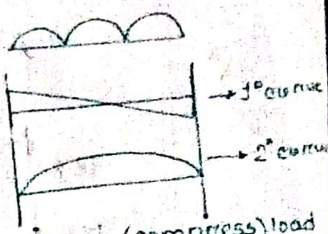
At A, $x = 0$, $M_A = 500$ KN/m

At B, $x = L = 10$ m, $M_B = 0$

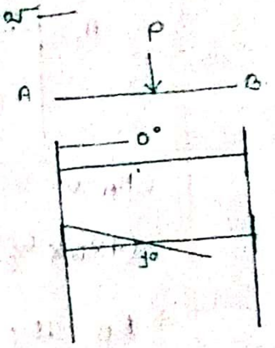
26/02/2020

Mithun Sir

যদি distributed load হয়—

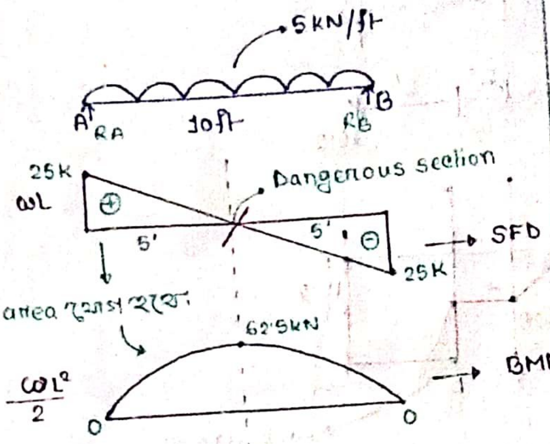


যদি shear (compress) load হয়—



4) Draw SFD and BMD:

$-\frac{1}{2} \times 5 \times 25$ = Area



এই section এর moment ই হবে bending moment
left or right section নি

$\Sigma M_A = 0$

$\Rightarrow 5 \times 10 \times 5' - R_B \times 10' = 0$

$\Rightarrow R_B = 25$ KN

$\Sigma F_y = 0$

$\Rightarrow R_A + R_B - 5 \times 10 = 0$

$\Rightarrow R_A = 25$ KN

$x = L \longrightarrow V_A = P$

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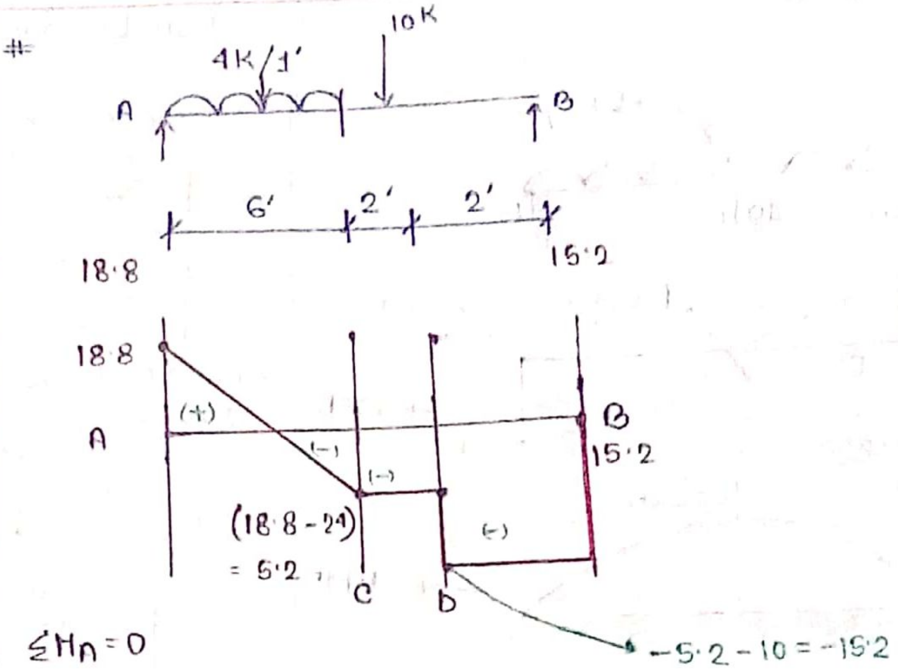


$\Sigma M_A = 0$

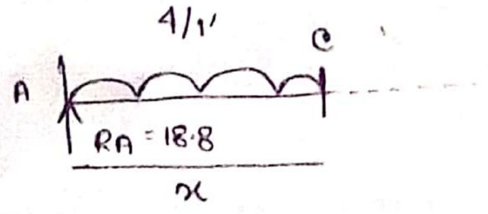
$\Rightarrow (4\times6)\times \frac{6}{2} + 10\times8 - R_B\times10 = 0$

$\Rightarrow R_B = 15.2$ K

$\Sigma F_y = 0$

$\Rightarrow R_A + R_B - 4\times6 - 10 = 0$

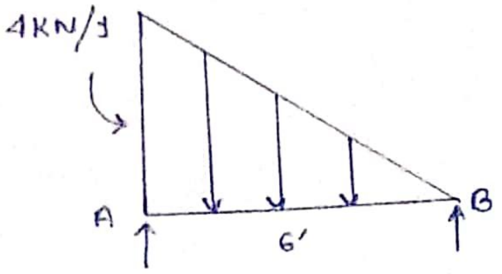
$\Rightarrow R_A = 18.8$ K

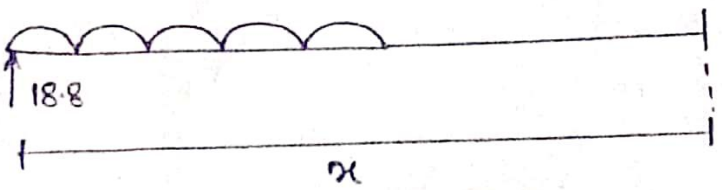


$V = 18.8 - 4\times x$

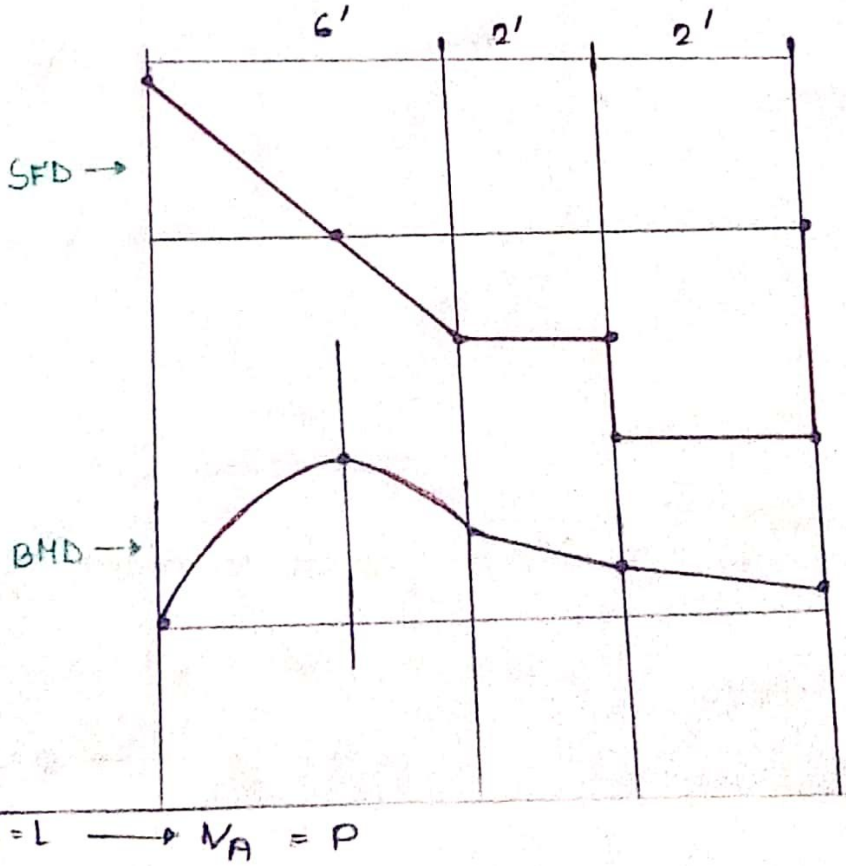
$x = 0 \rightarrow$

$x = 6 \rightarrow$





$V = 18.8 - 24 \longrightarrow$ variation নেই (x নেই)



$x = L \longrightarrow V_A = P$

02/03/2020

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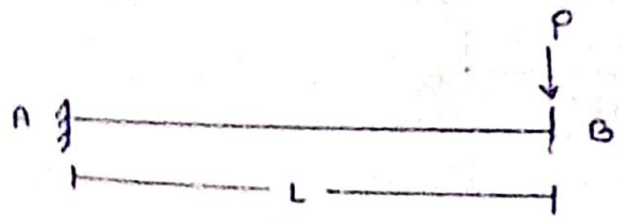
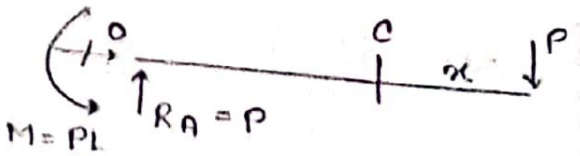


Draw SFD and BMD for the cantilever beam.

⇒



$\Sigma M_A = 0$

$\Rightarrow P \times L = 0$

$\Rightarrow PL = M$

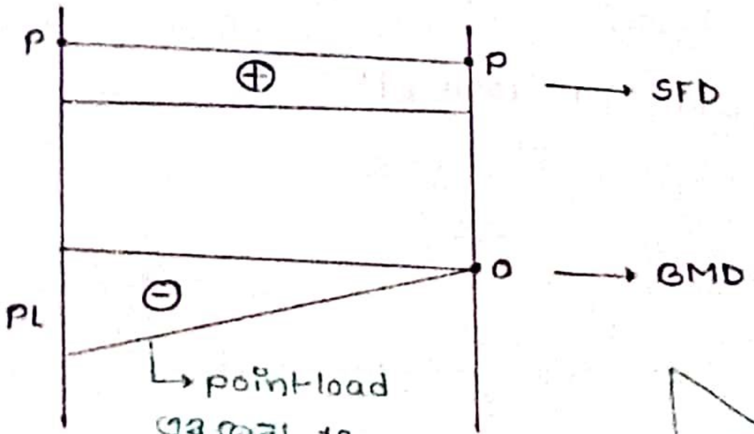
$\Sigma F_y = 0$

$\Rightarrow R_A = P$

Consider any section c at a distance x. from B.

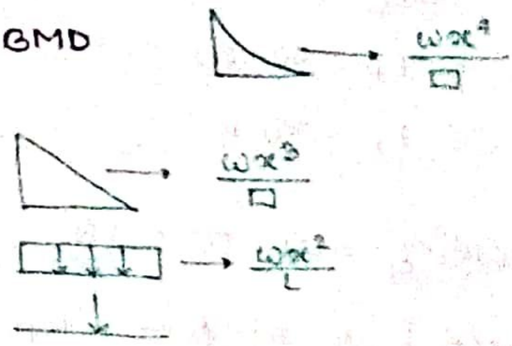
Shear force at c (consider right portion):

$V_x = P$ [downward ⊕]



↳ point load
এর জন্য 1°

↳ distributed load
হলে 2°



Bending moment at any section c. [For right portion → clockwise ⊕]

$M_x = -Px$

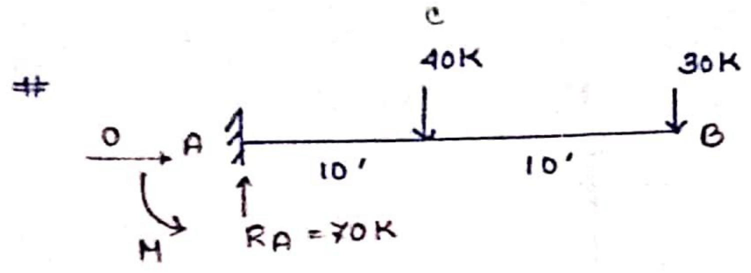
when $x = 0$, $M_B = 0$

$x = L$, $M_A = -PL$

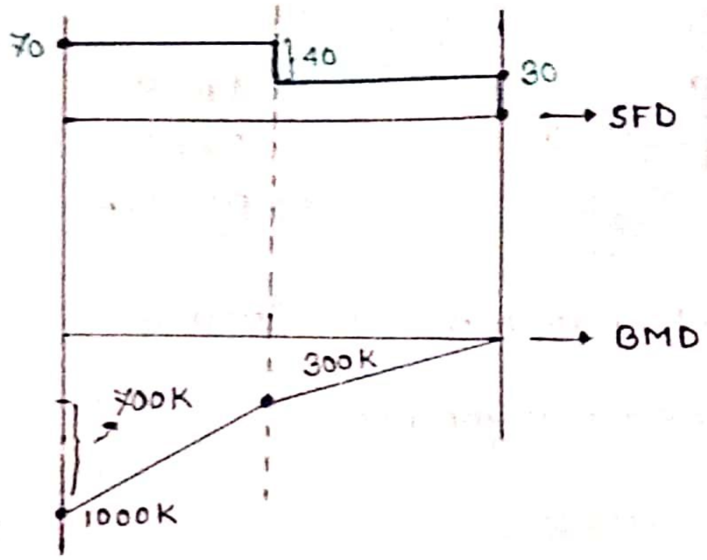
when $x = 0 \longrightarrow V_B = P$

$x = L \longrightarrow V_A = P$

#



Draw SFD and BMD.



(Point load এর জায়গাগুলোতে Shear force বের করতে হবে।
A, C, B

For SFD:

$\Sigma M_A = 0$

$\Rightarrow -30 \times 20' - 40 \times 10' = M \Rightarrow M = 1000$ kft

$\Sigma F_y = 0$

$\Rightarrow R_A = 40 + 30$

$\Rightarrow R_A = 70$ K.

Starting from point A.

Shear force at A $\longrightarrow R_A = V_A = 70$ K.

" " " C $\longrightarrow V_C = 70 - 40 = 30$ K.

" " " B $\longrightarrow V_B = 70 - 40 - 30 = 0$ K.

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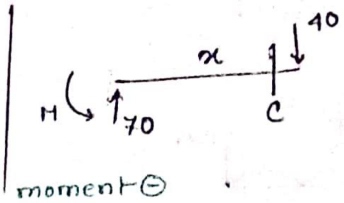
For BMD: (right থেকে শুরু করলে সহজ)

BM betn A and C:



(Consider left portion)
└→ anti-clockwise moment ⊖

$M_x = -M + R_A * x$ [Moment at C]

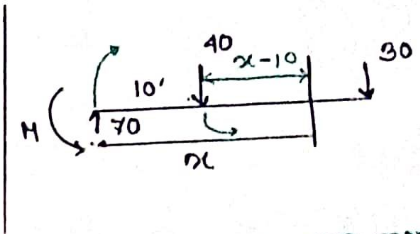
$A \rightarrow x = 0 \longrightarrow M_A = -M = 1000$ kft

$C \rightarrow x = 10 \longrightarrow M_C = -1000 + 70 \times 10 = -300$ kft

$\Big\}.$ $x = 10 \sim 20$

BM at any point betn C and B:

(Consider left portion)



$M_x = \underbrace{-M + R_A \times x}_{(x \leq 10')} - 40 * \underbrace{(x-10)}$

→ এর value ⊖ হলে 40k এর moment ও— হিসেবে নেয়া যাবে না, পুরোটার জন্য একটা general eqn তৈরি হবে

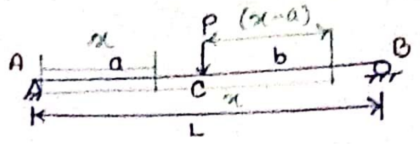
Assignment

#

#

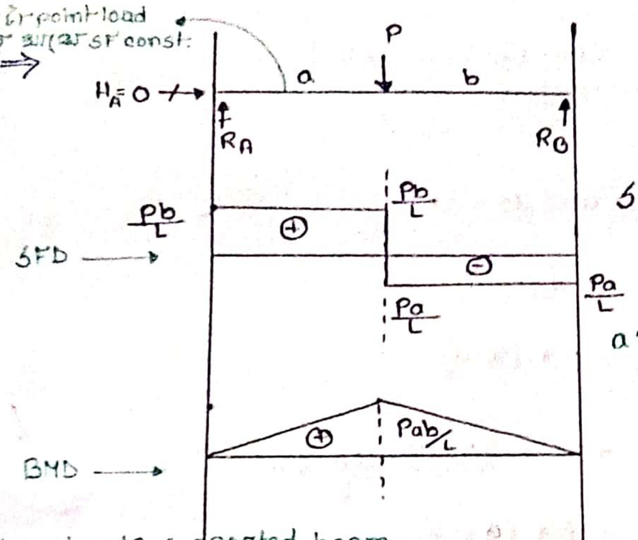
#

03/03/2020



Draw SFD and BMD for this beam.

যেটা point load এর আগে SF const.



$\Sigma M_A = 0$

$\Rightarrow P \times a - R_B \times L = 0$

$\Rightarrow R_B = \frac{Pa}{L}$

Similarly,

$R_A = \frac{Pb}{L}$

a বাড়বে → R_B বাড়বে

For simple supported beam.
যেখানে point আছে, BMD-তে সেখানে একটা peak point পাব / peak value পাব।

SF at any section betn A and C →

$V_x = R_A$

at A → $x = 0$, $V_x = R_A$

at C → $x = a$ $V_a = R_A$

SF at any section betn C and B →

$V_x = R_A - P$

BM at any section betn A and C ⟶

$$M_x = R_A * x$$

$$= \frac{Pb}{L} * x$$

$x = 0 \longrightarrow M_A = 0$

$x = a \longrightarrow M_C = \frac{Pab}{L} \longrightarrow$ Max bending moment at load point.

BM at any point betn C and B ⟶

$$M_x = R_A * x - P * (x-a)$$

$$= \frac{Pb}{L} * x - P * (x-a)$$

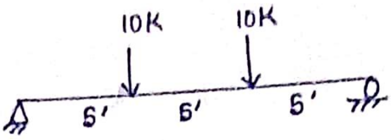
$x = a \longrightarrow M_B = \frac{Pb}{L} * a - P * (a-a) = \frac{Pb}{L} * a$

$x = L \longrightarrow M_L = \frac{Pb}{L} * L - P * (L-a)$

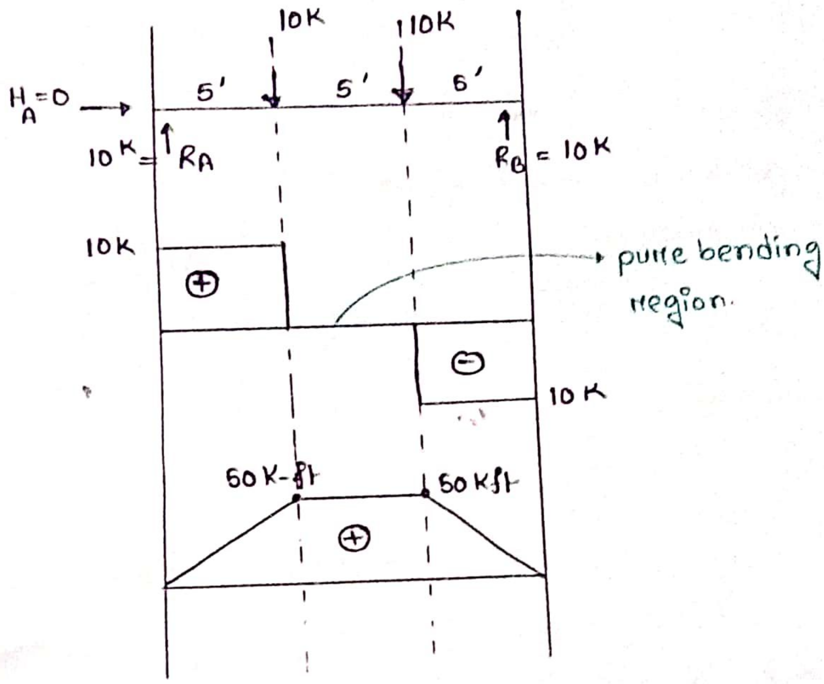
$$= Pb - Pb$$

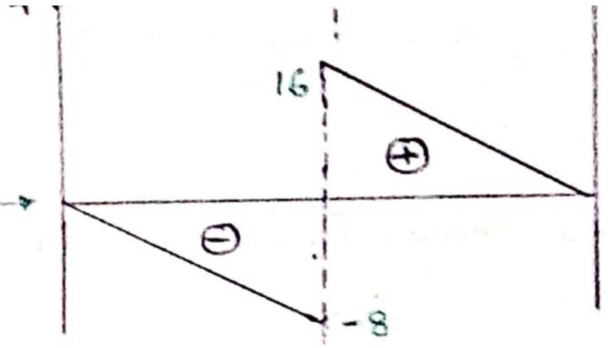
$$= 0$$

[1]



Draw SFD and BMD for the beam.





SF at any section betn A and B →
(considering left)

$$V_x = -R_A = -4$$

SF at any section betn B and C →

$$V_x = -R_A = -4$$

BM betn At any point betn A and B →

$$M_x = -R_A * x$$ (left, anti clockwise)

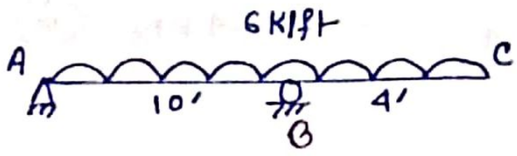
At A → $x = 0$ → $M_A = 0$

At B → $x = 2$ → $M_B = -8$ kN-m

BM at any point betn B and C →

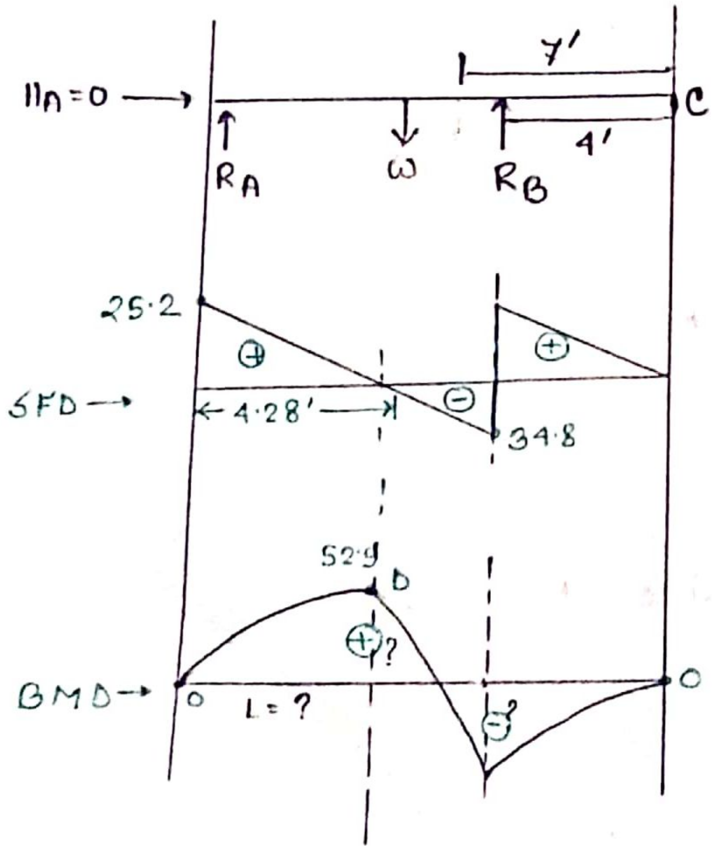
$$M_x = -R_A * x + 24$$

$x = 6m \longrightarrow M = 0$

\# 

(overhanging beam)

An overhanging beam is loaded at shown in figure. Draw SFD and BMD.



$\Sigma M_A = 0$

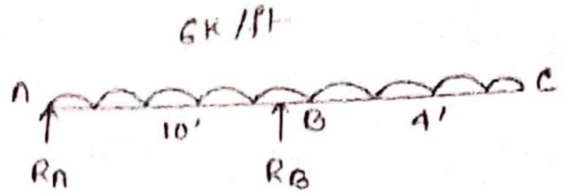
$\Rightarrow (6 \times 14) \times 7 - R_B \times 10 = 0$

$\Rightarrow R_B = 58.8\,K$

$\Sigma F_y = 0$

$\Rightarrow R_A + R_B - 6 \times 14 = 0$

$\Rightarrow R_A = 25.2\,K.$



$R_A = 25.2K$

$R_B = 58.8K$

SF

Shear force at any section betn A and B:
(Considering left portion)

$V_x = R_A - \omega x \qquad (x < 10')$

$= 25.2 - 6 * x$

$x = 0 \longrightarrow V_A = 25.2 - 6 * 0 = 25.2\ K.$

$x = 10' \longrightarrow V_{BL} = 25.2 - 6 * 10 = -34.8\ K.$
(just left)

Shear force betn B and C:

$V_{xR} = R_A - \omega x + R_B \rightarrow (x \geq 10') \longrightarrow x = 10' \sim 14'$
(just right)

(consentrated load-এ sharpe change হচ্ছে

location of zero shear force. (betn A and B)

$V = 0 = 25.2 - 6x$

$\Rightarrow x = 4.28'$ (point D)

$M_x = R_A * x - wx * \frac{x}{2}$ $(x < 10')$

$M_A = 0$

$M_{max} = M_{4.28'} = M_D = 25.2 * 4.28 - 6 * \frac{4.28^2}{2}$

$= 52.9$ kft

$x = 10' \longrightarrow M_B = -48$ kft

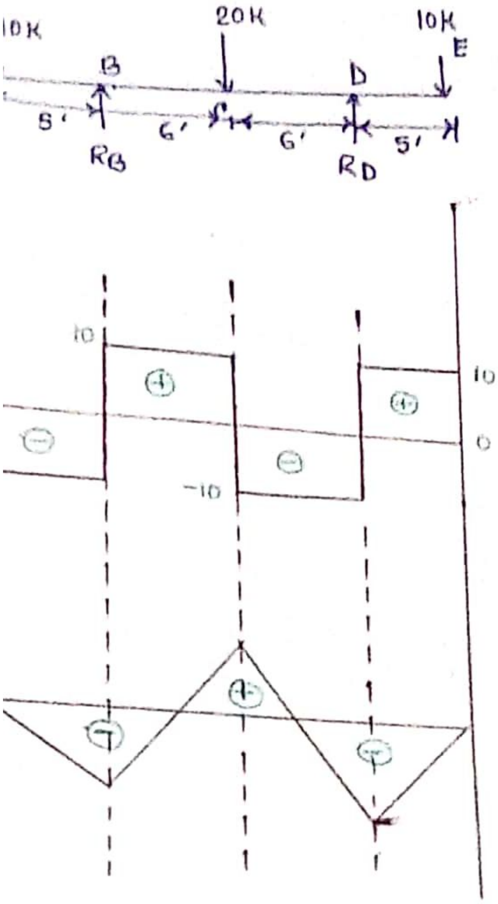
BM at any section betn B and C:

$M_x = R_A * x - R_B * (x-10) - \frac{wx^2}{2}$

$= 25.2x - 58.8(x-10) - \frac{6}{2}x^2$

Scanned by CamScanner

Draw SFD and BMD:



→ symmetrically loaded beam.

(Reaction গুলো সমান হবে)

$R_B = R_D = 20$ kips.

$\Sigma M_B = 0$

$\Rightarrow 20 * 6 + 10 * 7 - 10 * 5 - R_D * 12 = 0$

$\Rightarrow R_D = 20K.$

$\Sigma F_y = 0$

$R_B + R_D - 10 - 20 - 10 = 0$

$\Rightarrow R_B = 20K.$

BM

${}_L M_B = ? \quad = 10 * 5 \quad = -50$ kft

${}_L M_C = ? \quad = -10 * 11 + 20 * 6 = 10K$

${}_R M_D = ? = -10 * 5) = -50$ kft

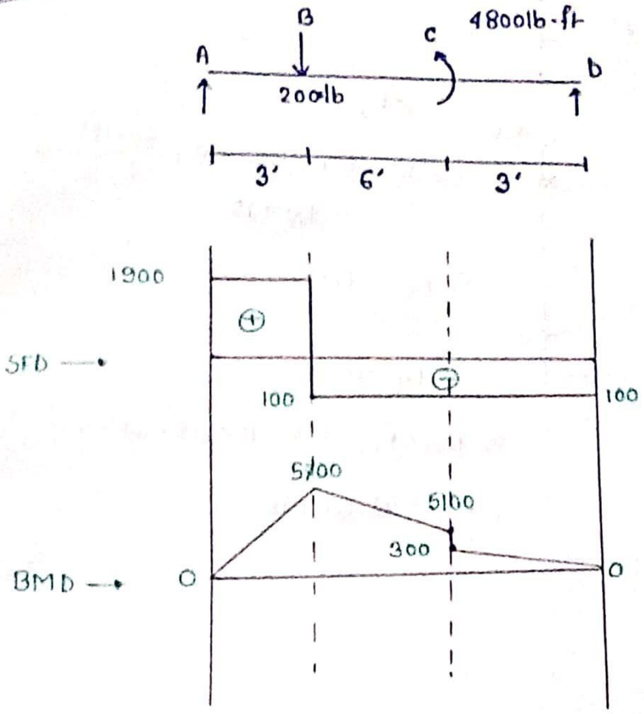
Portion consider

${}_L M_D = -10 * 17 + 20 * 12 - 20 * 6$

$= -50$ kft

14/03/2020

Q) Draw SFD and BMD:



$\Sigma M_A = 0$

$\Rightarrow 2000 \times 3 - 4800 - R_D \times 12 = 0$

$\Rightarrow R_D = 100$ lb

$\Sigma F_y = 0$

$R_A - 2000 + R_D = 0$

$\Rightarrow R_A = 1900$ lb

$V_A = 1900$lb, $V_B = 1900 - 2000$
$= -100$ lb

For BMD →

$M_A = 0$

$M_D = 0$

Left → $M_C = -4800$

Left → $M_B = R_A * 3 = 1900 * 3 = 5700$ lb-ft

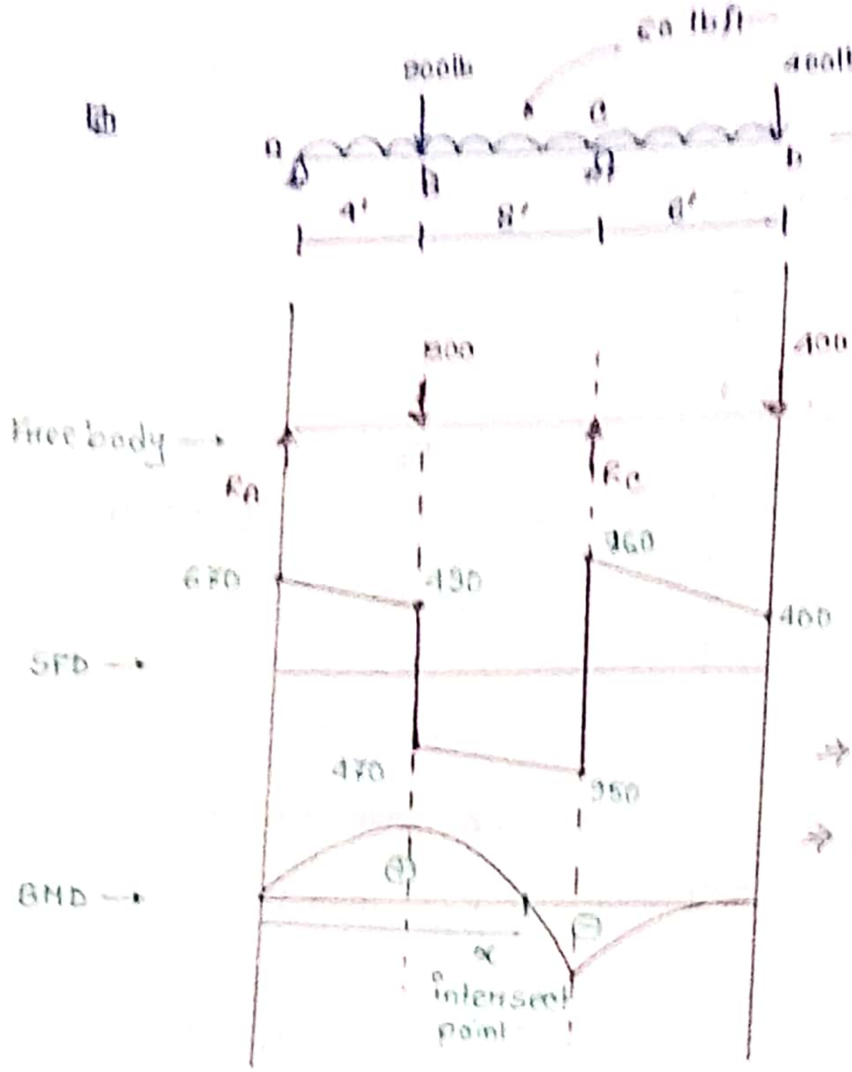
Right → $M_B = R_D * 9 + 4800 = 5700$ lb-ft

Right → $M_C = R_D * 3 = 300$ lb-ft

Left → $M_C = R_A * 9 - 2000 * 6 = 5100$ lb-ft

Shape change হবে (applied moment থাকলে)

4b



overhanging beam

$\frac{wl^2}{2}$

$\Sigma M_A = 0$

$\Rightarrow 900*4 + 400*18 + \frac{60*18^2}{2} - R_C*12 = 0$

$\Rightarrow R_C = 1710$ lb

$\Sigma F_y = 0$

$\Rightarrow R_A + R_C - 900 - 400 - 18*60 = 0$

$\Rightarrow R_A = 670$ lb

SF:

Shear force at any section betn A and B →

(left) $V_{AB} = R_A - 60 * x$

$x = 0 \longrightarrow V_A = R_A = 670$ lb

$x = 4' \longrightarrow V_B = 670 - 60*4 = 430$ lb

BC (left):

$V_{BC} = R_A - 60*x - 900$

$x = 4' \longrightarrow V_{B(\text{for BC portion})} = 670 - 240 - 900 = -470$ lb

$x = 12' \longrightarrow V_C = 670 - 60*12 - 900 = -950$ lb

CD (left)

$V_{CD} = 670 - 900 - 60 * x + 1710$

$x = 12' \longrightarrow V_C = 760\,lb$

$x = 18' \longrightarrow V_D = 400\,lb$

BM:

BM at any point betn A and B:

$M_{AB} = M_x = R_A x - \frac{\omega x^2}{2}$

$x = 0, \quad M_A = 670 * 0 - \frac{60 * 0^2}{2} = 0$

$x = 4, \quad M_B = 670 * 4 - \frac{60 * 4^2}{2} = 2200\ lb.ft$

BC: $M_{BC} = 670x - 900(x-4) - \frac{60x^2}{2}$

$x = 4, \quad M_B = 2200\,lb\,ft$

$x = 12, \quad M_C = -3480\ lb.ft$

CD:

$M_{CD} = -400x - 30x^2$ (Right)

$x = 0, \quad M_D = 0$

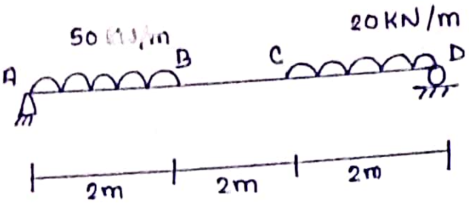
$x = 6, \quad M_C = -3480\ lb.ft$

here,

$M_{BC} = 0$ হলে x এর মান পাব, যেখানে intersect করবে,

where, $x > 4$

$x < 12$


50
20 KN/m
A
B
C
D
2m
2m
2m

iii