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EXTENDED ABSTRACT

Numerical Modeling of the Dynamic Response and Effect of Far and Near Earthquakes on the Metro Station Located In The Vicinity of the Fault-a Case Study of Tabriz Metro Line 2 Stations

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1. Introduction

For the first time in January 1991, the issue of studies and construction of urban trains was proposed by the esteemed representatives of the city of Tabriz in the Islamic Consultative Assembly. Due to the increasing growth of intercity travel in Tabriz and the need to use a 2-rail transportation system in order to reduce traffic problems, studies of Tabriz city train lines were conducted and Tabriz city train network including 4 routes, a total of 60km and 63 stations were designed.

The analysis of underground structures is very complex due to the interaction with the surrounding environment in a dynamic state. For this reason, less research has been done. One of the first people who investigated the effect of earthquakes on underground structures is Newmark, in 1968 he presented an easy method to calculate the relative strains of underground pipe structures and long tunnels (Bozorgnia et al., 1995). In 1969, Kuesel established a simple method for calculating earthquake forces on linear tunnels, which in most cases is the basic of later works. Douglas and Warshaw in 1971 presented the results of tunnel design analysis under the influence of earthquakes. Lee and Trifunac in 1979 investigated the response of the lined tunnel under the shear wave effect. In 1981, Owen and Scholl's studied three types of deformations, including compressive-tensile, longitudinal bending, and rhomboidal and elliptical deformations as the result of seismic vibrations in underground structures.

Fahmideh, Baghmisheh, Abbasi Square and Azad University Station are located in the northern development route of Tabriz Metro Line 2, that the Fahmideh station is located in shopping center and Baghmisheh station is located in fish bazar region and Abbasi station is in Abbasi square and also Azad university station is located behind university. Awareness of the stability situation and solving possible problems of a structure, before starting its construction, allows the designer and executor of the project to perform a correct technical and economic study of the construction conditions and permanent stability of the structure. A design engineer and operator of drilling and maintenance of a subway station can also use the stability analysis of the subway station to obtain important results about the stability of the station and the necessary equipment for its maintenance during construction and operation.

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2. Methodology

2.1. Numerical modeling

Abaqus has the ability to solve problems from a simple linear analysis to the most complex nonlinear modeling. This software has a very extensive set of elements that any geometry can be modeled by these elements.

Today, due to the increase in terrorist attacks, all structural engineers and architects in the world are trying to find solutions to control or prevent damage. In Iran, this effort is known as passive defense. Therefore, it is up to each student or professor in the field of engineering to learn how to model and deal with this burden and generalize it so that he can get a right result from it and take a positive step in this direction. This subject is not possible except with a lot of study and familiarity with the types of modeling that is done in relation with the explosion charge in different finite element software.

2.2. Station modelling

In this section, structural elements such as floor structures, concrete slabs and soil in real size in meters are drawn and stored. Solid element is used to model the structure of floors, concrete slabs and soil, although solid or shell elements can also be used, but due to the fact that the wire is in two nodes, modeling and orientation of beams and columns must be done with special care. But the cost of software calculations and analysis is significantly reduced and the accuracy and accuracy of results increase significantly, that this issue in the case of solid modeling, due to the increase of elements and nodes and consequently the increase of node forces created in the structure and the complexity of equations for solving equations, the cost of calculations increases sharply and the accuracy of the results decreases. 3D numerical model is illustrated in Fig. 1.

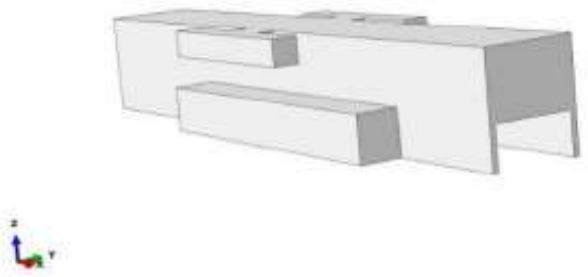

Fig. 1. Three-dimensional view of structure in ABAQUS environment

3. Results and discussion

According to the results, soil acceleration in the effect of Varzaqan earthquake in every 4 stations is more than structure. The lateral displacement of the structure in all stations under the Imperial Earthquake record is higher than the others and it has a constant effect along the structures, while the other three records have less effects but differ more along the displacement. Vertical displacement occurs at all stations and under all records in the middle of the structure. But the Kobe and Chichi earthquakes caused the least vertical displacement in all stations, while in Fahmideh station, Imperial earthquake and in the other two stations, Varzeqan earthquake, caused the most vertical displacement. Also results show that in the depth of Fahmideh and Abbasi stations, under all records in the middle of the structure, highest stress occurs but in the Azad university station, a special order can be seen in the depth of the structure. It turns out from analytical model, the highest shear force is created in the middle of the station structure in all records. Also, the Imperial and Varzaqan earthquakes have created more shear force in the structures of the stations. And the subsidence curvature shows that Varzeqan earthquake records caused the most subsidence in all stations and two earthquakes in Chichi and Kobe caused the least subsidence in all stations. The location of selected points in soil are shown in Fig. 2.

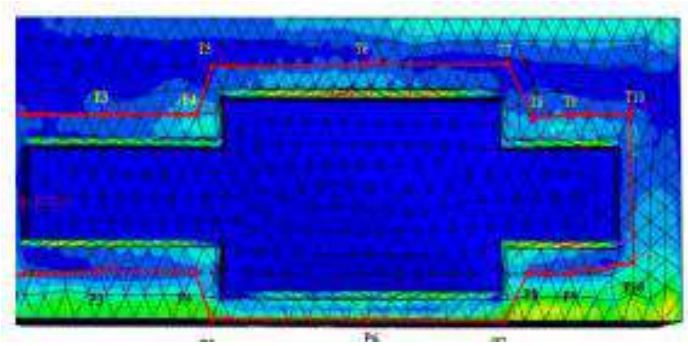

Fig. 2. The location of selected points in soil

4. Conclusions

1. By examining the results, the effect of acceleration on the soil was greater (both in distant and near earthquakes) but under the soil and structure, the same acceleration was occurred.
2. The amount of vertical displacement in Fahmideh and Baghmisheh stations was greater than the two stations of Abbasi and Azad University, but on the contrary, the effect of Varzeqan earthquake in Abbasi station and Azad University was more than Fahmideh and Baghmisheh stations.
3. The effect of a distant earthquake is equal to the earthquakes near the fault in the lateral displacement in the length of the structure.
4. As the height of the structure increases, the structural stress increases in near and far earthquakes.
5. The amount of shear force in different parts of the structure in a distant earthquake is more than a near earthquake and in the middle of the structure it is more than other points that should be considered in the design of station structures.
6. Structural subsidence in Varzeqan earthquake is greater in the mentioned stations.

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