Tensegrity Bridge with Prestressed Deck

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Summary

In this paper, structural analysis and design of a tensegrity bridge with prestressed deck is introduced. As a matter of fact, cable pretension results in prestressing of the deck. Nonlinear geometric effects, key load cases, influence of main cable's rise and modal analysis of this type of structure is studied by finite element. The structural behaviour of the tensegrity bridge appears to be suitable for footbridges, although peculiar with respect to traditional ones. Some suggestions about structural design, material properties and structural behaviour are summarized.

Keywords: tensegrity bridge; structural design; static behaviour; modal analysis

1. Introduction

A tensegrity system is defined as a spatial structure formed by a set of tensile components and compressive components. Tensile members are continuously connected throughout the structure, while compression struts are discontinuous members and only connected with tensile members[1,2].

Many living beings, or part of them, are structured as tensegrity systems. This structural principle governs the structure of cells, radiolarian and so on [3]. Even the net of some spiders is structured as a tensegrity. As a matter of fact, forms of nature are optimized, and the tensegrity principle, minimizing the set of compression members in the continuous set of tensile members, allows to exploit structural materials in an efficient way[4].

Nevertheless, only some sculptures in tensegrity have been assembled since Buckminster Fuller[5,6] proposed the early examples of tensegrities, and the use of tensegrities in architecture and civil engineering has been very narrow. Despite of their favourable properties, only some transmitting antenna towers and some covers have been built. René Motro[7] identified the main obstacles to the application of tensegrity structures as the following:

(a) Strut congestion, with a big number of rods close one to the other;

(b) Large deflection, as compared with conventional geometrically rigid structures, and therefore a nonlinear geometric behaviour;

(c) Complexity and difficulty of fabrication;

(d) Inadequate design tools, with a lack of design and analysis techniques.

Robert Burckardt[8] has then focused his attention in applying nonlinear programming methods to design tensegrities. He pointed out how to shape tensegrities under the design constrainst (for instance strut length and so on) that limit their reliabilities.

To provide the construction functionality, in some structures for architecture and civil engineering the tensegrity principles are respected almost everywhere, except for some members where are violated. For instance, compressed members could be the diagonals of tetrahedrons, cuboctahedrons

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