CALIFORNIA STATE SCIENCE FAIR
2003 PROJECT SUMMARY

Name(s)
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Project Number
J0230

Project Title
Effects of Stiffness and Density on a Material's Natural Frequency

Abstract

Objectives/Goals
My objective was to find whether stiffness, density, or both, affected a material's natural frequency.

Methods/Materials
First, I gathered five springs of different stiffness' and eleven different weights. By hanging weights on the end of spring, I determined the natural frequency. I did this by pulling the weights down and releasing them, measuring the spring's vertical motion in cycles per second. I then graphed my test results, finding a mathematical relationship between stiffness to frequency and mass to frequency.

Results
From the graphs of my test data and the equation of each trendline, I made an equation using both stiffness and mass to determine a material's natural frequency. I made this equation so that I would be able to find the natural frequency of any object using it.

My equation was Frequency = 0.346 (stiffness^ 0.4072/ mass^ 0.486)

Conclusions/Discussion
I looked up the real frequency equation in a math book and found that:

Frequency = ½'pi' or 0.159 (stiffness^0.5/mass^0.5).

I found that the equation I had derived was slightly off. Using my equation, I could find the natural frequency of any given structure, such as a fence, bar, or even building. The concentrated mass on the end of each spring represented, and served the same purpose as, the density of any given structure.

Summary Statement
In my project I wanted to find whether stiffness, density, or both, affected a material's natural frequency.

Help Received
Interviewed an Acoustical Engineer, Andy Harris, at BF Goodrich Aerospace. My father Randy St.Hilaire, a Structural Engineer at Northrop Grumman, helped me think of ways to do my experiment, interpret my data, and build my test apparatus.