CALIFORNIA STATE SCIENCE FAIR
2007 PROJECT SUMMARY

Name(s)

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Project Number

S0209

Project Title

An Energy-Efficient, Self-Correcting, Deployable Bridge: Applying the Concept of Tensegrity in Harsh Environments

Abstract

Objectives/Goals

An easily deployable bridge is often required in real life situations. Some examples include emergency relief operations, military operations, or simply reaching inaccessible areas. The challenge is to create a bridge that is easily deployable, energy efficient, cost effective, and is able to withstand harsh environments and unique situations. Our goal was to find innovative methods to create strong structures with few and easily fabricated materials.

Methods/Materials

Our search led us to the physical concept of tensegrity, a natural phenomenon present in the structure of biological cell membranes. Tensegrity structures are essentially amalgamations of sticks and strings that fit together so that the conditions of static equilibrium are always satisfied. Unlike conventional structures, tensegrity structures maintain their rigidity through only axially-loaded forces. By controlling these forces through the tension of the strings, tensegrity structures can easily alter their shape. Using lightweight materials such as aluminum and elastic strings, we were able to assemble a deployable tensegrity bridge. We did this with the use of relatively inexact tools such as readily-available drills and other classroom tools.

Results

The structural concepts are supported empirically by our load tests in which our prototype held up to 29 times its own weight. The spring-like nature of our bridge should make it easy to compact and transport. Our test results showed the bridge structure can be compacted down to approximately 50% of its original size. Finally, we have found that even when the bridge is damaged (i.e. if a tendon were to break or a rod were to be damaged) overall failure of the structure will not occur due to compensating measures in the physical tensegrity design.

Conclusions/Discussion

Other issues in the designing of such a bridge or surface with the use of our tensegrity â#oplatesâ## must be explored further to put our bridge to real world practice. For example, we need to test the bridge with well-established construction techniques such as arches, anchoring methods, material selection, and environmental testing. We believe, though, that our tensegrity bridge demonstrates promise for the future, requiring fewer resources, less technical expertise, and less industrial technology to implement while delivering a product that withstands better the punishment of harsh and unstable environments.

Summary Statement

By using simple materials, we created a deployable tensegrity bridge that maintained its rigidity after placing loads of up to 29x its own weight, making it highly effective in environments where pre-existing infrastructure was destroyed.

Help Received

Mr. Bruce Kawanami helped give direction; Mr. John Alciati helped give direction; Dads helped paste together board