Deployable Tensairity Structures

Development, design and analysis

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Inflatable structures have been used by engineers and architects for several decades. These structures offer lightweight solutions and provide several unique features, such as collapsibility, translucency and a minimal transport and storage volume. In spite of these exceptional properties, one of the major drawbacks of inflatable structures is their limited load bearing capacity. This is overcome by combining the inflatable structure with cables and struts, which results in the structural principle called Tensairity.

A Tensairity structure has most of the properties of a simple air-inflated beam, but can bear to hundred times more load. This makes Tensairity structures very suitable for temporary and mobile applications, where lightweight solutions that can be compacted to a small volume are a requirement. However, the standard Tensairity structure cannot be compacted without being disassembled. By replacing the standard compression and tension element with a mechanism, a deployable Tensairity structure is achieved that needs - besides changing the internal pressure of the airbeam - no additional handlings to compact or erect the structure.

The development of such a deployable Tensairity structure is investigated in this research. Insight is gained in the structural and kinematic behavior of this type of Tensairity structures by means of experimental and numerical investigations on small and large scale models. The first part of this dissertation focuses on the development of an appropriate mechanism for the deployable Tensairity structure. The second part investigates by means of experiments on scale models and numerical investigations the structural behavior of a deployable Tensairity beam and the effect of several design parameters on it. The insight gained in the first two parts results finally in the development of a full scale prototype of a deployable Tensairity beam, which is evaluated experimentally in the third part of this research.

New insights in the structural and kinematic behavior of Tensairity structures are created with this research. They form a solid base for further research on deployable Tensairity structures and bring us one step closer to the realization of an optimal deployable Tensairity beam.