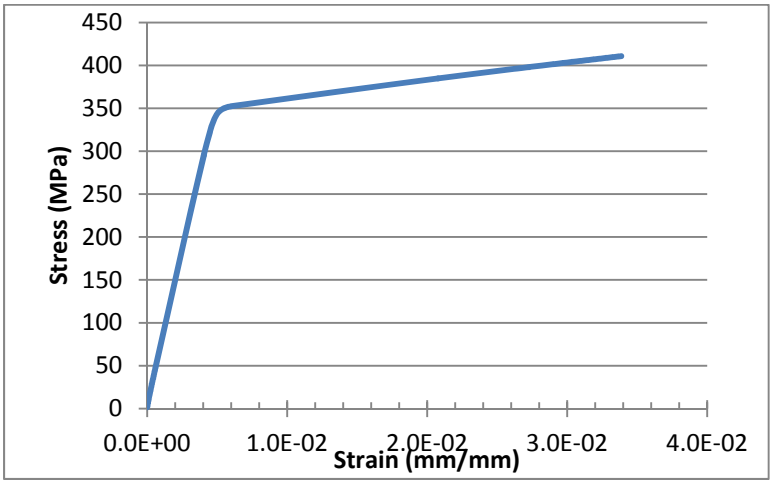
Donald P. Shiley School of Engineering
EGR 221 Materials Science
Assignment 6, Fall 2015

1) Given a straight round bar made from steel alloy with Young's modulus (E) of 207GPa and yield strength (σ_{ys}) of 400MPa.
   a) What is the axial strain at yielding? (hint: the answer is close to 0.002mm/mm)
   b) If a strain gage was used to measure the axial strain to be 0.001mm/mm, can the axial stress be determined? If not, why not? If so, what is the axial normal stress?
   c) If a strain gage was used to measure the axial strain to be 0.003mm/mm, can the axial stress be determined? If not, why not? If so, what is the axial normal stress?
2) A cylindrical metal specimen having an original diameter of 12.8mm (0.505in) and a gage length of 50 mm (~2.0 in) is pulled in tension until fracture occurs. The diameter at the point of fracture is 7.2 mm and the fractured gage length is 74.3 mm. Calculate the ductility in terms of both percent reduction in area (%RA) and percent elongation (%EL).
3) The following stress-strain curve is from 2024-T351 aluminum alloy. If a straight bar made of 2024-T351 aluminum had a length of 100mm before loading, what would the length of the bar be with the following:
   a) 200 MPa axial load applied.
   b) Loaded to 200 MPa, and then the load is removed.
   c) 400 MPa axial load applied.
   d) Loaded to 400 MPa, and then the load is removed.



4) Using equation 6-18 in the textbook (RE: tensile strength = 500HB).
   a) What is does HB refer to in this equation?
   b) Using this equation, what is the hardness of steel with tensile strength of 560MPa?
   c) Can this equation be used to determine the tensile strength of brass if its hardness was measured to be 120 HB? If not, why not? If so, what would the tensile strength be?

5) In words, what is ductility? What is toughness? Would you expect a material with high ductility to also have high toughness? Explain why/why not.

6) What happens to the ductility of a chocolate bar when you “freeze” it (and “test” it while cold)? Does something similar happen to most metals? What happens to toughness?

7) Speculate – what would have happened to the Titanic had it hit an “iceberg” while sailing in the warm waters of the South Pacific? (okay, probably no icebergs in the warm waters, but something equivalent). Briefly explain.

8) Speculate – had the Titanic been made from an FCC metal such as aluminum, what would have happen when it struck the iceberg in the cold North Atlantic? Briefly explain.

9) The presence of sulfur in steel causes an increase in the ductile to brittle transition temperature. The sulfur content in the Titanic’s steel exceeded norms for modern steel (which is typically somewhere around up to 0.008% sulfur allowed). Speculate – what would have happen when it struck the iceberg in the cold North Atlantic had the sulfur content been much lower than it was; low enough to meeting today’s norms? Briefly explain.