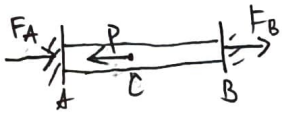
E14082181 蘇品瑄 材力期末

1.



$F_A + F_B = P$

$\sigma_{CB} = \sigma_Y = 30\ ksi = \frac{F_B}{A} \Rightarrow F_B = 30\times(\frac{4}{2})^2\pi = 377\ kip$

$\delta = \frac{F_B L_{BC}}{AE} = \frac{F_A L_{AC}}{AE} \Rightarrow F_A = \frac{F_B L_{BC}}{L_{AC}} = \frac{377\times5}{3} = 628.33\ kip$

$\sigma_{AC} = \frac{F_A}{A} = \frac{628.33}{2^2\pi} > \sigma_Y$

$\therefore \sigma_{AC} = \sigma_Y = 30\ ksi = \frac{F_A}{A} \Rightarrow F_A = 377\ kip$

$P_{min} = 377\times2 = 754\ kip$ #

$\delta_c = \varepsilon L = 0.001\times(5\times12) = 0.06\ in$

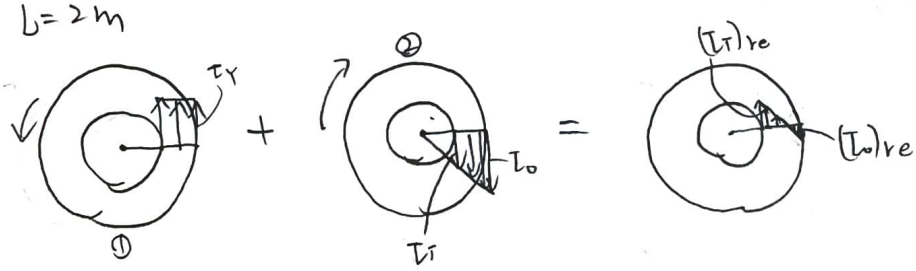
$\delta_c' = \frac{F_A' L_{AC}}{AE} = \frac{F_B' L_{BC}}{AE} \Rightarrow \begin{cases} F_A' = F_B' = 5 = 3 \\ F_A' + F_B' = P \end{cases} \Rightarrow \begin{cases} F_A' = \frac{5}{8}P \\ F_B' = \frac{3}{8}P \end{cases}$

$(F_A)_{re} = F_A - F_A' = 377 - \frac{5}{8}\times754 = -94.25$ (compression)

$(F_B)_{re} = F_B - F_B' = 377 - \frac{3}{8}\times754 = 94.25$ (tension)

$(\delta_c)_{re} = \frac{FL}{AE} = \frac{94.25\times(8\times12)}{2^2\pi\times\frac{\sigma_Y}{\varepsilon_Y}} = 0.024\ in$ #

2. $L = 2m$



$\phi = \phi_1 - \phi_2$

$\phi_1 = \frac{\gamma L}{c} = \frac{0.006\times2}{80\times10^{-3}} = 0.15\ rad$

$\phi_2 = \frac{T_p L}{GJ} = \frac{(130.2\times10^3)\times2}{(7\times10^{10})\times(4.4\times10^{-5})} = 0.085\ rad$

$T_p = 2\pi\int_{0.06}^{0.08}\tau_Y\rho^2 d\rho = 2\pi\times(210\times10^6)\left[\frac{\rho^3}{3}\right]_{0.06}^{0.08} = 130.2\ kN\cdot m$

$G = \frac{\tau_Y}{\gamma_Y} = \frac{210\times10^6}{0.003} = 7\times10^{10}\ Pa$

$J = \frac{\pi}{2}(0.08^4 - 0.06^4) = 4.4\times10^{-5}\ m^4$

$\phi = \phi_1 - \phi_2 = 0.15 - 0.085 = 0.065\ rad$ #

$\tau_o = \frac{T_p c}{J} = \frac{(130.2\times10^3)\times0.08}{4.4\times10^{-5}} = 236.7\ MPa$

$\tau_i = \frac{T_p\times0.06}{J} = 177.5\ MPa$

$(\tau_o)_{re} = \tau_Y - \tau_o = 210 - 236.7 = -26.7\ MPa$

$(\tau_i)_{re} = \tau_Y - \tau_i = 210 - 177.5 = 32.5\ MPa$

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3, $L = 2m$

$\phi = \phi_1 - \phi_2$

$\phi_1 = \frac{\gamma_Y L}{0.05} = \frac{0.007 \times 2}{0.05} = 0.28$ rad

$\phi_2 = \frac{T_P L}{GJ} = \frac{(354.2 \times 10^3) \times 2}{(4 \times 10^{10}) \times (9.324 \times 10^{-5})} = 0.19$ rad

$T_P = 2\pi \int_{0.05}^{0.09} \tau_Y \rho^2 d\rho = 2\pi \times (280 \times 10^6) \times \left[\frac{\rho^3}{3}\right]_{0.05}^{0.09} = 354.2$ kN·m

$G = \frac{\tau_Y}{\gamma_Y} = \frac{280 \times 10^6}{0.07} = 4 \times 10^{10}$ Pa

$J = \frac{\pi}{2}(0.09^4 - 0.05^4) = 9.324 \times 10^{-5}$ m^4

$\phi = 0.28 - 0.19 = 0.09$ rad #

4,

$I = \frac{1}{12} \times 0.2 \times 0.2^3 - \frac{1}{12} \times 0.16 \times 0.16^3 = 7.872 \times 10^{-5}$ m^4

$\sigma' = \frac{M_P c}{I} = \frac{244000 \times 0.1}{7.872 \times 10^{-5}} = 309.96$ MPa (compression = ⊖, tension = ⊕)

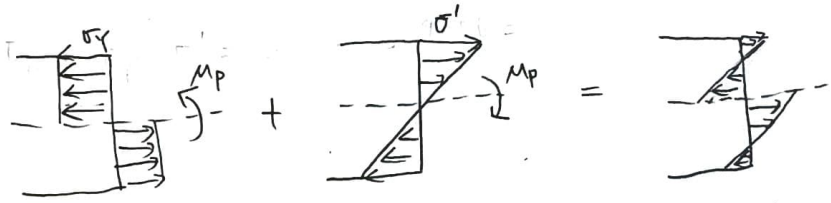
$M_P = (\sigma_Y \times A_1 \times y_1 + \sigma_Y \times 2A_2 \times y_2) \times 2 = 250 \times 10^6 \times (0.004 \times 0.09 + 2 \times 0.0016 \times 0.04) \times 2 = 244000$ N·m

$A_1 = 0.2 \times 0.02 = 0.004$

$A_2 = 0.02 \times 0.08 = 0.0016$

$y_1 = 0.08 + 0.01 = 0.09$

$y_2 = \frac{0.08}{2} = 0.04$



$(\sigma_{re})_{top} = \sigma' - \sigma_Y = 309.96 - 250 = 59.96$ MPa

$(\sigma_{re})_{bottom} = \sigma_Y - \sigma' = 250 - 309.96 = -59.96$ MPa #

5, $I = \frac{1}{12} \times 0.16 \times 0.2^3 - \frac{1}{12} \times 0.15 \times 0.18^3 = 3.3167 \times 10^{-5}$ m^4

$M_P = (\sigma_Y \times A_1 \times y_1 + \sigma_Y \times A_2 \times y_2) \times 2 = 250 \times 10^6 \times (0.0016 \times 0.095 + 0.0009 \times 0.045) \times 2 = 96250$ N·m

$A_1 = 0.16 \times 0.01 = 0.0016$

$A_2 = 0.01 \times 0.09 = 0.0009$

$y_1 = \frac{0.18}{2} + \frac{0.01}{2} = 0.095$

$y_2 = \frac{0.09}{2} = 0.045$

$\sigma' = \frac{M_P c}{I} = \frac{96250 \times 0.1}{3.3167 \times 10^{-5}} = 285.04$ MPa

$(\sigma_{re})_{top} = \sigma' - \sigma_Y = 285.04 - 250 = 35.04$ MPa

$(\sigma_{re})_{bottom} = \sigma_Y - \sigma' = 250 - 285.04 = -35.04$ MPa #

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