ME 305 Fall 2014

Lab 3: Bending

Grading Rubric

**Introduction (10 points)**

* Objectives of the lab
  + Observe bending of uniform samples under various boundary conditions. (4 points)
  + Evaluate the validity of Euler-Bernoulli bending theory with measurements. (4 points)
* Why is the lab important and why is this useful to an engineers? (2 points)

**Theory (15 points)**

* Differential equation for beam bending (1.5 points)
* Boundary conditions:
  + Cantilever with end load (1 point)
  + Simply supported beam loaded at the center (1 point)
* Deflection curve formula (v(x) in the lab handout) for three-point bending loaded at the midpoint (2 points)
* V(x) for cantilever beam loaded at the end (0.5 point)
* (2 point)
* (cantilever) and (three-point) (2 points)
* and (cantilever) and (three-point) (2 points)
* and (2 points)
* = constant for each material (1 point)

**Measurements/Procedure (15 points)**

* *Equipment* (2.5 points)
  + Megazord apparatus
  + Samples – 3 materials (aluminum, brass, steel)
  + Weights
  + Ruler
  + Level
  + Paper clip
  + Vernier depth guage
* *Procedure - cantilever (5.5 points)*
  + Level apparatus (0.5 points)
  + Measure and record the length of the cantilever beam from the collar to the hole the paper clip hangs from (1 point)
  + Load the sample and clamp into place, calibrate vernier gauge (1 point)
  + Add weights to paper clip in 20 g increments, up to 80 g, measuring the deflection at the paper clip for each weight increment (3 points)
* *Procedure - three-point (5 points)*
  + Set U-bolt 12 in. from wall support, record this as the length of the beam (1point)
  + Load sample and calibrate vernier gauge (1 point)
  + Add weights to hanger located at the midpoint of the beam in 50 g increments, up to 200 g, measuring the deflection at the midpoint for each weight increment (3 points)
  + Repeat the three-point procedure for lengths of 15 in and 18 in (1 point)
* *Procedure - deflection curve (2 points)*
  + For a three-point deflection length of 18 in, first with a load of 100 g and then with a load of 200 g, measure the deflection as a function of length in one inch increments from the wall of the apparatus to the midpoint of the beam (2 points)

**Results and Analysis (25 points)**

* Reporting all measurements (2 points)
* Load vs. deflection for all loading situations for all three materials (6 points)
* Fit a line to all linear data sets and either display the equation for the line or the slope of the line and the y-intercept of the line (giving and ) (2 points)
* All 12 values (1 point)
* All 12 values and their percent difference (2 points)
* values for each (1 point)
* values (1 point)
* values (2 points)
* Comparison of to the precision of the vernier gauge (2 points)
* Plots with experimental deflection curves (including error bars) and comparing calculated theoretical deflection curve (6 points)

**Discussion and Conclusion (25 points)**

* *Discussion (20 points)*
  + Sources of error (6 points)
    - Deformation of shaft samples
    - Offset error
    - Finite gauge width
    - Human errors in measurement
    - Reading Vernier depth gauge
    - Errors due to depth gauge pushing down and adding to the deflection of samples
  + How can the lab be improved (2 points)
  + Answer the discussion questions in the handout (12 points)
* *Conclusion (5 points)*
  + Were the lab objectives met? (2 points)
  + Major results (2 points)
  + Why is the experiment useful? (1 point)