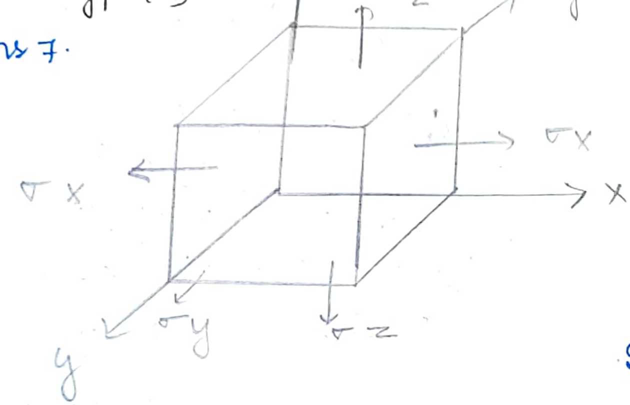
Ans 7.



element subjected to volumetric stress -

$$\underline{\underline{\varepsilon x}} = \frac{\sigma x}{E} - \frac{\mu \sigma y}{E} - \frac{\mu \sigma z}{E} \quad (1)$$

$$\sigma = \sigma x = \sigma y = \sigma z$$

Similarly, for y-axis

$$\mu = \frac{\varepsilon La}{\varepsilon Lo} \Rightarrow \varepsilon La = \varepsilon Lo\,\mu \Rightarrow \varepsilon La = -\mu\left(\frac{\sigma y}{E}\right) \quad (2)$$

For z-axis, $\varepsilon La = -\frac{\mu \times \sigma z}{E}$ — (3)

$\therefore$ Total deformation in x-axis $= \frac{\sigma x}{E} - \frac{\mu \sigma y}{E} - \frac{\mu \sigma z}{E} \Rightarrow \frac{1}{E}(\sigma x - \mu \sigma x - \mu \sigma z)$

similarly for y-axis, Total deformation $= \frac{1}{E}(\sigma y - \mu \sigma x - \mu \sigma z)$

for z-axis, total deformation $= \frac{1}{E}(\sigma z - \mu \sigma y - \mu \sigma x)$

$\therefore$ Total deformation along each axes $= \frac{\sigma}{E}(1 - 2\mu)$

$\Rightarrow$ Total deformation along all axes $= \frac{3\sigma}{E}(1 - 2\mu)$ — (4)

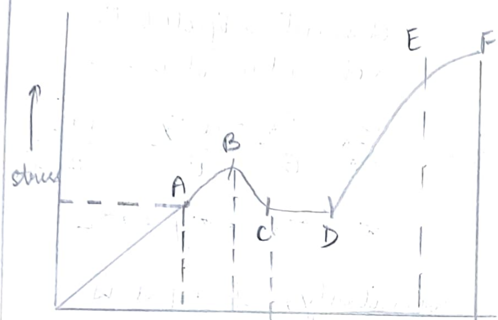
We know that, Bulk modulus $(K) = \frac{\text{vol. stress}}{\text{vol. strain}}$

In eqn (4), $\left[\begin{array}{l}\text{Total deformation} \\ \text{along all axes}\end{array} = \text{volumetric strain}\right]$

$\therefore$ volumetric strain $= \frac{3\sigma_v}{E}(1-2\mu)$

$\Rightarrow \boxed{E = 3K(1-2\mu)}$, where K = bulk modulus

Q6. Type (B).



(i) Low carbon / mild steel (0·25–0·45%)

(I) Point A = limit of proportional.
i.e. within this limit (stress & strain) as per Hook's law $\Rightarrow \left(E = \frac{\sigma}{\epsilon}\right)$

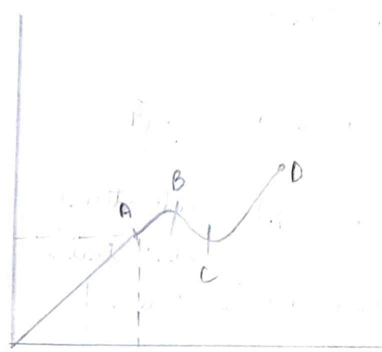
(II) Point B = Elastic limit i.e. only upto this point the material shows elasticity.

(III) Point C = Yeild point (upper): At this point, the strain constantly increases without any stress i.e. plastic deformation is consistent.

(IV) Point D = Lower Yield point: After this point the stress in increased rapidly.

(V) Point E = Ultimate Tensile Strength i.e. the max load the material can bear.

(ii)



High carbon / Brittle material (0·45 – 2%)

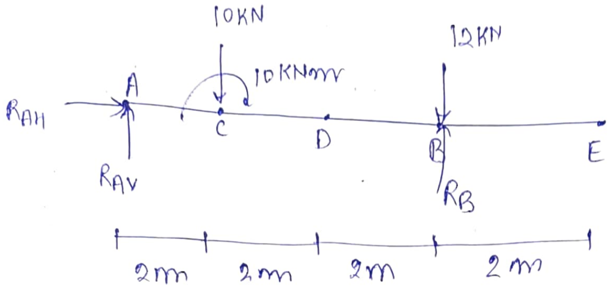
Point A = approximate limit of proportionality

B = elastic limit

C = Yield point

D = UTS = Fracture point

Type (c)



We know that in equilibrium, $\Sigma F_x = 0, \Sigma F_y = 0, \Sigma M = 0$

(i) $\Sigma F_x = 0$

$\therefore \boxed{R_{AH} = 0\,KN}$

(ii) $\Sigma M_A = 0$

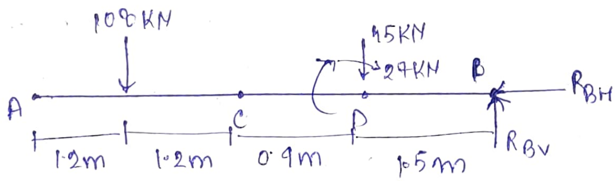
$\Rightarrow 10(2) + 10 + 12(6) - R_B(6) = 0$

$\Rightarrow 20 + 10 + 72 - 6R_B = 0 \Rightarrow \boxed{R_B = \frac{102}{6} = 17\,KN}$

(iii) $\Sigma F_y = 0$

$\Rightarrow R_{AV} - 10 - 12 + R_B = 0 \Rightarrow \boxed{R_{AV} = 22 - 17 = 5\,KN}$

Q4.



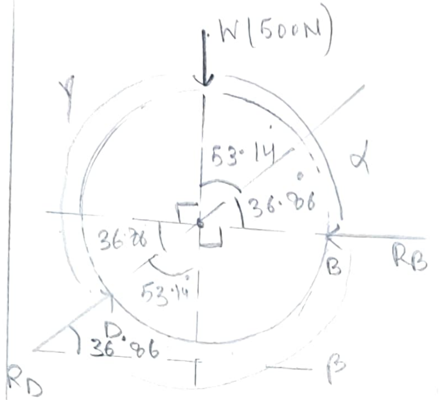
(i) $\Sigma F_x = 0 \Rightarrow -R_{BH} = 0 \Rightarrow \boxed{R_B = 0\,KN}$

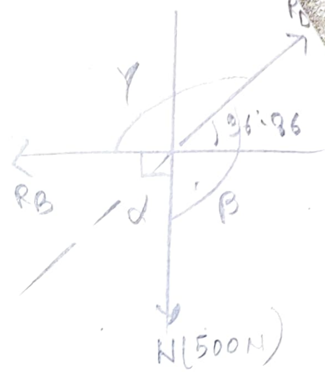
(ii) $\Sigma F_y = 0$

$\Rightarrow -108 - 45 + R_{BV} = 0$

$\Rightarrow \boxed{R_{BV} = 153\,KN}$

Q10. ## For ball Q





$\alpha = 90°$

$\beta = 126.86°$

$\gamma = 143.14°$

$$\frac{W}{\sin\gamma} = \frac{R_B}{\sin\beta} = \frac{R_D}{\sin\alpha}$$

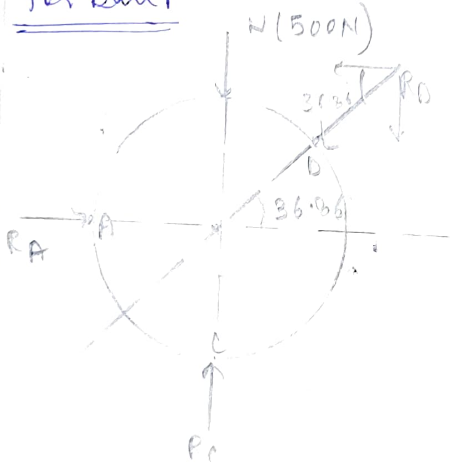
$$\therefore \frac{500}{0.599} = \frac{R_B}{0.800}$$

$$\Rightarrow \boxed{R_B = 667.77 KN}$$

$$\Rightarrow \frac{500}{0.599} = \frac{R_D}{1}$$

$$\Rightarrow \boxed{R_D = 834.72 KN}$$

For Ball P



$\Sigma F_x = 0$

$\Rightarrow -R_D \cos 36.86° = 0$
$+ R_A$

$\Rightarrow R_A = (834.72)\,0.800$

$\Rightarrow \boxed{R_A = 667.86 KN}$

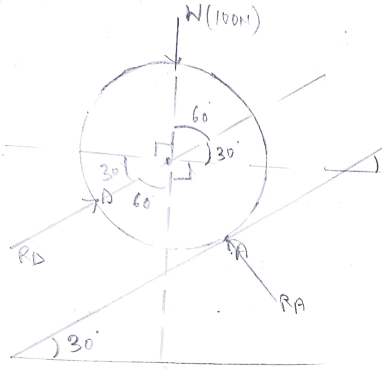
$\Sigma F_y = 0$

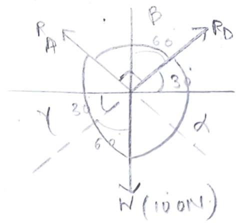
$\Rightarrow -W + R_C - R_D \sin 36.26° = 0$

$\Rightarrow R_C = 500 + 500.71$

$= \boxed{1000.71 KN}$

For Ball P





$\alpha = 90° + 30° = 120°$

$\beta = 90°$

$\gamma = 150°$

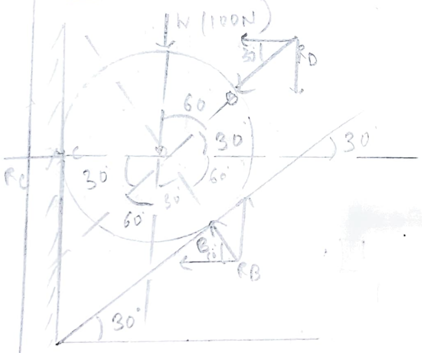
$$\frac{W}{\sin\beta} = \frac{R_D}{\sin\gamma} = \frac{R_A}{\sin\alpha}$$

$$\Rightarrow \frac{100}{1} = \frac{R_D}{0.5} \Rightarrow \boxed{R_D = 50N}$$

$$\Rightarrow \frac{100}{1} = \frac{R_A}{0.866}$$

$$\Rightarrow \boxed{R_A = 86.6N}$$

For Ball Q



(i) $\Sigma F_x = 0$

$\Rightarrow R_C - R_D \cos 30° - R_B \cos 60° = 0$

$\Rightarrow R_C = 43.3012 + R_B \cos 60$ —— ①

(ii) $\Sigma F_y = 0$

$\Rightarrow -W + R_B \sin 60° - R_D \sin 30° = 0$

$\Rightarrow R_B (0.866) = 25 + 100$

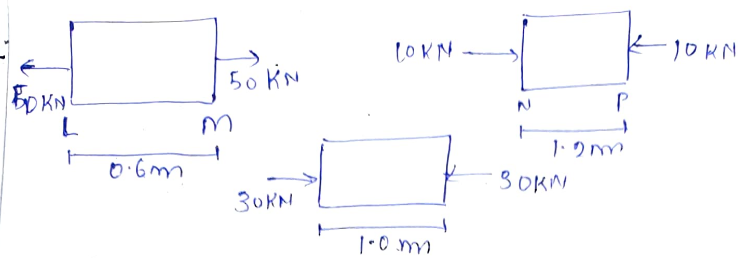
$\Rightarrow \boxed{R_B = 144.34N}$

putting this value in eq^n ①,

$\Rightarrow R_C = 43.3012 + 72.17$

$\boxed{R_C = 115.471N}$

Q12.



$A = 1000\,mm^2$

$E = 10^{11}\,N/m^2 = \frac{10^{11}}{10^6} = 10^5\,N/mm^2$

Ans12. $\delta(l) = \frac{1}{EA}\left(P_1 l_1 + P_2 l_2 + P_3 l_3\right)$

$= \frac{1}{10^5 \times 10^3}\left[\left(50\times10^3(0.6\cdot10^3)\right) + \left(-30\cdot10^3\cdot 1\times10^3\right) + \left(-10\cdot10^3\cdot(1.2)\cdot10^3\right)\right]$

$= \frac{10^6}{10^8}\left(\cancel{30} - \cancel{30} - 12\right) = (-12)\times10^{-2}$

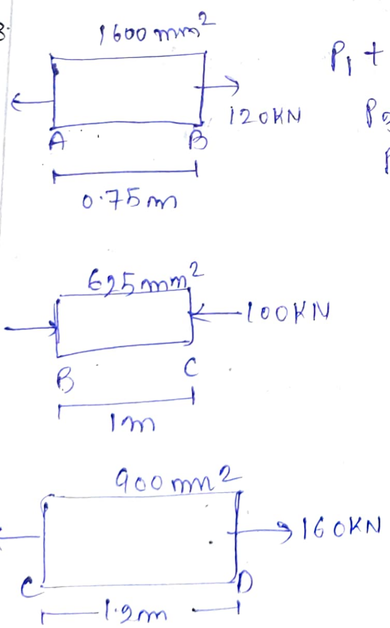
$= \boxed{0.12\,mm}$

(i) $\sigma = \frac{P}{A} = \frac{50\times\cancel{10^3}}{\cancel{10^3}} = \boxed{50\,N/mm^2}$

(ii) $\sigma = \frac{30\times\cancel{10^3}}{\cancel{10^3}} = \boxed{30\,N/mm^2}$

(iii) $\sigma = \frac{P}{A} = \frac{10\times\cancel{10^3}}{\cancel{10^3}} = \boxed{10\,N/mm^2}$

13.



$P_1 + P_3 = P_2 + P_4$

$P_3 = 380 - 120$

$P_3 = \underline{\underline{260\,KN}}$

where $P_1 = 120\,KN$

$P_2 = 220\,KN$

$P_4 = 160\,KN$

$E = \frac{2\times10^{11}}{10^6} = 2\times10^5\,N/mm^2$

$\delta(l) = \frac{1}{E}\left(\frac{120\cdot10^3\cdot 0.75\cdot10^3}{1600} + \frac{100\cdot10^6\cdot 1}{625} + \frac{160\cdot10^6\cdot 1.2}{900}\right)$

$= \frac{10^6}{2\cdot10^5}\left(0.05 - 0.16 + 0.21\right)$

$= \frac{1}{20}(0.42) = \underline{\underline{0.0213\,mm}}$