Application of fiber optic high temperature sensors for structural monitoring of structures submitted to fire

Paula RINAUDO
Civil Engineer
ICITECH, UPV
Valencia , Spain
pauri@posgrado.upv.es

Benjamín TORRES GÓRRIZ
Dr. Civil Engineer
ICITECH, UPV
Valencia , Spain
bentorgo@upvnet.upv.es

David BARRERA VILLAR
Dr. Telecomunication Engineer
ITEAM, UPV
Valencia, Spain
dabarvi@iteam.upv.es

Ignacio PAYÁ ZAFORTEZA
Dr. Civil Engineer
ICITECH, UPV
Valencia , Spain
igpaza@upvnet.upv.es

Pedro CALDERON GARCIA
Dr. Civil Engineer
ICITECH, UPV
Valencia , Spain
pcaldero@cst.upv.es

Salvador SALES MAICAS
Dr. Telecomunication Engineer
ITEAM, UPV
Valencia, Spain
ssales@dcom.upv.es

Summary

Recent events such as the fires on St. Gotthard (2001), the Twin Towers in New York (2001) and the Windsor Building in Madrid (2005) show the importance and the necessity of a monitoring strategy for fire vulnerable structures. Through this strategy, the assessment of fire damaged structures would be possible and if necessary, their demolition operation could be guided. To monitor structures subjected to fire it is essential to have high temperature sensors. Nowadays, the measurements of temperatures during fires are done by high temperature thermocouples, that have the typical drawbacks of the electric sensors. This paper presents a new high temperature fiber optic sensor (FOS) able to measure temperatures up to 1200ºC developed at the Universitat Politècnica de València in Spain. The paper explains the operating principle of the FOS to measure temperatures as well as experimental (fire test) and numerical studies conducted to verify the sensor performance.

Keywords: Fire; high temperature measurement; structural health monitoring (SHM); fibre optic sensor; fiber bragg gratting.

1. Introduction

Structural Health Monitoring (SHM) has been defined as the use of in-situ, continuous or regular (routine) measurements and analyses of key structural and environmental parameters under operating conditions, for the purpose of warning impending abnormal states or accidents at an early state to avoid casualties as well as giving maintenance and rehabilitation advice [1].

Although the formal establishment of this discipline is relatively recent, dam or building monitoring is relatively old (first half of the twentieth century). Currently, structural health monitoring is booming and is very common to install sensors in complex structures, in dangerous construction process or in structural repairs.

Monitoring systems are composed of three elements: a sensor array, a data processing system (acquisition, transmission and data storage) and a structural assessment system. To monitor structures submitted to fire, high temperature sensors are essential. In the case of accidental loads like fires, earthquake (which frequently results in occurrence of fire) and terrorist attacks, continuous monitoring is very helpful to evaluate structural safety, evacuation and, if necessary, to define a safe procedure for demolition.

Sometimes, structures have been monitored taking into account the earthquake action (see e.g. [2]), but, as far as the authors know, fire action has been considered more in laboratory tests (see e.g. [3]) than in real world structures. For this reason, a monitoring strategy for fire vulnerable structures has not been defined yet.

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