No
Date

$$\text{strain} = \frac{\Delta L}{L}$$ $$\text{stress} = \frac{F}{A}$$

$$\text{Young modulus } Y = \frac{\text{stress}}{\text{strain}}$$ strain $\rightarrow \varepsilon$

$$G_F = \frac{\Delta R / R}{\Delta L / L} = 1 + 2\gamma$$

$$\text{Poisson's ratio} = \gamma = \frac{-\Delta D / D}{\Delta L / L}$$

$$\text{Lateral strain} = \frac{-\Delta D}{D}$$ For compression

$$= \frac{+\Delta D}{D}$$ For elongation

$$\text{Resistance of unstrain gauge} = \frac{\rho L}{A}$$ ρ = resistivity of wire

Thermistor

$$R_T = R_o \left[1 + \alpha_T (T - T_o) \right]$$

Sheet (5)

1) $L = 0.1m$ & $A = 4cm^2$ & $Y = 207\, GN/m^2$ & $R = 240\,\Omega$
$G_f = 2.2$ & $\Delta R = 0.013\,\Omega$ Find ΔL & F

Soluation

$$G_f = \frac{\Delta R/R}{\Delta L/L}$$

$$2.2 = \frac{0.013/240}{\Delta L/0.1}$$

$$\because \Delta L = \frac{0.013/240}{2.2/0.1} = 2.46 * 10^{-6} m = 2.46\,\mu m \ \#$$

$$Y = \frac{\text{stress}}{\text{strain}} = \frac{F/A}{\Delta L/L}$$

$$\frac{F}{A} = Y * \frac{\Delta L}{L} \qquad F = A \cdot Y \cdot \frac{\Delta L}{L}$$

$$F = 4 * 10^{-4} * 207 * 10^{9} * \frac{2.46 * 10^{-6}}{0.1} = 2036.88 \simeq 2037\, N \ \#$$

2) $R = 120\,\Omega$ & $G_f = 2$ & stress $= 0.2\, GN/m^2$ & $Y = 68.7\, GN/m^2$
Find ΔR

soluation

$$Y = \frac{\text{stress}}{\text{strain}}$$

$$\because \text{strain} = \frac{\text{stress}}{Y} = \frac{0.2}{68.7} = 2.9 * 10^{-3}$$

$$\text{strain} = \frac{\Delta L}{L} = 2.9 * 10^{-3}$$

$$\because G_f = \frac{\Delta R/R}{\text{strain}}$$

$$\because \Delta R = G_f * \text{strain} * R$$
$$= 2 * 2.9 * 10^{-3} * 120 = 0.696\,\Omega \simeq 0.7\,\Omega$$

$\because$ change in resistance $= 0.7\,\Omega$ #

[3] $L = 0.1m$ & $R = 120\,\Omega$ & $\Delta R = 0.21\,\Omega$ & $\Delta L = 0.1mm$

Find G_f

Solution

$$G_f = \frac{\Delta R/R}{\Delta L/L} = \frac{0.21/120}{(0.1 * 10^{-3})/0.1} = 1.75 \ \#$$

[4] $\text{stress}_{\text{steel}} = 1400\ kgf/cm^2$ & $Y = 2.1 * 10^6\ kgf/cm^2$ & $G_f = 2$

Find Percentage change in resistance of strain gauge

Solution

$$Y = \frac{\text{stress}}{\text{strain}} \qquad \therefore \text{strain} = \frac{\Delta L}{L} = \frac{\text{stress}}{Y}$$

$$\therefore \text{strain} = \frac{1400}{2.1 * 10^6} = 6.67 * 10^{-4} \simeq 0.00066$$

$$G_f = \frac{\Delta R/R}{\Delta L/L} \qquad \therefore \frac{\Delta R}{R} = G_f * \text{strain}$$

$$\therefore \frac{\Delta R}{R} = 2 * 0.00066 = 1.33 * 10^{-3} = 0.00133$$

$$\frac{\Delta R}{R}\,\% = 0.00133 * 100 = 0.133\% \ \#$$

[5] $G_f = 2$ & $\text{stress} = 1000\ kg/cm^2$ & $Y = 2 * 10^6\ kg/cm^2$

Find $\frac{\Delta R}{R}\,\%$ & Poisson's ratio

$$Y = \frac{\text{stress}}{\text{strain}}$$

$$\text{strain} = \frac{\text{stress}}{Y} = \frac{1000}{2 * 10^6} = 5 * 10^{-4}$$

$$\text{strain} = \frac{\Delta L}{L} = 5 * 10^{-4}$$

$$\therefore G_f = \frac{\Delta R/R}{\Delta L/L}$$

$$\therefore \frac{\Delta R}{R} = G_f * \text{strain} = 2 * 5 * 10^{-4} = 10^{-3}$$

$$\therefore \frac{\Delta R}{R}\,\% = 10^{-3} * 100 = 0.1 \ \#$$

$$^2 G_f = 1 + 2\gamma \qquad 2\gamma = 1 \qquad \therefore \gamma = \frac{1}{2} \ \#$$

6. $R = 120\ \Omega$ at $T = 25^\circ c$ Find R at $T = 75^\circ c$

$\alpha_T = 0.00392$ at $25^\circ c$ & if $R = 180\ \Omega$ Find T_3

Soluation

$$R_T = R_o(1 + \alpha_T(T - T_o))$$

$$R = 120[1 + 0.00392(75 - 25)] = 143.52\ \Omega \ \#$$

$$R_3 = R_o[1 + \alpha_T(T_3 - T_o)]$$

$$180 = 120[1 + 0.00392(T_3 - 25)]$$

$$\frac{\frac{180}{120} - 1}{0.00392} + 25 = 152.55^\circ c \ \#$$

7. $R = 15\ \Omega$ at $t = 20^\circ c$ & $\alpha_T = T.C = 0.00425$ at $t = 20^\circ c$

Find limitting Value of resistance R if max Temp $T = 175^\circ c$

Soluation

$$R_T = R_o[1 + \alpha_T(T - T_o)]$$

$$R = 15[1 + 0.00425(175 - 20)] = 24.88\ \Omega \ \#$$

8. $\alpha = -0.05$ over Temp range $25 - 50^\circ c$

Find R at $40^\circ c$ if $R_o = 120\ \Omega$ at $T_o = 25^\circ c$

Soluation

$$R_T = R_o[1 + \alpha_T(T - T_o)]$$

$$= 120[1 + (-0.05)(40 - 25)]$$

$$= 30\ \Omega \ \#$$