

Monitoring Forces in Tension Structural Members of Lightweight Architecture

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Abstract

Lightweight Architecture and Structures are gaining on importance in the modern world. Looking at some modern structural projects one thing comes to mind: "Only sky is the limit."

The scientific understanding of tensile technology in late XX century has arguably revolutionized the engineering design and the construction methods of structures with cables, ropes and tension rods. Adding covers with modern materials like membranes or ETFE foils large wide span structures are now achievable.

With the raise in size of wide span structures also the impact of wind, snow, sand and hail is significant and the physical demand on primary structure (mostly steel structure) is getting bigger. Snow has a massive influence on the primary structure despite the very short and nowadays predictable duration of snow impact over the year. The combination of modern lightweight structural design with monitoring forces in the structure allows more economical use of raw materials and timely adjustment of the building form to the changed environmental conditions.

Two examples about the possible use of monitoring systems are presented with BC-Place Stadium in Vancouver and the ETH Lausanne Congress center.

BC-Place Stadium uses a pneumatic system in its retractable roof to actively change the air pressure in the fabric cushions and to increase load capacity of the retractable roof based on the weather conditions and snow loads on the tension structure.

ETH Lausanne is based on a more traditional warning system. A monitoring system is permanently reading the load in the tension cables. An alarm is triggered when the load reaches defined limit levels and then snow needs to be removed from the roof.

Next to the precision in force readings of a tensioned structure a simple implementation is key for an economical use of lightweight architecture throughout the year or just to push the boundaries of wide span structures further.

The monitoring system LoadSCAN™ is a good example for an integrated measurement system of tension members.

The recent development of the LoadSCAN™ system enables the load control during installation and the whole life span of a tension structure. LoadSCAN™ can be combined with geometric survey data of the structure and other readings to provide full monitoring that analyses the performance of a building. The applications vary from bridges and long span roofs down to simple warning systems for snow loads. The LoadSCAN™ system is based on an ultrasonic measurement principle. It has been developed by PFEIFER for the wide range of applications in the construction industry.

Keywords: Lightweight structures, tension members, cable systems, pneumatic membrane systems, snow loads, pre-tensioning, force measurement, monitoring of forces, monitoring of structures.