SEISMIC PROTECTION OF BRIDGES IN THE WORLD AND IN IRAN: THE BASE ISOLATION AND ENERGY DISSIPATION APPROACHES

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Keywords: Seismic Protection, Passive Control, Infrastructures

The passive control of structures to reduce the effects of earthquakes on structures through seismic isolation and/or energy dissipation has come of age in the last 25 years, as an alternative to conventional seismic design methods (capacity design) based on the ductile response of structural elements – which accept even serious damage to the structure provided it does not collapse. The aforesaid passive control technique makes possible the avoidance of any damage to the structure.

Seismic isolation implies the introduction of appropriate devices - called isolators - into a structure (at its base, in buildings or pier caps in bridges) that, thanks to their low horizontal stiffness, uncouple the movement of the structure from ground motion (i.e. change the dynamic properties of the structures to move its fundamental frequency far away from the dominant frequencies of the earthquake). In other words, seismic isolation reduces the energy that an earthquake inputs into a structure. This causes a reduction in the accelerations transmitted to said structure so that structural elements remain within an elastic field even during high intensity earthquakes.

Large displacements at the seismic isolation level can be reduced by increasing the damping of the isolation system. Seismic isolation, often combined with energy dissipation, is mainly applied to bridges, buildings, certain industrial plants such as nuclear power plants and, more recently, to petrochemical plants. Field observations/measurements in recent earthquakes (California, Japan and Turkey) have confirmed the advantages of this technique, which had been previously theoretically shown by a large number of numerical and experimental studies.

In terms of seismic isolation of bridges, the best seismic isolation systems are generally considered those offering large amounts of energy dissipation through strong non-linear behaviour. In effect, in the overall evaluation of a bridge seismic protection, the main goal is to reduce seismic forces as well as deck movements, providing a solution to the need for minimizing expansion joints and bearings' stroke as well as costs thereof. Therefore, in order to reduce both stroke and force, a solution has been found in high damping devices (more than 30% of equivalent viscous damping) and in particular, strongly non-linear devices such non-linear fluid viscous dampers or those exhibiting elastic-plastic behaviour, that can limit the forces transmitted to piers.

The aim of introducing energy dissipation devices in a structure is to dissipate as much as possible the energy of the earthquake through properly designed devices (dampers) instead of dissipating it through damage to structural elements, and thus strongly reduce ductility demands on said structural elements.

In the paper, the most widely used isolation/dissipation devices are described, by making reference to recent applications through the world, in particular to those combining curved surface sliders with fluid viscous dampers (see, for example Figure 1), as well as in Iran.

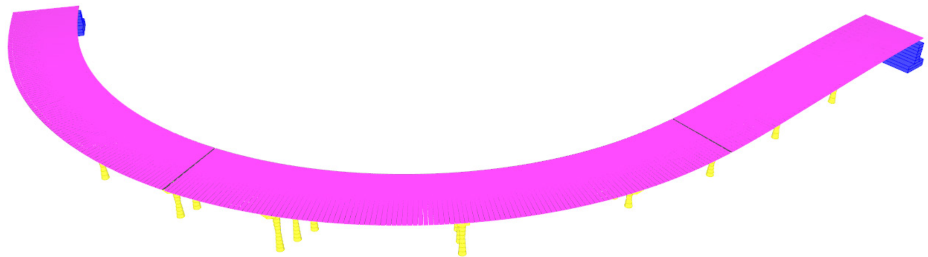

Figure 1. Finite Element Model of the Saina Ryskulova viaduct in Kazakhstan

REFERENCES

Infanti S and Castellano MG (2007) Sheikh Zayed Bridge seismic protection system, *Proceedings of 10th World Conference on Seismic Isolation, Energy Dissipation and active Vibrations Control of Structures,* Istanbul, Turkey

Infanti S, Papanikolas P and Stathopoulos-Vlamis A (2010) The Behavior of Rion - Antirion Bridge Seismic Protection System During the Earthquake of "Achaia-Ilia" on June 8, 2008, *Proc. of the 14th European Conference on Earthquake Engineering*, Ohrid, FYROM

Matildi G, Isani S, Cammarota G, Tomaselli F and Castellano MG (2014) Seismic isolation of highway viaducts through pendulum isolators, *Proceedings of Istanbul Bridge Conference*, Istanbul, Turkey

Tomaselli F, Castellano MG and Baldo P (2014) Seismic isolation system for railway viaducts in Venezuela, *Proceedings of Istanbul Bridge Conference*, Istanbul, Turkey