Answers for Problems 5

5.1

5.5 節参照のこと

5.2

5.7 節参照のこと

5.3

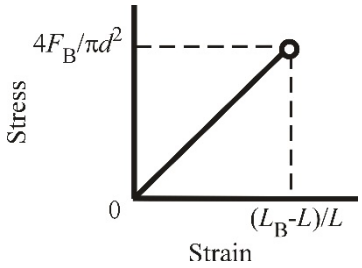
0.833 mm (円筒の変形は 9.09×10^{-3} mm にすぎない)

5.4

5.6 節参照のこと

5.5

(1) $E=\dfrac{4F_B}{\pi d^2}\dfrac{L}{L_B-L}$

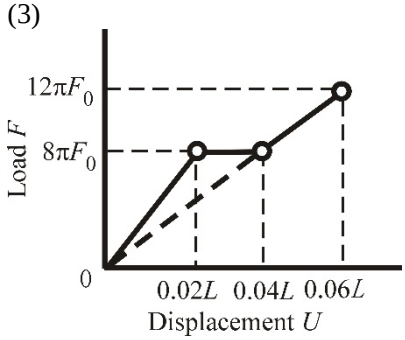


(2) $\dfrac{P_0}{F_B}\left(\dfrac{d^2}{d_1^2}\dfrac{L_1}{L}+\dfrac{d^2}{d_2^2}\dfrac{L_2}{L}+\dfrac{d^2}{d_3^2}\dfrac{L_3}{L}\right)(L_B-L)$ (3) $\dfrac{d_1^2}{d^2}F_B$

5.6

(1) $E_I=\dfrac{200F_0}{d^2},\quad E_{II}=\dfrac{50F_0}{d^2}$ (2) $P=\dfrac{400\pi F_0}{L}U$

(3)

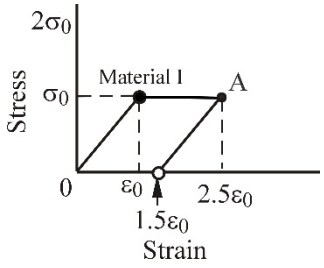


5.7

(1) $\dfrac{PL}{2A_aE_a+A_bE_b}$ (2) $\dfrac{PL}{2A_aE_a}$

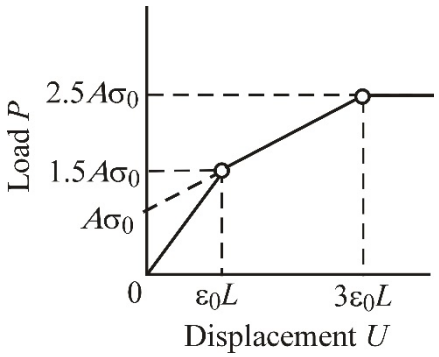
5.8

(1) $E_I = \dfrac{\sigma_0}{\varepsilon_0}$, $E_{II} = \dfrac{\sigma_0}{2\varepsilon_0}$



(2) $\sigma_1 = \dfrac{2P}{3A}$, $\sigma_1 = -\dfrac{P}{3A}$

(3)



5.9

(1) $E_A = \dfrac{P_{A2}}{A_0}\dfrac{L_{A1}}{L_{A2}-L_{A1}}$, $E_B = \dfrac{P_{B2}}{A_0}\dfrac{L_{B1}}{L_{B2}-L_{B1}}$, $P_A = \dfrac{A}{A_0}P_{A3}$, $P_B = \dfrac{A}{A_0}P_{B2}$

(2) $\sigma_B = \dfrac{L_1 - L}{L}E_A$ (3) $\sigma_B = \dfrac{L_1 - L}{L}\dfrac{E_A E_B}{E_A + E_B}$

5.10

(1-a) $\dfrac{\sigma_A}{E_A} = \dfrac{\sigma_B}{E_B}$ (1-b) $u_1 = \dfrac{L}{A_A E_A + A_B E_B}P_1$

(2-a) $P_2 = \dfrac{A_A E_A}{L}u_2$ (2-b) $P_2 = \dfrac{LA_B E_B + (L-C)A_A E_A}{L(L-C)}u_2 - \dfrac{CA_B E_B}{L-C}$

5.11

(1) $E_A = \dfrac{4xP_0}{\pi D^2(a-1)}$, $E_B = \dfrac{8yP_0}{\pi D^2(b-2)}$ (2) $\sigma_B = \dfrac{(a-1)y}{(b-2)x + (a-1)y}\dfrac{4F}{\pi D^2}$

(3) $F_1 = \dfrac{(b-2)x + (a-1)y}{(b-2)x}xP_0$ (4) $u_B = \dfrac{\{(b-2)x + (a-1)y\}L}{y}$

5.12

(1) Young's modulus: $\dfrac{4P_1}{\pi d_0^2}\dfrac{a_1 - a_0}{a_0}$, Tensile strength: $\dfrac{4P_1}{\pi d_0^2}$, $d = d_0 - \nu\dfrac{a_1 - a_0}{a_0}\dfrac{P}{P_1}d_0$

(2) $a_0 + \dfrac{f_a}{\pi d_0^2/4}\dfrac{1}{E}a_0 = b_0 + \dfrac{f_b}{k}$

(3) $L_0 = \dfrac{4b_0k + \pi d_0^2 E}{\pi d_0^2 E + 4a_0 k}a_0$

(4) $k = \dfrac{\pi\sigma_B d_0^2 E}{4E(b_0 - a_0) + 4a_0\sigma_B}$

5.13

(1) $P_1 = \sigma_y A, \quad P_2 = \sigma_B A, \quad L_1 = L + \dfrac{\sigma_y L}{E}$

(2) $U = \dfrac{FL}{3AE}$

(3) $F = 2.25\sigma_y A$

5.14

(1) Longitudinally elastic modulus: σ_1/ε_1, yield stress: σ_1, tensile strength: σ_2, Maximum load: $\sigma_2 A$

(2) $\sigma = 0$ in the thick part, $\sigma = \dfrac{F}{A_0}$ in the thin part

(3) $L = \dfrac{3L_1L_0}{2L_1 + L_0}$

5.15

(1) Young's modulus: $\dfrac{P_1}{A_0}\dfrac{L_0}{L_1 - L_0}$, yield stress: $\dfrac{P_1}{A_0}$, tensile strength: $\dfrac{P_2}{A_0}$, $L_A - \dfrac{P_A}{P_1}(L_1 - L_0)$

(2) $\sigma_I = \dfrac{1}{3}\alpha E\Delta T$, $\sigma_{II} = \dfrac{4}{3}\alpha E\Delta T$

(3) $\Delta T < \dfrac{3\sigma_Y}{4S\alpha E}$

5.16

(1) $\sigma_I = \dfrac{F_0}{\pi a^2}, \quad \sigma_{II} = 0$

(2) $u_A = \dfrac{16F}{\pi Ea}$

(3) $\sigma_I = \dfrac{F}{2\pi a^2}, \quad \sigma_{II} = -\dfrac{F}{2\pi a^2}$

(4) $u_B = \dfrac{8F}{\pi Ea^2}$

(5) $\sigma_I = \dfrac{CE}{32} + \dfrac{F}{2\pi a^2}, \quad \sigma_{II} = \dfrac{CE}{32} - \dfrac{F}{2\pi a^2}$

5.17

R is radius.

(1) $\sigma_A = \dfrac{1}{\pi\alpha^2 R^2} F_1, \quad \sigma_B = \dfrac{1}{\pi R^2} F_1$

(2) $\sigma_A = \dfrac{E}{L}\dfrac{1}{1+\alpha^2} u_2, \quad \sigma_B = \dfrac{E}{L}\dfrac{\alpha^2}{1+\alpha^2} u_2$

(3) $\sigma_A = \dfrac{1}{\pi R^2}\dfrac{1}{1+\alpha^2} F_2, \quad \sigma_B = \dfrac{1}{\pi R^2}\dfrac{1}{1+\alpha^2} F_3$

5.18

(1) $\sigma_I = \dfrac{F_1}{A}$

(2) $\sigma_2 = -\dfrac{1}{a+b}\dfrac{F_2}{A}$

(3) $\sigma_1 = \dfrac{a(b-1)}{a+b} E$

5.19

(1) $E_A = \dfrac{100F}{A}, \quad E_B == \dfrac{400F}{A}, \quad \sigma_{B\_A} = \dfrac{F}{A}, \quad \sigma_{B\_B} = \dfrac{2F}{A}$

(2) $\sigma_2 = \dfrac{2P}{3A}$

(3) Bar II. $P = 3F_0$ to break Bar II. $P = 6F_0$ to break Bar I.

5.20

(1) $\sigma_1 = \dfrac{4P}{\pi D^2}, \quad \sigma_2 = 0$

(2) $\sigma_1 = -\dfrac{2E(2L - L_R)}{3L}$

(3) $\sigma_1 = -\dfrac{4aT_1E}{3}$