**ENGR 350 - Mechanics of Materials, Fall 2013**

**Homework #3**

**Due: Wed., Sept. 17**

1. Problem P2.18, p. 45
2. Problem P2.20, p. 45
3. Problem P3.3, p. 63
4. Problem P3.17, p. 66

*(all problems are from the textbook).*

## Problem 2.18

Given: $T = 40°F$ $g = .08\text{ in}$ $\alpha_1 = 12.5 \times 10^{-6}/°F$

$\alpha_2 = 9.6 \times 10^{-6}\ /°F$

Find: determine the lowest temperature at which the two bars contact eachother

Solution:

$$\alpha_1 (\Delta T) L_1 + \alpha_2 \Delta T L_2 = .08\text{ in}$$

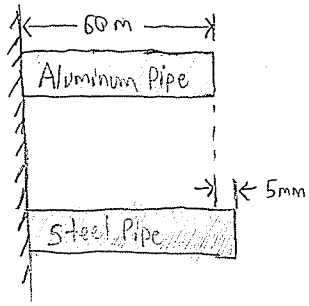
$$\Delta T = \frac{.08\text{ in}}{\alpha_1 L_1 + \alpha_2 L_2}$$

$$= \frac{.08}{(12.5 \times 10^{-6})(40) + (9.6 \times 10^{-6})(55\text{ in})}$$

$$\boxed{\Delta T = 77.821°F}$$

2.20)

⟨Given⟩




$T_i = 10°C$

$L_{i,A} = 60\,m$

$L_{i,s} = 60.005\,m$

$\alpha_A = 22.5 \times 10^{-6}/°C$

$\alpha_s = 12.5 \times 10^{-6}/°C$

⟨Goal⟩

Find $T_f$ that will satisfy the following:

$L_{f,A} = L_{f,s} + 0.015\,m$, given that $T_f = T_i + \Delta T$

⟨Solution⟩

$$L_{f,A} = L_{f,s} + 0.015\,m$$

$$L_{i,A} + L_{i,A} \cdot \Delta T \cdot \alpha_A = L_{i,s} + L_{i,s} \cdot \Delta T \cdot \alpha_s + 0.015\,m$$

$$L_{i,A} + \Delta T(L_{i,A} \cdot \alpha_A - L_{i,s} \cdot \alpha_s) = L_{i,s} + 0.015\,m$$

$$\Delta T(L_{i,A} \cdot \alpha_A - L_{i,s} \cdot \alpha_s) = L_{i,s} - L_{i,A} + 0.015\,m$$

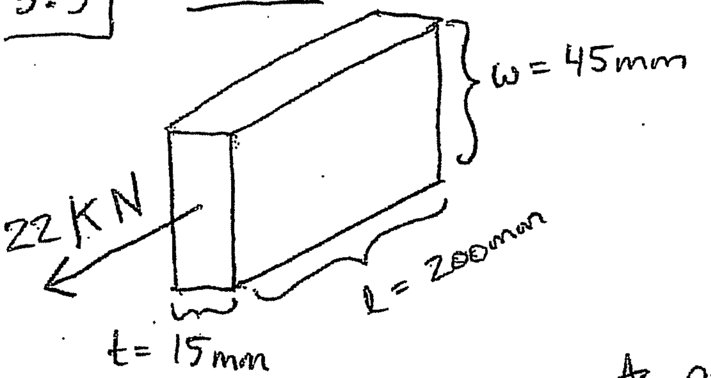
$$\Delta T = \frac{L_{i,s} - L_{i,A} + 0.015\,m}{L_{i,A} \cdot \alpha_A - L_{i,s} \cdot \alpha_s}$$

$$\Delta T = \frac{60.005\,m - 60\,m + 0.015\,m}{60\,m \cdot 22.5 \times 10^{-6}/°C - 60.005\,m \cdot 12.5 \times 10^{-6}/°C}$$

$$\Delta T = 33.3\,°C$$

$$T_f = T_i + \Delta T = \boxed{43.3\,°C}$$

3.3 Given:




elongation = 3.0 mm

width contraction = 0.25 mm

★ polymer assumed ~~to~~ to be isotropic

$E_x = E_y = E_z$ & $\nu_x = \nu_y = \nu_z$

Find: a) $E$

b) $\nu$

c) Δ thickness

for a) $\delta = \frac{PL}{AE} \Rightarrow \frac{(22000)(0.2m)}{(0.015m * 0.045m)E} = 0.003m$

$\rightarrow E = 2172839506 \boxed{= 2.17 \text{ GPa}}$

for b) $\nu = \frac{\varepsilon_{lat}}{\varepsilon_{long}} = \frac{\frac{\Delta \omega}{\omega}}{\frac{\Delta l}{l}} = \frac{\frac{0.25}{45}}{\frac{3.0}{200}} \rightarrow \boxed{= 0.37}$

usally $0.1 \leq \nu \leq 0.5$

for c) $\frac{45}{0.25} = 180$, $\frac{15}{180} = 0.083$

$\boxed{\Delta \text{thickness} = 0.083 \text{ (contraction)}}$

3.17

Determine:

a) modulus of elasticity

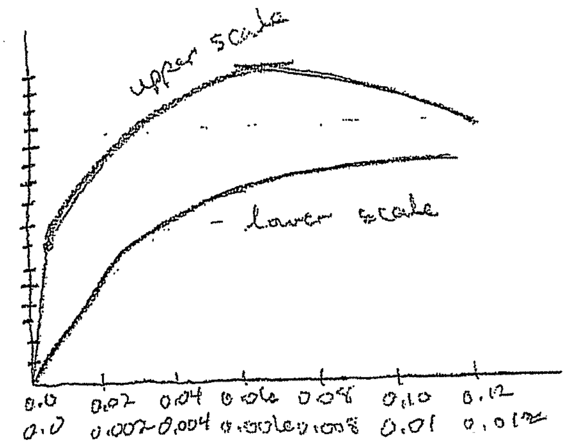
$$E = \frac{\sigma}{\varepsilon} = \frac{60\ ksi}{0.002\ m/m} = 30{,}000\ ksi$$

b) $\sigma_{PL} = 60\ ksi$

c) $\sigma_u = 159\ ksi$

D) $\sigma_y = 80\ ksi$

E) $\sigma_{fracture} = 135\ ksi$




f) True fracture Stress if $d_f = 0.350$ in @ fracture location.

$$A_o = \pi/4(0.495\ in)^2 = 0.192442\ in^2$$
$$A_f = \pi/4(0.350\ in)^2 = 0.096211\ in^2$$

$$\text{true } \sigma_{fracture} = 135\ ksi\left(\frac{0.192442\ in^2}{0.096211\ in^2}\right)$$
$$= \boxed{270\ ksi}$$