EVALUATION OF THREE SPAN ARCH STONE BRIDGE IN DRODGARAN UNDER EARTHQUAKE

M. KEIVANNIA
Malayer Islamic Azad University
m_kivannia@yahoo.com

Amirhoshang AKHAVEISSY
Assistant Professor, Razi University, Kermanshah, Iran
ahakhaveissy@razi.ac.ir

Keywords: Stone Bridge, Seismic Behavior, Nonlinear Analysis, Seismic Response, Tensile Damage

In this research, three spans arch stone bridge in Drodgran of Malayer from Hamedan State is analyzed under support excitation. This bridge is constructed in through of Iran by Ministry of Roads and Urban development. The plan of this bridge is as the constant type plan. The length of the bridge is 27.2m, width of the bridge 23m, span length 6m, the thickness of the side piers 2.2m and the middle piers 2.4m and also the hight of the embankment on the bridge is 4 m. Figure 1 shows the geometry of the bridge. It is noticeable that the stone masonry bridge generally analyzed for gravity forces (Kishi et al., 2011; Betti, 2006).

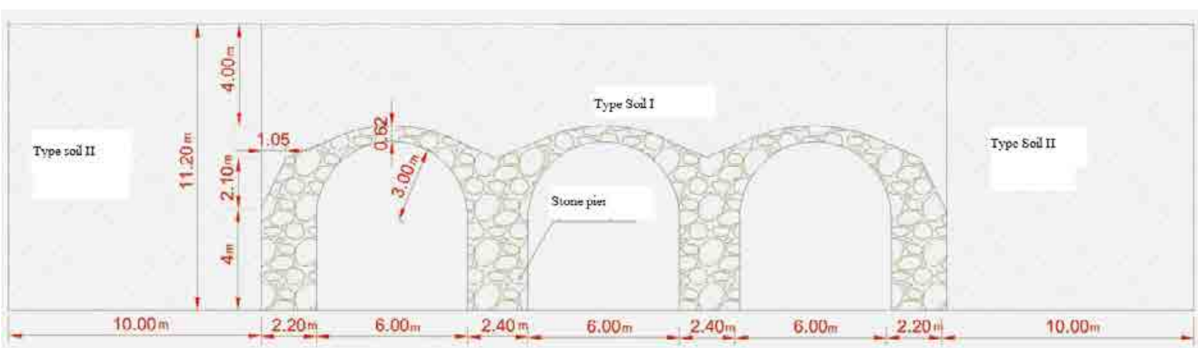

Figure 1. The geometry of the bridge

Table 1. The elastic parameters of the stone and soils

Poisson ratio	Elastic modulus (N/mm2)	Weight of the volume (N/mm3)	material
0.2	7462	$23\text{x}10^{-6}$	Stone and mortar joints
0.35	85	$20\text{x}10^{-6}$	Soil type I
0.35	85	$21\text{x}10^{-6}$	Soil type II

The finite element model and the horizontal displacement of the crest of the stone bridge are shown in Figure 2. The model is included 22848 nodes and 15819 brick elements. The bridge is excited under Tabas earthquake with 0.82g PGA. The model parameters are determined based on a experimental speciemens series. Therefore, predicted results based on the parameters can be used to assess the vulnerability of the bridge under earthquake forces. Hence, three stone prism are constructed by applied material for the construction of the Drodgran's bridge. Also, macro-element model based on the damage plasticity is used for analysis of the bridge. Stress-Strain curves of the material is constructed by Hagnestad model (Akhaveissy and Desai, 2011; Akhaveissy and Milani, 2013).

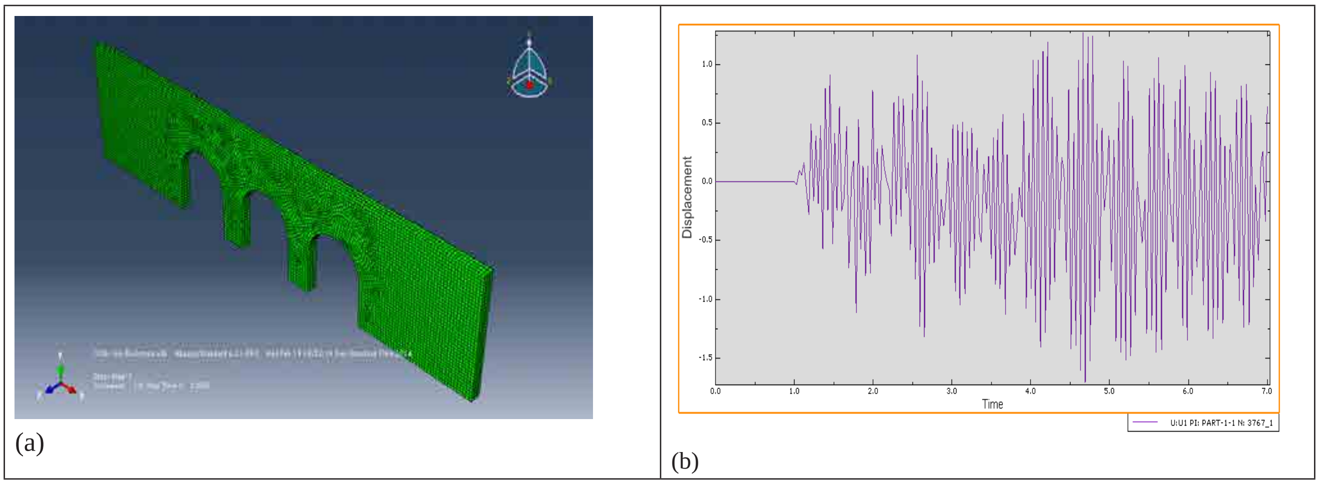

Figure 2. a) The finite element model and b) the horizontal displacement at the crest of the stone bridge

Predicted results show the bridge can not tolerate such earthquake excitation. Also, Figure 3 shows the distribution of the tensile damage due to Tabas earthquake. The maximum value of the tensile damage is 0.747 at the base of the piers. The tensile damage equal to one show the full failure of the element. Hence, it seem that the bridge is at life safety performance level. Therefore, the bridge should be strengthened againts the earthquake. It is noticeable that the Drodgran's bridge is evaluated as a lifeline. The bridge connect different cities and counties.

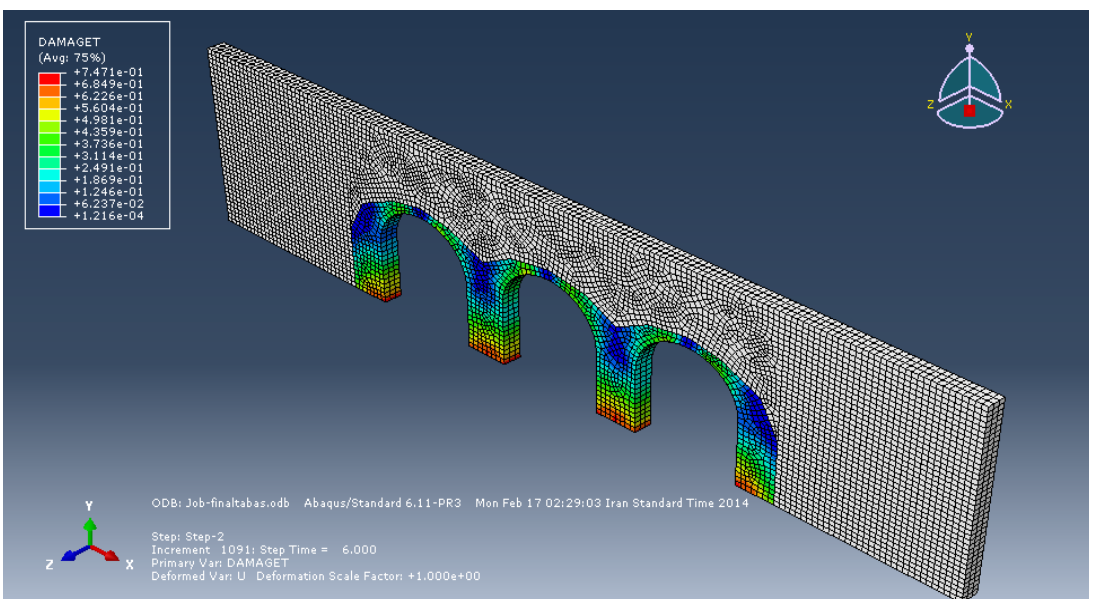

Figure 3. Distribution of the tensile damage under Tabas earthquake

REFERENCES

Akhaveissy AH and Desai CS (2011) Unreinforced Masonry Walls: Nonlinear Finite Element Analysis with a Unified Constitutive Model, *Arch Comput Methods Eng.*, 18, 485–502

Akhaveissy AH and Milani G (2013) Pushover analysis of large scale unreinforced masonry structures by means of a fully 2D non-linear model, *Construction and Building Materials,* 41, 276–295

Betti M, Drosopoulos GA and Stavroulakis GE (2006) On the collapse analysis of single span masonry/stone arch bridges with fill interaction/ Arch'07 – *5th International Conference on Arch Bridges*, 617-624

Kishi Y, Nozaka K and Izuno K (2011) Nonlinear Behavior of Masonry Arch Bridge Under Ground Deformation, *Journal of Disaster Research*, 1(6): 44-45