Ceramic Tensegrity

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Abstract

This paper focuses on the development of a new type of tensegrity structure design through the use of ultra-light, bow-like struts composed of 3D printed joints and ceramic cables. Ceramics and tension forces can be considered mismatches when discussing structural design but, for the competition and in an effort to honor the rich history and widespread use of ceramics throughout Barcelona, the team wanted to explore and challenge traditional thought about how ceramics may be used today. The discovery of new ceramic materials is a particularly active field of research - and small scale pavilion design offers the perfect laboratory for experimentation and testing of structural properties. Ceramic fibers have well known properties such as fire and abrasion resistance and high tensile strength[1] which have led to their use in composite materials[2], but attempts to weave these fibers into a larger cables are rare. 3D printing is being researched at perhaps an even greater magnitude. It is beneficial to this design in that the joints can be precisely shaped and manufactured to reduce material quantity demands without compromising strength. In addition, prototypes can be quickly produced and tested to discover and remediate any design flaws. The Ceramic Tensegrity structure design uses 3D printed ball joints along with a 3D printed tension ring located in the center of each strut. These parts will allow flexibility in placing and connecting struts during assembly while also providing an easy and efficient way of maintaining tensile stability as new struts are added through small adjustments in individual cable tension. This design also calls for the utilization of socket cap screws to mechanically clamp the ball joints and to serve as an adjustable mounting point for the ceramic cables on the tension ring. By focusing on the design of the individual strut, the whole structure becomes a larger composition of an intentionally repetitive kit of parts which can easily be assembled by a small team. This presentation will demonstrate how these parts were developed and the functions they serve. The Ceramic Tensegrity structure embraces the uncertainty that invariably comes with innovation through the use of new ceramic materials and 3D printed parts. The design presents a question, an answer, and a new direction in materials use and lightweight structural design.

References

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[2] 3M Advanced Materials Division, “3M Nextel Ceramic Fibers and Textiles Technical Reference Guide,” November 2018, Available: https://multimedia.3m.com/mws/media/1327055O/3m-nextel-technical-reference-guide.pdf. [Accessed January 31, 2019]