The bending of a cantilever - lab report example

Science, Physics

The Bending of a Cantilever

The paper " The Experiment with the Torsional Pendulum" is a great example of a lab report on physics. The deflection of the cantilever beam has a beam measured by varying load and the length of the cantilever beam. The measured values of deflection were used to calculate Young’s Modulus (E) of steel. It was found that the deflection of a cantilever beam is directly proportional to the applied load and cube of the length of the cantilever. These measurements provided the value of Young’s modulus of steel to be 203 GPa (Fixed length cantilever) and 174 GPa (Fixed load cantilever). These values are very close to those reported in the literature. The experiment and the calculations are described in this report. ObjectiveThe experiment was aimed at measuring Young’s Modulus (E) of a material by measuring the deflection of a cantilever with varying applied load or length of the cantilever. Theory and Formulae: A long and thin bar clamped at one end is termed as the cantilever (figure below). When the load is applied at the free end, it deflects. The vertical deflection of a cantilever subjected to a load W is theoretically given by the formula Here, a and b are width and thickness of the bar respectively; L is length and E is Young’s Modulus of the material. Ideally one should incorporate the correction for deflection of the cantilever under its own weight. It may be ignored if the contribution from its weight in the total deflection is small. Thus by measuring the deflection of a cantilever, one can measure Young’s Modulus of the material forming the cantilever. Materials and Procedure: Metallic strips of different lengths – 50, 60, 70 and 80 cm and 12. 8 mm wide and 4. 8 mm thickness were taken as Cantilever. Three different weights of 0. 5, 1

and 2 kg were used to cause deflection in the cantilever. For foxed length 60 cm of the cantilever, the vertical deflection was measured for different weights of 0. 5, 1 and 2 kg and the same was recorded. The deflection was plotted vs. the weight and from the slope Young's Modulus (E) was calculated. For a fixed weight of 1 kg, the vertical deflection was measured for cantilevers of different lengths – 50, 60, 70 and 80 cm and the same was recorded. The deflection was plotted vs. L3 and from the slope Young's Modulus (E) was calculated. Data and Calculations

- Fixed Length Case

Length of the Cantilever L = 60 cm = 0. 60 mWidth of the Cantilever a = 12. 8 mm = 0. 0128 mThickness of the Cantilever b = 4. 8 mm = 0. 0048 mDeflection vs. Load DataLoad (kg)0. 512Deflection (m)2*10-23. 5*10-26. 5*10-2 Chart Showing Deflection vs. Load PlotThe slope of the deflection vs. load line is 0. 03 m/kgTherefore, Young's Modulus (E) will be given byGPAError Analysis: The first calculation was the slope of the line (m) - d vs WError for this (m) will be given as Finally, error for the Young's Modulus E will be given as

- Fixed Load Case

Applied Load W = 1 kgWidth of the Cantilever a = 12. 8 mm = 0. 0128 mThickness of the Cantilever b = 4. 8 mm = 0. 0048 mDeflection vs. Load DataLength (m)0. 50. 60. 70. 8Deflection (m)2*10-23*10-26*10-28*10-2 Chart Showing Deflection vs. L3 PlotThe slope of the deflection vs. load line is 0. 0162 m/m3Therefore, Young's Modulus (E) will be given byGPAError Analysis: The first calculation was the slope of

the line (m) - d vs L3Error for this (m) will be given as Finally, error for the Young’s Modulus E will be given as Conclusions: Based on these experiments it can be concluded that the deflection of a cantilever beam is directly proportional to the applied load and cube of the length of the cantilever. This is a very simple method of finding young’s modulus of a material. The results obtained are very close to the value reported in the literature and different books (~ 210 GPa). This shows how one can use a method as simple as cantilever deflection to measure a very important material property.