Chapter 5 Supplemental Problems

1. A specimen of aluminum having a rectangular cross section 10 mm × 12.7 mm is pulled in tension with 35,500 N force, producing only elastic deformation. Calculate the resulting strain.
2. A cylindrical specimen of a titanium alloy having an elastic modulus of 107 GPa and an original diameter of 3.8 mm will experience only elastic deformation when a tensile load of 2000 N is applied. Compute the maximum length of the specimen before deformation if the maximum allowable elongation is 0.42 mm.
3. A steel bar 4.0 in. long and having a square cross section 0.8 in. on an edge is pulled in tension with a load of 20,000 lb_f, and experiences an elongation of 4.0×10^{-3} in.). Assuming that the deformation is entirely elastic, calculate the elastic modulus of the steel.
4. A cylindrical rod of copper (E = 110 GPa) having a yield strength of 240 MPa is to be subjected to a load of 6660 N. If the length of the rod is 380 mm, what must be the diameter to allow an elongation of 0.50 mm?
5. A specimen of ductile cast iron having a rectangular cross section of dimensions 4.8 mm × 15.9 mm is deformed in tension. Using the load-elongation data tabulated below, complete problems a through e.

Load		Length	
N	lb	mm	in.
0	0	75.000	2.953
4,740	1065	75.025	2.954
9,140	2055	75.050	2.955
12,920	2900	75.075	2.956
16,540	3720	75.113	2.957
18,300	4110	75.150	2.959
20,170	4530	75.225	2.962
22,900	5145	75.375	2.968
25,070	5635	75.525	2.973
26,800	6025	75.750	2.982
28,640	6440	76.500	3.012
30,240	6800	78.000	3.071
31,100	7000	79.500	3.130
31,280	7030	81.000	3.189
30,820	6930	82.500	3.248
29,180	6560	84.000	3.307
27,190	6110	85.500	3.366
24,140	5430	87.000	3.425
18,970	4265	88.725	3.493

(a) Plot the data as engineering stress versus engineering strain.
(b) Compute the modulus of elasticity.
(c) Determine the yield strength at a strain offset of 0.002.
(d) Determine the tensile strength of this alloy.
(e) What is the ductility, in percent elongation?

6. Sometimes $\cos\phi \cos\lambda$ in Equation 5.18 is termed the Schmid factor. Determine the magnitude of the Schmid factor for an FCC single crystal oriented with its [100] direction parallel to the loading axis.
7. The lower yield point for an iron that has an average grain diameter of 5×10^{-2} mm is 135 MPa (19,500 psi). At a grain diameter of 8×10^{-3} mm, the yield point increases to 260 MPa (37,500 psi). At what grain diameter will the lower yield point be 205 MPa (30,000 psi)?

Answers

1. 4.1×10^{-3}
2. 250 mm
3. 223 GPa
4. 7.65 mm
5. (b) 200 GPa; (c) 280 MPa; (d) 410 MPa; (e) 18.4%
6. 0.408
7. 1.48×10^{-2} mm

Thought Problems/Review Questions

1. What are the different ways to increase the modulus of a metal? Discuss how each method influences the microstructure of the metal and how that new structure influences the modulus and yield stress of the metal.
2. How does the size and shape of a flaw at either the surface of the interior of a specimen determine the local stress field?
3. Describe the qualitative differences between brittle, ductile and fatigue fracture surfaces.
4. Describe two fundamental models for viscoelasticity and describe their creep and relaxation behavior. Do they model real behavior of materials? If they do not, how can they be modified to accurately model real materials?
5. Discuss why the theoretical shear modulus and tensile fracture stress are much greater than usually observed in real materials. What real material comes close to these theoretical values and why?
6. How is hardness of a metal affected by the cold working process and annealing?