CALIFORNIA STATE SCIENCE FAIR
2003 PROJECT SUMMARY

Name(s)
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Project Number
S0212

Project Title
How Does Arch Shape Affect Load Carrying Capacity?

Abstract

Objectives/Goals
This project's purpose was to determine how an arch's span/rise ratio affects the maximum load it supports before it fails.

Methods/Materials
To give all arches equal spans (a control), a test stand 30.5 cm wide was built. To create arches with different heights (the independent variable), balsa pieces were cut into ten different lengths. During each test, a balsa piece was bent into an arch and positioned in the stand. A bucket was suspended from the arch, and gravel was added until the arch failed. To calculate the arch's load capacity, the gravel's mass was measured and added to the bucket's mass. After each of the ten arch shapes was tested ten times, load capacities were averaged and compared. Also, written descriptions of arches' failures were compared.

Results
The semicircular arch supported the highest average load. The shallowest and steepest arches became unstable and failed under the lightest loads.

Conclusions/Discussion
The shallower or steeper an arch is, the lighter will be the load it supports before it fails. When extremely shallow arches become unstable, they invert their shape and fail by snapthrough buckling. When steep arches become unstable, their sides behave as pillars do; they collapse to the side and fail by Euler buckling. Semicircular arches support the highest loads because they are least prone to either type of buckling.

Summary Statement
This project studied how an arch's shape affects the maximum load it supports before it fails.

Help Received
Father and family friend helped build test stand.