Reliability of Inflatable Bridge Structures: Challenge and First Results for a New Eurocode

Jean-Christophe Thomas, Franck Schoefs

GeM (Institute for Research in Civil and Mechanical Engineering), Université de Nantes-Ecole Centrale Nantes, UMR CNRS 6183, 2, rue de la Houssiniere, BP 92208,

Contact: jean-christophe.thomas@@univ-nantes.fr

Abstract

Tensioned textile membrane structures are now common in the field of construction and they are the subject of a standardization process to harmonize the design rules among Europe. The stiffness of the structure relies on the pretension of the membrane, which can be provided mechanically or pneumatically. The stiffness of pneumatic structures depends on the internal pressure. They are able to support external loads which are much more important than their own weight. A first reliability study is conducted on a two parallel inflatable beams structure, which can be used as a footbridge. The serviceability limit states (SLS) and ultimate limit state (ULS) are defined. The reliability analysis is conducted with the FORM method, providing reliability indices as well as sensitivity factors.

Keywords: Lightweight structure, membrane, inflatable bridge, pneumatic structure, reliability analysis, limit states

1 Introduction

Tensioned textile structures are increasingly used throughout the world. They have an important variety of potential uses. These structures are built in a growing number of countries. They are therefore subject to a wide variety of loadings. Shapes and sizes are varied, ranging from small canopies to textile covers of large stadiums. Tensile structures can be subjected to high loads, particularly because of the weather, which can lead to significant displacements and (or) collapses.

Because of the growing interest in textile structures, it became important to coordinate the rules for calculation and design. That is why the European Community decided in 2010 to set up a work-group devoted to the development of a semi-probabilistic design code for tensile membrane structures named CEN/TC/250 WG5. The final objective of this work-group is a Eurocode dedicated to membrane structures. The first step is the publication of a Scientific and Policy Report by the Joint Research Centre (JRC), which presents scientific and technical explanations for the design of membrane structures; a state-of-the-art overview on existing codes, rules, or recommendations already existing in Europe, and proposals for European harmonized rules that could be adopted in the future Eurocode [1]. The next step is the establishment of common rules based on a reliability framework to ensure acceptable performance.

Among textile membrane structures, pneumatic structures are a family composed of air-supported

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