Repair and Retrofit of a Roman Bridge in Turkey

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ABSTRACT

This study assesses the earthquake performance of a historical masonry arch bridge in Aizanoi ancient city, which is located in the mid part of Turkey near Kütahya. Aizanoi was the capital of the territory called Aizanitis, located in the area of Phrygia. Historians agreed that Roman settlement in this area started in 3rd millenium BC. The structure is made of stone and has five arches of 5.40m, 6.70m, 7.30m spans. Rise of the arches are varying from 2.70m to 3.65m. Restoration works have completed in 2018. Before the restoration works have been started the bridge was used for vehicles, even for heavy trucks. Today the bridge is using only for pedestrians. After a detailed site investigation, material characterisation and soil tests were performed, ambient vibration test was carried out on site, by placing accelerometers at several points on bridge span to capture dynamic properties of the structure. Different methods such as Frequency Domain Decomposition, SSI were used to extract the experimental natural frequencies, mode shapes, and damping ratios from these measurements. Experimental results were compared with those obtained by the linear finite element analysis of the bridge. Good agreement between mode shapes was observed in comparison, though natural frequencies disagree by 8-10%. The boundary conditions of the linear finite element model of the bridge were adjusted such that the analytical predictions agree with the ambient vibration test results. According to the total strain crack material model, the calibrated linear FE model was extended into a nonlinear model then Nonlinear Static Pushover analyses of the bridge along longitudinal and transversal directions were performed. Obtained results are in good agreement with previous case studies' results.

In order to compare collapse load of the bridge with pushover analysis results, kinematic limit analysis procedure is used to assess longitudinal and transverse seismic capacities. The capacity curves are obtained by means of limit analysis approach. The study is aimed to identify on one hand the horizontal load multiplier that activates the kinematic mechanism, on the other hand the collapse displacement. The numerical results of the structural capacity so found have been compared with the results available in literature and acceptable agreement of the results have been obtained.

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