Implementation of Seismic Eco-Isolators in a vehicular bridge

Juan Sebastián Martínez*[a], Andrés Álvarez G.[†], Felipe Guerrero M.[†], Albert R. Ortiz[†], Peter Thomson R.[†], Johannio Marulanda A.[†]

[*] Research Group in Seismic, Wind, Geotechnical, and Structural Engineering (G7)
Universidad del Valle
Campus Meléndez, Calle 13 # 100-00, Cali, Colombia
e-mail: juan.martinez.sandoval@correounivalle.edu.co, web page: https://eicg.univalle.edu.co/G-7/

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ABSTRACT

Seismic isolation is one of the most commonly used types of structural control systems to reduce the vulnerability of vehicular bridges to seismic events. Although isolators perform well, their application in Colombia is limited due to their typically high costs. Currently, there is no consolidated production line in the country, so they must be manufactured and validated in another country before being imported. An alternative to this problem is the production of low-cost seismic isolators made from recycled rubber from used tires and reinforced with polyester fibers ("Eco-Isolators"). This work consists of evaluating the performance of these devices in their application on a vehicular bridge in Cali, Colombia. The performance evaluations were conducted through computational simulations using two finite element models created in SAP2000 and OpenSees. Both models were based on the structural plans of the bridge and technical data of the materials. To adjust the dynamic properties of the models, the results of a dynamic characterization study of the structure were used, which included the identified frequencies and mode shapes. The percentage difference and the Modal Assurance Criterion (MAC) were applied to compare these two properties, respectively. Once both finite element models were adjusted, computational simulations were performed to evaluate the performance of the designed isolator system. These simulations included response spectrum analysis and time-history analysis, evaluating parameters such as periods, base shears, displacements, accelerations, and equivalent seismic forces transmitted to the piers. As a reference for comparison, the same simulations were conducted for two additional models: one without seismic isolation and another with the existing LCRB isolators. Starting from the model without isolation, after implementing the designed Eco-Isolators on the model without isolation, there was an increase in the fundamental periods in the longitudinal and transverse directions of the model, respectively, allowing for a 54.3% reduction in the equivalent seismic forces. Additionally, there was a reduction of up to 45% in the base shear. It was concluded that the designed Eco-Isolators demonstrate a high-level performance in reducing the vulnerability of the bridge to seismic events.