Seismic reliability analysis of historical bridges

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Historical bridges, especially arch bridges of the rail network, are one of the most important historical structures in any country. There are at least 9000 masonry arch bridges in Iran's railway network. Therefore, accurate and realistic assessment of their seismic performance according to the complexity of material behavior as a discrete jointed environment and also the existence of uncertainty of material properties is essential. In this research, the discrete element method (DEM) was used to analysis bridges. In the first part of the research, two stone arch bridges of Iran's railway network have been analyzed under the influence of selected earthquakes using incremental dynamic analysis (IDA) until the failure stage. The destruction process and dominant failure patterns of both bridges were identified and the fragility curve of each bridge was determined. The results showed that the spectral acceleration of the collapse threshold of the larger bridge is about 45% to 61% of the acceleration of the smaller bridge. In the second part, the mechanical properties of stone materials of the smaller bridge were selected as random variables. By using the response surface method (RSM), the response functions of the bridge were determined and after determining the criterion of the limit state of failure, the limit state function was determined in any spectral acceleration for all selected earthquakes. Seismic reliability analysis of the smaller bridge was performed with FORM, SORM and MSC methods. The results of the analysis showed that the uncertainty of the mechanical properties increases the seismic response and vulnerability, and for spectral accelerations greater than 0.8g, the failure probability is higher than the target failure probability and the bridge will not have the necessary seismic safety. By conducting a sensitivity analysis, it was determined that the normal stiffness of material joints and the angle of internal friction have the greatest effect on changing the probability of bridge failure.

Keywords: Masonry materials, Arch bridges, Discrete element method, Fragility curve, Reliability.