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MULTITEXCO - High performance smart multifunctional technical textiles for tensile structures

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Abstract

In recent years, the textile industry developed a new generation of advanced textile materials for the construction sector designed to address the needs of one of the largest markets for textile products. Examples of the advanced textiles developed include fabrics for the rehabilitation of buildings, geotextiles for the consolidation of a wide range of soil structures and the high performance technical textiles for tensile structures. When combine with innovative sensors the fabrics provide an useful tool for the constant monitoring of the structures and can be used to record the mechanical performance or detect anomalies in the expected use of the structures by measuring applied loads, deformations, operating temperatures or other important parameters.
This work highlights recent advances in sensor embedded textiles for structural health monitoring of tensile structures. Attention is paid on ease of application, integration in the textile and the use of established and relatively low cost sensing methodologies. The real innovation lies therefore in transferring these methods to unexplored technological fields for smart textiles such as tensile structures.

Keywords: Smart textiles, structural health monitoring, tensile structures;

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1. The MULTITEXCO project

The research project MULTITEXCO [1] is an European Research Project founded by the FP7-SME research programme "Capacities: Research for the benefit of SMEs" in order to fully exploit the potentialities of the new generation of advanced technical textiles and smart composites favoring their effective use in the construction sector. The MULTITEXCO project aims at the following main Scientific and technological objectives:

- To develop a knowledge-base able to identify and characterize the performance specifications of existing products and the newly developed knowledge by the RTD performers during extensive scientific characterization laboratory work and tests on the field;
- To develop a collaborative web based knowledge platform to be integrated in the project website and to be provided to the SME Associations as proprietary tool;
- To perform a detailed LCA and LCCA;
- To provide a scientific basis for norms and standards in the construction sector for the new multifunctional textiles in order to favor the standardization process.

MULTITEXCO is focusing on key developments in smart textiles for roadwork and embankments, structure retrofitting and fabrics for tensile structures. This contribution will show examples from the last application area focused on high performance textiles for tensile structures and will provide an overview on multifunctional fabrics that can be used for monitoring tensile structures..

2. High performance textiles for tensile structures

On the basis of the day to day real life experience from the industrial partners of the project, MULTITEXCO identified a series of bottle necks that potentially could decrease the stability and reliability of a given structure.

- Unexpected stresses in the fabric (modelling can become very complex)
- Extreme wind or snow load (difficult to model)
- Friction between support and fabric (small vibrations)
- Misuse (elevated temperatures, chemicals, ..)

The behaviour of the structure can be monitored and investigated through a number of standalone systems available today [2]. However, these require external mounting, additional wiring and/or localized measurements by hand. A new generation of smart textiles with integrated sensors able to identify the various causes of potential failure may increase confidence in tensile structures or signal pending failure. In brief, the development of multifunctional materials integrating pressure, strain, vibration and temperature sensors that can signal design or confection flaws or send out an alarm triggered by a severe environmental impact like snow load or heavy wind. In addition, the materials could signal misuse of the fabrics by using chemical responsive coatings and provide means to avoid warranty dispute. Clearly, the reliability of the sensors introduced in the fabrics needs to match the expected life time of the structure. [3]

In addition to the sensor life time, proper connections between the fabric and the supporting structure are mandatory to ensure the construction is at equilibrium state. In contrast to conventional rigid structures, the tensile structures endure small movements and vibrations. This may cause defects at the fabric-retaining structure interface due to puncture, abrasion and repeated bending.

From the various multifunctional membranes developed, an assessment was done in order to identify the most useful sensor for further testing. This was done in close communication with people in the field of tensile structures. The assessment focuses on applicability, state of development and usefulness (Table 1). From this, the most interesting multifunctional membranes are identified and subjected to further testing.