Seismic Behaviour Assessment of Long Viaducts: a combined FEM and SHM approach

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Summary

In this article, we introduce an innovative approach for the seismic behaviour assessment of great length viaducts during or after a seismic event. This methodology is based on the combined use of a monitoring system installed at the structure and Finite Element Models. The sensors network provides real-time information about the structure, and its validity to continue in service after an earthquake. If anomalies are detected, the system triggers a number of alarms and coordinates human protocols for further evaluation of the structural health of the structure.

Keywords: instrumentation; structural health monitoring SHM; damage detection; seismic event; real-time response.

1. Introduction

In recent decades, many cities have developed large transport infrastructure in order to tackle the urban traffic increase. The construction of great length viaducts inside cities is one of the solutions most frequently developed. Some representative examples of these infrastructures- and also recent construction projects - are the Electric Train in Lima, with an urban viaduct 33 km long and, in the case of urban traffic, the Bicentenario Viaduct and the Viaduct of the Autopista Urbana Norte in Mexico City, with overall lengths of 23 and 10 km respectively.

There is a large number of examples and literature about the use Structural Health Monitoring (SHM) systems. But these tend to focus on smaller bridges or on singular bridges, such as cable-stayed viaducts. However, the real behaviour of these large urban infrastructures in case of seismic events is little known. A fast and precise assessment of the structure status after an earthquake would be very useful to confirm its expected seismic capacity. This information can be especially advantageous in structures that are part of toll road concessions. In these cases, it would be easier to take a quick decision about continuing with its operation after a seismic event.

Additionally, this operational assessment can be complemented by the acquisition of more data and information about its dynamic behaviour. This extra information would increase the knowledge about these structures and also be used to improve the design and maintenance techniques of similar viaducts.

In this article, a methodology to address these problems is proposed. This methodology is based on the use of a SHM system, combined with the development and analysis of Finite Elements Models (FEM) of the structure.

The network of installed sensors provides - after software post-processing – remote, real time information, about the static and dynamic structure´s behaviour through an easily accessible Web Interface. The available information is provided before, during and after the occurrence of a seismic event. Theoretical models will be calibrated with data obtained from the monitoring system, in order not only to predict the future behaviour of these structures in more intense seismic events, but also to evaluate safety thresholds and alarms on the system.

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