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ACTUATION PROPERTIES OF KAGOME LATTICE STRUCTURES

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The two-dimensional kagome lattice has been shown to have exceptional properties for actuation, and therefore is a prime candidate for manufacturing active structures. Activation of some members results in a global macroscopic shape change. Small deformation models show that the kagome lattice's properties are critically dependent on its initial geometry. As actuation inevitably creates geometrical changes, it is of interest to examine how the kagome properties will change when geometrically non-linear effects are imposed by large actuation strains.

This dissertation investigates the fundamental actuation properties of a kagome lattice subject to large deformations. In particular, two main aspects are examined: the actuation resistance, and the passive stiffness of the structure.

To investigate non-linear effects on actuation resistance, the simplest type of actuation, whereby one truss member is replaced by an actuator capable of altering a bar spacing arbitrarily, is utilised. Numerical results on the actuation force are presented for an infinitely large kagome lattice, by means of finite element analyses. The displacement pattern of the structure and some possible failure mechanisms are examined, including yielding and buckling. Actuation resistance is found to be lowered with expansive actuation; a limiting peak actuation stiffness is observed when the actuator is flexible. Conversely, actuation resistance is found to increase with contractile actuation.

To investigate non-linear effects on passive stiffness, a 'column' of actuators are introduced into a kagome lattice, so that for every actuator, the actuator directly above and below is also activated; the horizontal stiffness of the system is then measured. Numerical results show that when the actuators are extended, there is a sudden drop in passive stiffness at a 'critical' actuation strain. This critical actuation strain depends on the aspect ratio of the bars of the lattice, and the stiffness of the actuators themselves. For lattices with contracting actuators, the stiffness degradation is gradual, and less severe.

Finally, an experimental kagome lattice model has been manufactured from silicone rubber and has been tested by single-member actuation. The mode of deformation was recorded and the nodal displacements of the rubber model are compared to the finite element results. Close agreement of the two is obtained, thereby providing validation of the computational results presented.

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