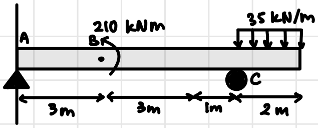
CV1011 Semester 1 2022/2023 Examination

by: Cynthia Oktaviani Pantoro

1



(a) $F_R = 35 \times 2 = 70$ kN

$F_R \cdot x = (35\times2)(8) - 210$

$70x = 350$

$x = 5$ m

$\therefore F_R = 70$ kN, located 5 m from A

(b) $R_C \times 7 = F_R \times 5$ (CCW moment = CW moment)

$R_C = 50$ kN //

(c) $\Sigma F_y = 0$

$R_C + R_A = F_R$

$R_A = 70 - 50 = 20$ kN

τ_{allow} of pin A

$\tau_{allow} = \frac{R_A/2}{A} = \frac{10}{\frac{\pi}{4}d^2}$

$200\times10^6 = \frac{10}{\frac{\pi}{4}d^2}$

$d_{min} = 0.007$ m $= 7$ mm

$\sigma_{b,allow}$ between pin A & bracket

$\sigma_{b,allow} = \frac{0.5 R_A}{t_{br} \times d}$

$100 \times 10^6 = \frac{10000}{0.006 \times d}$

$d_{min} = 0.017$ m $= 17$ mm

$\sigma_{b,allow}$ between pin A & beam

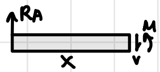
$\sigma_{b,allow} = \frac{R_A}{t_{beam} \times d_{min}}$

$100\times10^6 = \frac{20000}{0.01 \times d_{min}}$

$d_{min} = 0.02$ m $= 20$ mm

$\therefore d_{min} = 20$ mm //

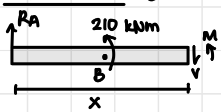
(d) Section AB $(0 \leq x \leq 3)$



$V = R_A = 20$ kN //

$M = R_A \cdot x = 20x$ kNm //

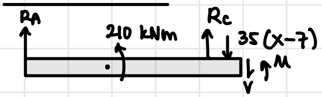
Section BC $(3 \leq x \leq 7)$



$V = R_A = 20$ kN //

$M = R_A . x - 210 = (20x - 210)$ kNm //

Section C - end



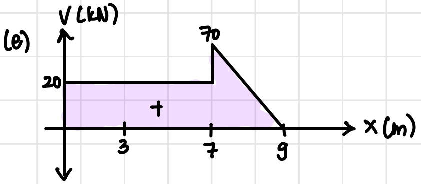
$V = R_A + R_C - 35(x-7) = (315 - 35x)$ kN

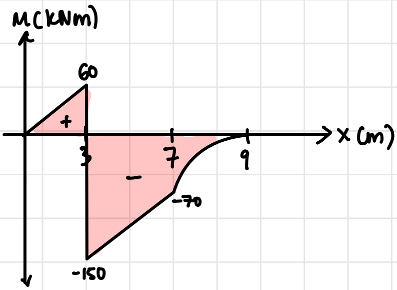
$M = R_A \cdot x + R_C(x-7) - 210 - 35(x-7)\frac{(x-7)}{2}$

$= 20x + 50x - 350 - 210 - 17.5(x^2 - 14x + 49)$

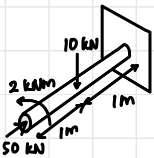
$M = (-17.5x^2 + 315x - 1417.5)$ kNm //

(e)





② (a)



- Vertical reaction : $V_A = 10$ kN //
- Torsion : $T_A = 2$ kNm //
- Normal reaction : $H_A = 50$ kN //
- Moment reaction : $M_A = 10 \times 1 = 10$ kN //

(b) $\phi = \frac{TL}{GJ} = \frac{(2000)(2)}{80\times10^9 \times \frac{\pi}{2} \times 0.1^4} = 3.183 \times 10^{-4}$ rad $\times \frac{180°}{\pi}$

$= 0.0182°$ // (CCW)

(c) Normal stress

Due to normal force : $\sigma = \frac{H_A}{A_A} = \frac{50000}{\frac{\pi}{4}(0.2)^2} = 1591549$ Pa $= 1.59$ MPa

bending : $\sigma = \frac{M_A y}{I} = 0$ (since y=0)

$\therefore \sigma_{total} = 1.59$ MPa //

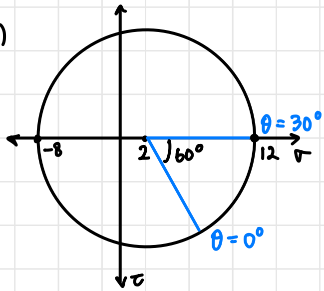
Shear stress

Due to shear force : $\tau = \frac{V_A Q}{It} = \frac{(10000)(\frac{\pi}{2}(0.1)^2)(\frac{4(0.1)}{3\pi})}{\frac{\pi}{4}(0.1)^4 \times 0.2} = 424413$ Pa $= 0.42$ MPa (↓)

torsion : $\tau = \frac{T\rho}{J} = \frac{(2000)(0.1)}{\frac{\pi}{2}(0.1)^4} = 1273239.5$ Pa $= 1.27$ MPa (↑)

$\therefore \tau_{total} = 1.27 - 0.42 = 0.85 \text{ MPa}$ //

③ (a)



(i) Principal stresses

$\sigma_1 = 12$ MPa at $\theta = 30°$

$\sigma_2 = -8$ MPa at $\theta = -60°$

(ii) $\cos 60° = \frac{\sigma_0 - 2}{10}$

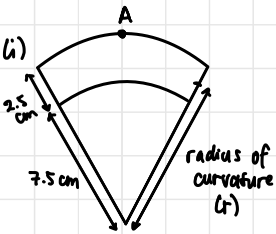
$\sigma_0 - 2 = 5$

$\sigma_0 = 7$ MPa // (tensile)

$\sin 60° = \frac{\tau_0}{10}$

$\tau_0 = 8.66$ MPa // (upwards)

③ (b) (i)



Based on measurement, $r = 8.75$ cm //

(ii) $\varepsilon = \frac{y}{r} = \frac{1.25}{8.75} = \frac{1}{7}$

$E = \frac{\sigma}{\varepsilon} \Rightarrow 20 \times 10^6 = \frac{\sigma}{\frac{1}{7}}$

$\sigma = 2.86$ MPa //

$\tau = 0$ // ($\tau = 0$ at free surfaces)