CALIFORNIA STATE SCIENCE FAIR
2007 PROJECT SUMMARY

Name(s)
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Project Number
S0212

Project Title
Which Type of Roof Shape Can Withstand a Given Amount of Force with the Least Deflection?

Abstract

Objectives/Goals
The purpose of this project is to test different types of roof shapes through three dimensional and finite element modeling, and report the maximum deflection of each roof shape under a fixed force. This purpose will be met by testing seven various roof shapes through the use of a commercially available Computer-aided design system (CAD/CAE), which has integrated analysis capabilities. The seven roof shapes being tested are high-pitched, medium-pitched, dome, half-cylinder, flat, small curved, and gambrel.

Methods/Materials
Firstly, the NX CAD/CAE system was used to create three dimensional models of the various roof shapes. The roof shapes were then meshed (divided up) into many flat quadrilateral 10 mm elements. The resulting finite element roof meshes were then constrained to simulate the points were the roof is attached to walls. A uniform load of 10 Newtons was applied to the finite element mesh and submitted to the NX Nastran for structural analysis.
The results were post-processed in the NX CAD/CAE system using three dimensional animation of each roof deflection. In addition, the maximum and minimum deflections along with specific nodal deflections of each roof shape were populated onto an excel spread sheet.

Results
The most important finding in this computer simulated experiment was that the dome shape roof had the least defection under the given amount of force. The flat roof however had the maximum deflection, proving to be the weakest shape. The dome shaped roof had less than two percent of the total deflection of the flat roof, less that all other variables used in this project.

Conclusions/Discussion
The results can also be divided in to three main groups: curved shapes, triangular shapes, and flat shapes. Overall the curved shapes were able to deflect the least under the 10N force, and when compared to the flat roof, all three curved shapes were under 10%. The triangular shapes proved to be less efficient than the curved shapes, and when compared to the flat roof all three shapes were in the 6-30 percentage range. This shows inefficiency of triangular roofs as opposed to curved shaped roofs. The weakest of the three categories was the flat shapes. The flat roof was 100%, proving such shapes to be very inefficient roof shape.

Summary Statement
My project was about the use of computer aided finite element modeling and analysis to determine the deflection of various roof shapes under a given load.

Help Received
My father got permission for me to use the NX CAD-CAM CAE software; UGS for providing help and training in learning the tool.