

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

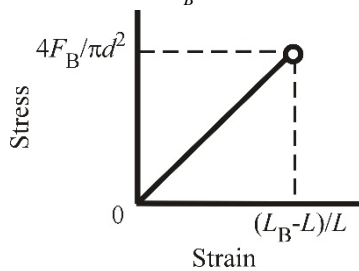
0.833 mm (円筒の変形は 9.09×10^{-3} mm にすぎない)

5.4

5.6 節参照のこと

5.5

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

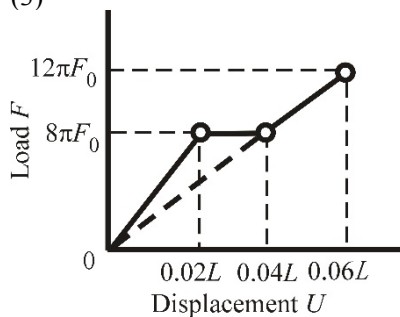


$$(2) \frac{P_0}{F_B} \left(\frac{d^2}{d_1^2} \frac{L_1}{L} + \frac{d^2}{d_2^2} \frac{L_2}{L} + \frac{d^2}{d_3^2} \frac{L_3}{L} \right) (L_B - L) \quad (3) \frac{d_1^2}{d^2} F_B$$

5.6

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

(3)

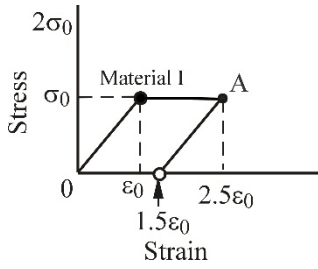


5.7

$$(1) \frac{PL}{2A_a E_a + A_b E_b} \quad (2) \frac{PL}{2A_a E_a}$$

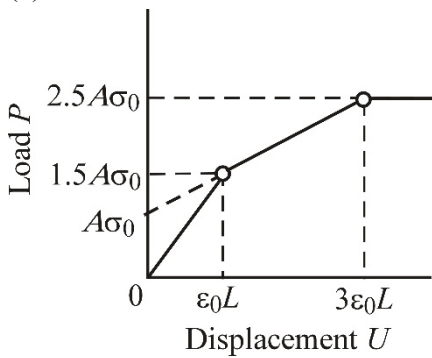
5.8

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



(2) $\sigma_1 = \frac{2P}{3A}$, $\sigma_2 = -\frac{P}{3A}$

(3)



5.9

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

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

5.10

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

(2-a) $P_2 = \frac{A_A E_A}{L} u_2$ (2-b) $P_2 = \frac{L A_B E_B + (L - C) A_A E_A}{L(L - C)} u_2 - \frac{C A_B E_B}{L - C}$

5.11

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

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

5.12

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

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

$$(3) L_0 = \frac{4b_0k + \pi d_0^2 E}{\pi d_0^2 E + 4a_0k} a_0$$

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

5.13

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

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

$$(3) F = 2.25\sigma_y A$$

5.14

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

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

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

5.15

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

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

$$(3) \Delta T < \frac{3\sigma_y}{4S\alpha E}$$

5.16

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

$$(2) u_A = \frac{16F}{\pi E a}$$

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

$$(4) u_B = \frac{8F}{\pi E a^2}$$

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

5.17

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

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

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

5.18

$$(1) \sigma_1 = \frac{F_1}{A}$$

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

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