Solution Manual 3rd Ed. Metal Forming: Mechanics and Metallurgy Chapter 1

Determine the principal stresses for the stress state

Solution: $I_1 = 10+5+7=32$, $I_2 = -(50+35+70) +9 +4 +16 = -126$, $I_3 = 350-48-40-80$ -63 = 119; $\sigma^3 - 22\sigma^2 -126\sigma -119 = 0$. A trial and error solution gives $\sigma = 13.04$. Factoring out 13.04, $\sigma^2 - 8.96\sigma + 9.16 = 0$. Solving; $\sigma_1 = 13.04$, $\sigma_2 = 7.785$, $\sigma_3 = 1.175$.

1-2 A 5-cm, diameter solid shaft is simultaneously subjected to an axial load of 80 kN and a torque of 400 Nm.

a. Determine the principal stresses at the surface assuming elastic behavior.
 b. Find the largest shear stress.

Solution: a. The shear stress, τ_s at a radius, r_s is $\tau = \tau_s r/R$ where τ_s is the shear stress at the surface R is the radius of the rod. The torque, T, is given by $T = \int 2\pi t r^2 dr = (2\pi \tau_s / R) \int r^s dr = \pi \tau_s R^3/2$. Solving for $= \tau_s$, $\tau_s = 2T/(\pi R^3) = 2(400N)/(\pi 0.025^3) = 16$ MPa

The axial stress is $.08MN/(\pi 0.025^2) = 4.07 \text{ MPa}$ $\sigma_{1},\sigma_{2} = 4.07/2 \pm [(4.07/2)^2 + (16/2)^2)]^{1/2} = 1.029, -0.622 \text{ MPa}$ b. the largest shear stress is (1.229 + 0.622)/2 = 0.925 MPa

A long thin-wall tube, capped on both ends is subjected to internal pressure. During elastic

loading, does the tube length increase, decrease or remain constant? Solution: Let y = hoop direction, x = axial direction, and z = radial direction. —

 $e_x = e_2 = (1/E)[\sigma - \upsilon(\sigma_3 + \sigma_1)] = (1/E)[\sigma_2 - \upsilon(2\sigma_2)] = (\sigma_2/E)(1-2\upsilon)$

Since u < 1/2 for metals, $e_x = e_2$ is positive and the tube lengthens.

4 A solid 2-cm. diameter rod is subjected to a tensile force of 40 kN. An identical rod is subjected to a fluid pressure of 35 MPa and then to a tensile force of 40 kN. Which rod experiences the largest shear stress?

Solution: The shear stresses in both are identical because a hydrostatic pressure has no shear component.

1-5 Consider a long thin-wall, 5 cm in diameter tube, with a wall thickness of 0.25 mm that is capped on both ends. Find the three principal stresses when it is loaded under a tensile force of 40 N and an internal pressure of 200 kPa.

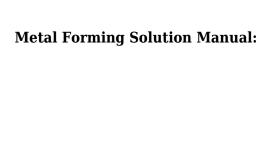
Solution: $\sigma_k = PD/4t + F/(\pi Dt) = 12.2 \text{ MPa}$

$$\sigma_y = PD/2t = 2.0 MPa$$

$$\sigma_{\rm w} = 0$$

Metal Forming Solution Manual

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Table of Contents Metal Forming Solution Manual

- 1. Understanding the eBook Metal Forming Solution Manual
 - The Rise of Digital Reading Metal Forming Solution Manual
 - Advantages of eBooks Over Traditional Books
- 2. Identifying Metal Forming Solution Manual
 - Exploring Different Genres
 - Considering Fiction vs. Non-Fiction
 - Determining Your Reading Goals
- 3. Choosing the Right eBook Platform
 - Popular eBook Platforms
 - Features to Look for in an Metal Forming Solution Manual
 - User-Friendly Interface
- 4. Exploring eBook Recommendations from Metal Forming Solution Manual
 - Personalized Recommendations
 - Metal Forming Solution Manual User Reviews and Ratings
 - Metal Forming Solution Manual and Bestseller Lists
- 5. Accessing Metal Forming Solution Manual Free and Paid eBooks
 - Metal Forming Solution Manual Public Domain eBooks
 - Metal Forming Solution Manual eBook Subscription Services
 - Metal Forming Solution Manual Budget-Friendly Options
- 6. Navigating Metal Forming Solution Manual eBook Formats

- ∘ ePub, PDF, MOBI, and More
- Metal Forming Solution Manual Compatibility with Devices
- Metal Forming Solution Manual Enhanced eBook Features
- 7. Enhancing Your Reading Experience
 - Adjustable Fonts and Text Sizes of Metal Forming Solution Manual
 - Highlighting and Note-Taking Metal Forming Solution Manual
 - Interactive Elements Metal Forming Solution Manual
- 8. Staying Engaged with Metal Forming Solution Manual
 - Joining Online Reading Communities
 - Participating in Virtual Book Clubs
 - $\circ\,$ Following Authors and Publishers Metal Forming Solution Manual
- 9. Balancing eBooks and Physical Books Metal Forming Solution Manual
 - Benefits of a Digital Library
 - Creating a Diverse Reading Collection Metal Forming Solution Manual
- 10. Overcoming Reading Challenges
 - Dealing with Digital Eye Strain
 - Minimizing Distractions
 - Managing Screen Time
- 11. Cultivating a Reading Routine Metal Forming Solution Manual
 - Setting Reading Goals Metal Forming Solution Manual
 - Carving Out Dedicated Reading Time
- 12. Sourcing Reliable Information of Metal Forming Solution Manual
 - Fact-Checking eBook Content of Metal Forming Solution Manual
 - Distinguishing Credible Sources
- 13. Promoting Lifelong Learning
 - Utilizing eBooks for Skill Development
 - Exploring Educational eBooks
- 14. Embracing eBook Trends
 - Integration of Multimedia Elements
 - Interactive and Gamified eBooks

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