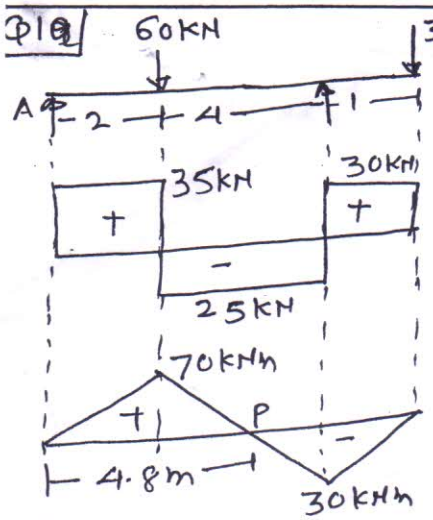
Class Test: T_1 Strength of Material (CVUA 2174): Solution

Date 10/10/18

U218-114(T1)

Q1a



$\Sigma F_y = 0$

$R_A + R_C = 90$

$\Sigma m_{cA} = 0$

$60 \times 2 + 30 \times 7 = 6R_C$

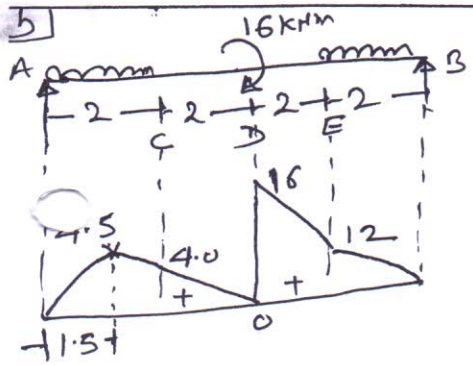
$R_C = 55$ kN

$R_A = 35$ kN } (2)

SFD -- (2)

BMD -- (2)

b



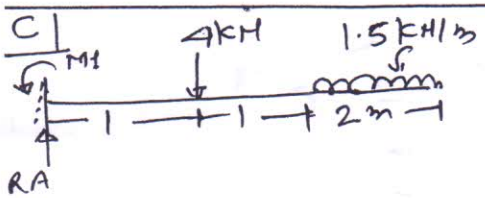
$R_A = 6$ kN

$R_B = 10$ kN } (1)

All correct - 5

Value of BM -- (5)

c



$\Sigma F_y = 0$

$R_A = 7$ kN ↑

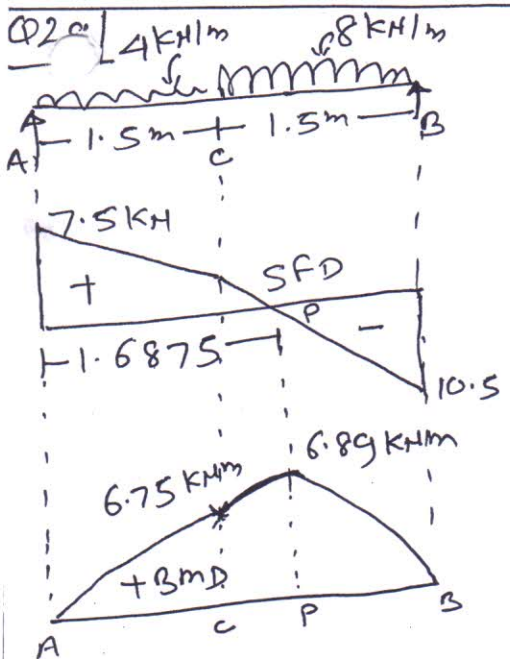
$\Sigma M_{cA} = 0$

$M_f = 13$ kNm

S.F. at $V_{0.5} = R_A = 7$ kN --- (2)

$BM_C = -13 + R_A \times 0.5 = -9.5$ kNm — (2)

Q2a

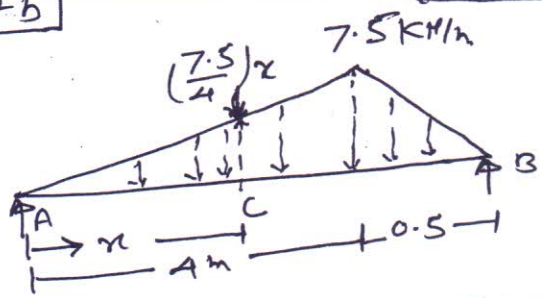


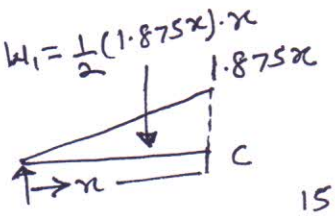
Reaction -- (2)

SFD --- (2)

BMD -- (2)

Q2b





$\Sigma F_y = 0$

$R_A + R_B = 16.875$ kN

$\Sigma m_{eA} = 0$

$15 \times \frac{2}{3}(4) + 1.875(4 + \frac{0.5}{3}) = 4.5 R_B$

$R_B = 10.625$ ↑

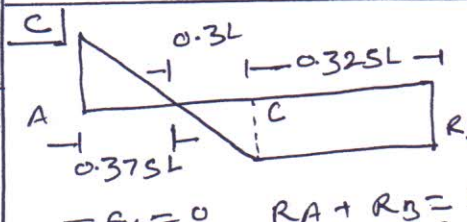
$R_A = 10.625$

S.f. is zero at C

$R_A - \frac{1}{2}(\frac{7.5}{4})x \cdot x = 0$, $\boxed{x = 2.58\text{m}}$

Reaction -- (2), $\boxed{x = 2.58\text{m}}$ -- (2)

c



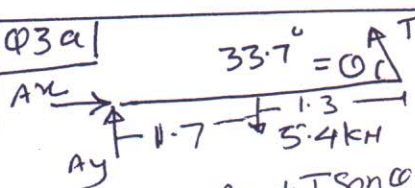
$\Sigma F_y = 0$, $R_A + R_B = \frac{0.675wL}{2}$

$\Sigma m_{eA} = 0$ $w(\frac{0.675wL}{2}) = L R_B$

$R_B = 0.2278 wL$ ---- (2)

$R_A = 0.4472 wL$ --- (2)

Q3a



$\Sigma F_y = 0$, $A_y + T \sin\theta = 5.4$

$\Sigma m_{eA} = 0$ $5.4 \times 1.7 = 0.5548 T \times 3$

$\boxed{T = 5.51\text{kN}}$ --- (3)

$\sigma = \frac{P}{A}$ $\therefore A = \frac{\pi}{4} d^2 = \frac{5.51 \times 10^3}{125}$

$\boxed{d = 7.50\text{mm}}$ -- (3)

b i) dia for stress $\sigma = P/A$

$\frac{\pi}{4} d^2 = \frac{10 \times 10^3}{160}$, $\boxed{d = 8.92\text{mm}}$ — (1)

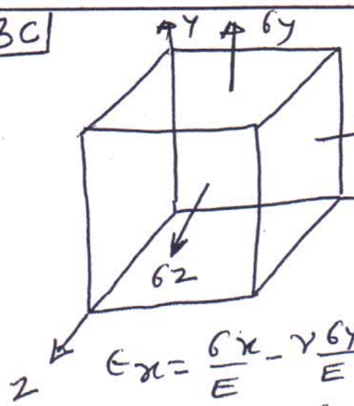
ii) dia for strain

$\delta = \frac{PL}{AE}$ $\therefore A = \frac{\pi}{4} d^2 = \frac{10 \times 10^3 \times 4000}{3 \times 200 \times 10^3}$

$\boxed{d = 9.23\text{mm}}$ — (2)

$\boxed{\text{Safe dia } d = 9.23\text{mm}}$ — (1)

Q3c

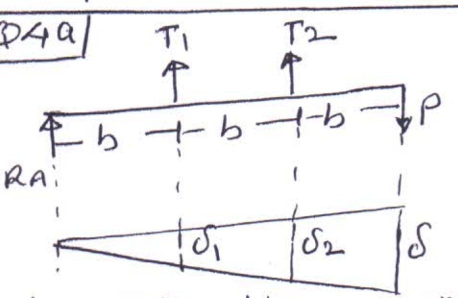


.. fig - (1)

$$\epsilon_x = \frac{6x}{E} - \nu\frac{6y}{E} - \nu\frac{6z}{E}$$
$$\epsilon_y = \frac{6y}{E} - \nu\frac{6x}{E} - \nu\frac{6z}{E}$$
$$\epsilon_z = \frac{6z}{E} - \nu\frac{6x}{E} - \nu\frac{6y}{E}$$
--- (1)

$$e = \frac{\delta V}{V} = \epsilon_x + \epsilon_y + \epsilon_z = \frac{(1-2\nu)}{E}(6x + 6y + 6z)$$ --- (2)

Q4a



$\Sigma F_y = 0.$

$R_A + T_1 + T_2 = P$

$\Sigma M_{@A} = 0$

$T_1 + 2T_2 = P$

deformation diag. - compatibility eq^n

$$2\delta_1 = \delta_2 \quad \therefore 2\left(\frac{T_1 L_1}{A_1 E_1}\right) = \frac{T_2 L_2}{A_2 E_2}$$ --→ (2)

~~$T_1 = 0.274 T_2$ OR $3.65 T_1 = T_2$~~

~~$T_1 = 0.375P$~~, ~~$T_2 = 1.369P$~~

For CD $\quad 6_1 = \frac{T_1}{A_1} \quad 200 = \frac{1.047 P \times 10^3}{12.567}$ (1.047 written over struck-through 0.375)

$P = 2400\,N$ -- (1)

$T_1 = 1.071 T_2$ OR $T_2 = 0.933 T_1$

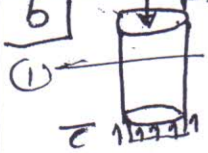
$= 1.047P \qquad = 0.976P$ (2)

For EF
$$6_2 = \frac{T_2}{A_2} \quad \therefore 175 = \frac{0.976P \times 10^3}{7.068}$$

$P = 1267.31\,N$

Safe value $P = 1.26\,kN$ --- (1)

b



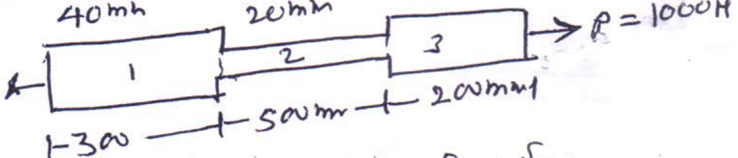
$$\text{Aver. stress } 6 = \frac{P}{\frac{\pi}{4}d^2} = \frac{110 \times 10^3}{\pi/4 (20)^2}$$

$6_{av} = 350.14\,MPa$ --- (2)

$$\text{aver. shear stress } \tau = \frac{P}{\pi d \cdot L} = \frac{110 \times 10^3}{\pi (20) 8}$$

$\tau_{av} = 218.83\,MPa$ --- (2)

C



$$\delta = \sum_{i=1}^{i=3} \frac{P_i L_i}{A_i E_i} = \delta_1 + \delta_2 + \delta_3$$

$$\delta = \frac{1000}{200 \times 10^3}\left(\frac{300}{40} + \frac{500}{20} + \frac{200}{30}\right)$$

$= 0.0375 + 0.125 + 0.0333$ (each 1×3 = (3))

$\delta = 0.1958\,mm$ --- (1)

end.

[signature] 1/10/18