19.

$\varepsilon = \frac{\Delta l}{l_0} = \frac{0.05\times10^{-3}}{0.5} = 1.0\times10^{-4}$

$A = \pi r^2 = \pi\times(2\times10^{-3})^2 = 1.2566\times10^{-5}\ (m^2)$

炭化ケイ素

$\sigma = E\varepsilon = 450\times10^9\times1.0\times10^{-4} = 45\ (MPa)$

$P = \sigma A = 45\times10^6\times1.2566\times10^{-5}$

$= 565.47\ [N]$

鉄

$\sigma = E\varepsilon = 196\times10^9\times1.0\times10^{-4} = 19.6\ [MPa]$

$P = \sigma A = 19.6\times10^6\times1.2566\times10^{-5}$

$= 246.32\ [N]$

銅

$\sigma = E\varepsilon = 124\times10^9\times1.0\times10^{-4} = 12.4\ [MPa]$

$P = \sigma A = 12.4\times10^6\times1.2566\times10^{-5}$

$= \frac{155.82}{6}\ [N]$

アルミ

$\sigma = E\varepsilon = 69\times10^9\times1.0\times10^{-4} = 6.9\ [MPa]$

$P = \sigma A = 6.9\times10^6\times1.2566\times10^{-5}$

$= 86.7X\ [N]$

ポリエステル

$\sigma = E\varepsilon = 3.2\times10^9\times1.0\times10^{-4} = 0.32\ [MPa]$

$P = \sigma A = 0.32\times10^6\times1.2566\times10^{-5}$

$= 4.02\ [N]$

20.

(1). $\sigma = \frac{P}{A} = \frac{20\times9.8}{\pi\times0.0025^2} = 9.98\ [MPa]$

$\sigma = E\varepsilon$ より,

$\varepsilon = \frac{\sigma}{E} = \frac{9.95\times10^6}{390\times10^9} = 2.55\times10^{-5}$

$\Delta l = \lambda = \varepsilon l_0 = 2.559\times10^{-5}\times0.05$

$= 1.2795\times10^{-6}\ [m]$

(2). $\frac{P}{A} = \sigma$, $E\varepsilon = \sigma$, $\varepsilon = \frac{\Delta l}{l_0}$, $A = \pi r^2$

$\frac{P}{A} = E\varepsilon$

$\frac{P}{\pi r^2} = E\frac{\Delta l}{l_0}$

$r^2 = \frac{Pl}{\pi E\Delta l}$

$= \frac{20\times9.8\times0.05}{\pi\times124\times10^9\times1.2795\times10^{-6}}$

$r^2 = 1.96639\times10^{-7}$

$r = 4.434\times10^{-3}\ [m]$

$d = 2r = 8.868\times10^{-3}\ (m)$

21.

(1) $\sigma = \frac{P}{A} = \frac{10\times9.8}{\pi\times0.0005^2} = 124.75\ [MPa]$

(2) $E\varepsilon = \sigma$, $\varepsilon = \frac{\Delta l}{l_0}$

$E = \frac{\sigma l_0}{\Delta l} = \frac{124.78\times10^6\times0.2}{0.0002}$

$= 124.8\ (GPa)$

(3) $d' = d + \varepsilon' d = d(1+\varepsilon')$

$\varepsilon' = -\nu\varepsilon = -0.32\times0.001$

$= -0.00032$

$d' = 0.0005\times(1 - 0.00032)$

$= 4.998\times10^{-4}$

$A' = \pi r^2 = \pi\times(4.9984\times10^{-4})^2$

$= 7.85\times10^{-7}\ (m)$

(4)

公称応力

(1) より $\sigma = 124.75\ [MPa]$

真応力 (3) より

$\sigma = \frac{P}{A'} = \frac{10\times9.8}{7.85\times10^{-7}} = 124.84\ [MPa]$