6th ECCOMAS Conference on Smart Structures and Materials
SMART2013
Politecnico di Torino, 24-26 June 2013
E. Carrera, F. Miglioretti and M. Petrolo (Editors)
www.smart2013.com

FBG SYSTEM FOR MONITORING OF DYNAMIC LOADS CAUSED BY CHEERING DURING FOOTBALL COMPETITIONS

Marek Skłodowski[*], Piotr Pawłowski[**], Daniele Posenato[†]

[*] Institute of Fundamental Technological Research, Polish Academy of Sciences
Department of Intelligent Technologies
ul. Pawińskiego, 5B
02-106, Warszawa, Poland
e-mail: msklod@ippt.gov.pl, web page: http://smart.ippt.gov.pl

[**] Institute of Fundamental Technological Research, Polish Academy of Sciences
Department of Intelligent Technologies
ul. Pawińskiego, 5B
02-106, Warszawa, Poland
e-mail: ppawl@ippt.gov.pl, web page: http://smart.ippt.gov.pl

[†] SMARTEC SA
Via Pobiette 11
CH-6928 Manno, Switzerland
e-mail: daniele.posenato@smartec.ch, web page: http://www.smartec.ch

Key words: FBG, Stadium monitoring, Dynamic loads.

Summary. *Nowadays large stadium structures are designed for assumed static loads and it is difficult to calculate important influence of real stresses resulting from dynamic loads caused by moving crowds. The paper presents Structural Health Monitoring System, based on multiplexed Fiber Bragg Grating sensors. They are used to measure strains and temperature of structural elements and allow us to measure dynamic deformations to observe changes in structural behaviour of the stadium during cheering on a football competition and calculate instantaneous anthropogenic loads.*

Nowadays large stadium structures are usually made of reinforced concrete elements. Material properties allow engineers to build slender supporting elements and large heavy modular sections of stands placed on them. Stadium structures are designed for assumed static loads and it is difficult to calculate important influence of real stresses resulting from dynamic loads caused by moving crowds. It is observed that during football competitions significant structural vibrations can be felt by humans standing at various places of the stadium, even quite far away from the stands.

The vibrations are forced by thousands of football fans moving or jumping rhythmically in some coordinated manner. In the case of monitored stadium a mass of the jumping crowd can be estimated as being over 500 000kg, which contributes in an uncontrolled dynamic manner to the total structural loads.

The most vibration prone elements are slender piles supporting stands and roof girders. Therefore it was decided to develop a measurement system for monitoring static and dynamic deformations of these elements under everyday ambient loads and during a football competition.

The Structural Health Monitoring System is based on multiplexed Fiber Bragg Grating sensors. They are used to measure strains and temperature of structural elements and allow us to measure dynamic deformations with the frequency of 100Hz to observe changes in structural behaviour of the stadium during cheering on a football competition and calculate instantaneous anthropogenic loads. Comparison of a long-term structural behaviour can also be done to monitor possible changes of vibration characteristics due to unexpected overloads or other damage accumulation processes.