



Risk Damage Evaluation of Surrounding Buildings of O7 Station of Line7-Tehran Metro Using Relative Stiffness Method

T. Abdolahi^{1*}, A. Jafari², M. saeedi¹, F. NzhadshahMohammad¹, H. Pourseedi¹

1- MSc Student, School of Mining, University of Tehran, Tehran, Iran

2- Assistant professor, School of Mining, University of Tehran, Tehran, Iran

(Received 3 Oct 2011, Accepted 1 Jul 2015)

ABSTRACT

Tunnel construction in soft ground causes ground displacements around it. Displacements influence surface and subsurface structures in urban areas and cause serious damages and injuries. So prediction of ground deformations and involved possible damages on surrounding structures are major parts of designing and planning in soft ground tunnelling. In this paper, O7 station of line7- Tehran metro was modeled using FLAC3D. This station is located in residential and commercial region with high density. Station excavated using underground method. At first, a gallery was excavated in middle of station in order to access and excavation of lateral piles and concrete arcs. To control the settlement, piles and concrete arcs created as temporary support with 1.2m spacing. In the next stage inside of station excavated and permanent support installed. It found that two buildings located in influence area of the station. Since the obtained value of settlement for both buildings was higher than 10mm, so in first stage assessment of risk damage these buildings were in unsafe region. Then second stage assessment of risk damage conducted using relative stiffness method. In this stage, building located in safe region. Therefore, It can be concluded that excavation of station has no risk damage on surrounding structures.

KEYWORDS

FLAC3D, Influence Region, Risk Damage Evaluation, Relative Stiffness.

* Corresponding Author, Email: t_abdolahi@yahoo.com

1- BRIEF INTRODUCTION

In preliminary building damage assessment, the presence of the building is not considered (Greenfield) and subsidence profile has been used for building damage estimation. MacDonald & Skempton (1956) method is the first method for assessment of building damage analyses that caused by subsidence. This method has been presented base on registered information from 100 sets of buildings that often has been made by concrete and steel. In this method, building damage has been assessed by using of maximum slope between 2 reference points. In 1963 Bjerrum criteria has been presented base on maximum slope. In 1988 Rankin has applied maximum subsidence and maximum slope as criteria for damage estimation. In secondary stage of damage assessment, building has been considered as a beam that follows Greenfield subsidence profile. Worth & Burland (1974) have applied permissive tensile strain ϵ_{lim} for elastic beam in order to studying of relation between building deformation and start of cracking. In 1997 Addenbrooke & Potts have presented relative stiffness method that building stiffness has been applied for building deformation prediction. Relative stiffness method has been assessed (by finite element method) and adjusted by Franzius (2003). In this paper Franzius method has been used for damage risk assessment.

2- METHODOLOGY

The design approach consists of three stages, schematically shown in Figure1 which are referred to as preliminary assessment, second stage assessment and detailed evaluation. This design approach which is currently used to assess potential building damage for tunnelling projects in London (Mair et al., 1996).

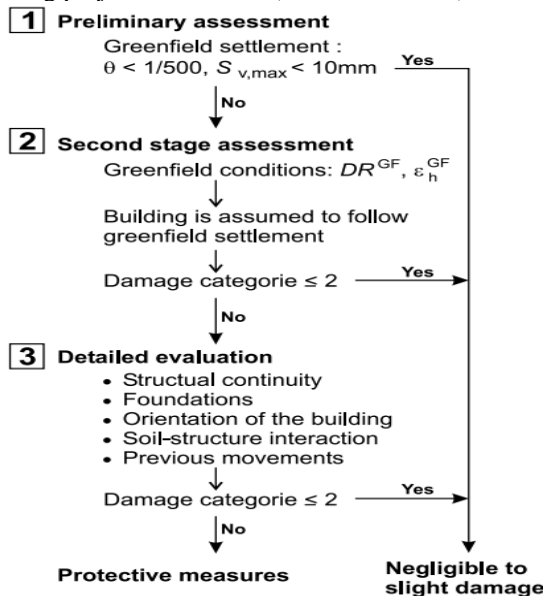


Fig.1- Schematic diagram of three-stage approach for damage risk evaluation.

3- MAIN CONTRIBUTIONS

Initial assessment of building damage risk methods is very simple and conservative as only greenfield settlement is considered. It does not provide any

information about the distortion of a building and often have been showed further than real amounts of damage because building strength against deformation hasn't been considered. So designing of underground spaces with this purpose to reduce damage of structures around it, by using initial methods of damage risk assessment, caused increasing at tunneling cost (because of exerting of extra supporting system). So in order to costs reduction of buildings that located in unsafe zone at first step of damage risk assessment, it must be assessed by secondary methods. In secondary methods of damage risk assessment, building has been considered as simple beam. Although this work is great sampling, but prediction of damage by these method has been corresponded to real instances.

4- SIMULATION RESULTS

In this paper after station modeling, damage risk of buildings around of station has been assessed. 2 sets of buildings located in settlement region. At the first step of assessment of damage risk for 2 buildings based on Rankin method, by attention that maximum subsidence under buildings is further than 10 mm, has been located in unsafe zone. Results of initial assessment have been shown in table 1:

Table.1- Asseement results of bulding damage risk by different criteria.

Criteria	variation of parameters	Building 5	Building 8
Rankin[1]	$\theta < 1/500$ $S_{max} < 10mm$	Unsafe	Unsafe
Bjrrum[2]	$\theta < 1/750$	safe	Safe
MacDonald &Skempton[4]	$\theta < 1/500$	safe	Safe
Tokar &Polshin[3]	$\theta < 1/200$	safe	safe

By exerting deflection ratio and adjustment strain at diagram of building damage level, damage level of buildings 5 and 8 as it shown in fig 2, has been determined. As it obtained by applying of relative stiffness method and by considering of buildings stiffness, deflection ratio of two buildings and horizontal strain has been reduced respectively by 80% ($M^{e_{ht}} = 0.2$) and 99% ($M^{DR_{hog}} = 0.0125$). By attention to this method, damage category of buildings have been located between 0-1. Thus buildings have been located in safe zone and excavation has no risk for buildings damage.

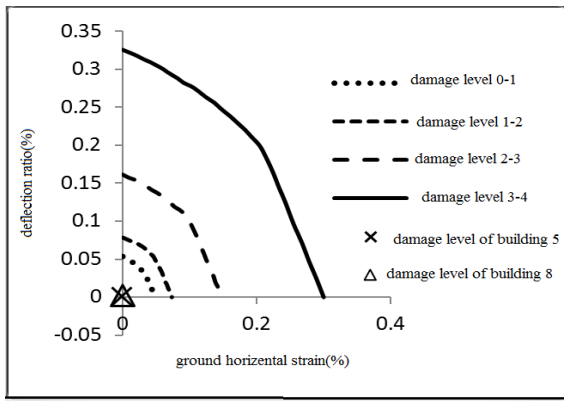


Fig.2- Damage category of buildings 8 & 5.

5- REFERENCES

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