Fused seismic shock absorbers – an innovative solution for a high-speed rail viaduct of the AVE Granada Line, Spain

Gianni MOOR
Civil Engineer
mageba USA
New York, USA
gmoor@magebausa.com

Gianni Moor, born 1968, received his civil engineering degree from the Swiss Federal Inst. of Technology (ETHZ) and his MBA from the IESE Business School. He is COO of mageba Group and CEO of mageba USA.

Niculin MENG
Civil Engineer
mageba sa
Bülach, Switzerland
nmeng@mageba.ch

Niculin Meng, born 1980, received his civil engineering and master's degrees from the Swiss Federal Institutes of Technology in Lausanne (EPFL) and Zurich (ETHZ) respectively. Today, he is Head of Sales of mageba.

Borja BAILLÉS
Civil Engineer
mageba sa
Bülach, Switzerland
bbailles@mageba.ch

Borja Baillés, born 1984, received his MSc. civil engineering degree from the Technical Univ. of Catalonia (UPC). He is mageba's area manager for West Europe and North Africa.

Summary

The high-speed AVE railway line to Granada is to cross a highly seismic area with an irregular topography. The design of a viaduct for one section requires its deck to be connected to one of its abutments by shock absorbers which generally act as rigid connections but which dissipate energy and protect the structure from overloading during a large earthquake. A solution has been developed, incorporating the modification of a standard shock absorber to feature an innovative fused connection. This connection is designed to resist fatigue from service loading, and to fail in a controlled manner under the action of a high seismic load, freeing the device to act as a damper. It thus provides seismic protection of the viaduct at its fixed point, contributing to an efficient abutment design. The device's design and behaviour are described, with reference to its fulfilment of the requirements of EN15129 and the testing that has proven its innovative functionality.

Keywords: seismic; damper; fuse; optimisation; abutment; railway; viaduct.

1. Introduction

The area around Granada in southern Spain has been known for its seismicity since Roman times. More recently, earthquakes in nearby Lorca (Murcia) in 2011 highlighted the persistence and dramatic potential of such events in the area. It is also an area with a rugged terrain around the mountains of Tejeda, Almijara and Alhama in the Sierra Nevada range. The new AVE high-speed railway line to Granada will traverse this region, requiring its designers and constructors to ensure its safety and serviceability in spite of seismic threats. In particular, structures such as viaducts must be protected from the type of seismic activity that is relatively common in the area [1], and must remain useable by emergency traffic even following a very large earthquake – conforming to the Spanish railway norm NCSP-07 and its European equivalents. The desire to improve efficiencies and reduce costs while fulfilling all such requirements has motivated the responsible engineers to consider how common seismic protection solutions can be adapted and developed to optimally achieve this for each structure.

This is particularly important where the seismic design load case is decisive for the design of the substructure (piers, abutments and foundations) and the connections to the bridge deck [2]. For continuous bridge deck solutions, in designing for longitudinal resistance, there are three basic options: with a fixed point at one abutment, with a fixed point at the middle pier, or a damping strategy with shock transmission units (STUs) at the abutments [2].

A solution presenting a variation of that third approach is presented here for a viaduct over the Rio Frio on the Loja variant of the AVE line. Instead of STUs, the engineer proposed the use of shock absorbers (SA) with very low damping exponent at an abutment, incorporating a fuse element which provides rigidity during normal operation.

https://doi.org/10.2749/222137814814068201