LESSON 9: PROPERTIES OF MATERIALS II

Friday, February 10th, 2017

LESSON OBJECTIVES
1. Define the Poisson’s ratio and the shear modulus.
2. Solve problems for unknown, stress, force, strain, or deformation, utilizing, \( \sigma = E \varepsilon \), \( \sigma = F/A \), and statics (including multiple FBD’s).
3. Solve problems for unknown, stress, force, strain, or deformation, utilizing, \( \tau = G \gamma \), \( \tau = V/A \), and statics (e.g., shear spring problems).
4. Solve problems for unknown, stress, force, strain, or deformation, utilizing Poisson’s ratio \( \nu = - (\varepsilon_{\text{lat}}/\varepsilon_{\text{long}}) \)

PHILPOT
- Philpot Chapter 3
- Examples 3.1, 3.2, 3.3.

IN-CLASS PROBLEMS

1. \( \sigma = E \varepsilon \) Problem: Determine \( P \) and \( \Delta C \) if \( A_{DB} = 400 \text{mm}^2 \) and \( E_{DB} = 70 \text{GPa} \). ABC is rigid. The strain in (1) is 2000 \( \mu \varepsilon \). Assume bar (1) is elastic.

2. \( \tau = G \gamma \) Problem: Determine \( P \). Thickness of the rubber block (depth into the page) is 100mm.

3. \( \nu = - (\varepsilon_{\text{lat}}/\varepsilon_{\text{long}}) \) Problem: Compute the change in cross-sectional dimensions. Given: A-36 Steel (\( E = 200 \text{GPa} \), \( \nu = 0.25 \)). Assume the bar is elastic.
HOMEWORK (DUE MONDAY)

For the following problems (A, B, C), you have been emailed the averaged data that was collected during Wednesday night labs in week 1 and 3. Your job is to provide pretty, professional-looking graphs. The grade will be based on the professional appearance and of the graphs:

A. Stress vs Strain of Steel and Aluminum – elastic range. Choose an x-axis range of 0.02 in/in. Provide: title, legend, axis labels and units. Highlight (e.g., with an “X” or a dot) the yield points of each material (note: if the 0.2% offset method is needed, show it). Highlight (with a straight line) the Elastic Modulus of each material. Label (in a textbox) the yield and elastic modulus values for each material.

B. Stress vs Strain of Steel and Aluminum – full scale. Choose an x-axis range of 0.30 in/in. Provide: title, legend, axis labels and units. Highlight (e.g., with an “X” or a dot) the yield and ultimate points of each material. Label (in a textbox) the yield and ultimate values for each material.

C. Stress vs Strain of High Strength Concrete and Wood (tested to 80% of Ultimate Strength). Choose an x-axis range of 0.005 in/in. Provide: title, legend, axis labels and units. Highlight (with a straight line) the Elastic Modulus of each material. Label (in a textbox) the elastic modulus values for each material. Be sure to mention the important fact that these tests were conducted to 80% of the ultimate strength (not to failure).

FOR ALL PROBLEMS, BELOW, ASSUME THAT THE MATERIALS REMAIN ELASTIC.

1. Determine the force P.
   Given: Prior to applying the load P, the steel bar (E=29000 ksi, v = 0.25) was 2.000 inches wide, 0.500 inches thick, and 25.000 inches long. After applying the load P, the width was reduced to 1.999 inches.

2. A 0.75-in.-thick rectangular metal bar is subjected to a tensile load P=32kips by pins at A and B, as shown. The width of the bar w=3.0-in. Strain gages bonded to the specimen measure a longitudinal (x) strain of 840\( \mu \varepsilon \) and a transverse (y) strain of -250 \( \mu \varepsilon \). Determine the Poisson’s ratio for this specimen, then determine the modulus of elasticity E, and the Shear Modulus G.

3. Philpot Problem P3.11 (it is the same problem in both the 2\(^{nd}\) and 3\(^{rd}\) editions)

4. Rigid bar \( ABC \) is supported by pin-connected axial member (1) and by a 0.75-in.-diameter double shear pin connection at C as shown below. Member (1) is a 2.75-in.-wide by 1.25-in.-thick rectangular bar made of aluminum with an elastic modulus of 10,000 ksi. When a concentrated load P is applied to the rigid bar at A, the normal strain in member (1) is measured as -880 \( \mu \varepsilon \). Determine:
   a. The magnitude of the applied load P.
   b. The average shear stress in the pin at C.