

A071 ENGR

Structural Phase Transition in a Simplex Tensegrity

Abstract

Tensegrity structures can be treated as a particular category of granular materials, where the relatively stiff struts carrying pre-compression can be viewed as grains which are physically isolated from each other "floating" in a sea of pre-tension. A three-strut simplex with six tension members and three compression members is the simplest three dimensional tensegrity structure. A structural phase transition in a three-strut simplex has been experimentally observed for the first time using a physical model built using wood struts and elastic bands. When the structure is compressed to a critical state, further deformation is accommodated by internal rotation of one of the struts, rather than potential energy change in the bands. At the end of the transition, the structure reaches a new configuration which is a twin of the undeformed one. Using potential energy minimization under constraints that mimic the experiment, a similar behavior has been demonstrated using numerical simulation. A potential application of the observed phenomenon is to greatly reduce the energy required to switch between two desired shapes in active morphing structures such as airplane wings or opening bridges.

The transition can also be exploited to design impact-absorbing structures based on lattice materials formed by combination of individual simplex modules.

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