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Application of an elastoplastic-viscoplastic constitutive model for time-dependent analysis of shallow tunnels

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Abstract

Application of an elastoplastic-viscoplastic constitutive model in shallow tunnel is presented in this paper. A section of Towheed tunnel situated in Tehran as a case study was selected and analyzed using FLAC code. In the first step, soil constitutive model parameters were identified using a back analysis process regarding to some of field data. Prediction of time-dependent behavior of tunnel was the purpose of second step of this work. The obtained results indicate the capacities of constitutive model in describing time-dependent behavior of selected tunnel in construction and life time phases.

Keywords: Back analysis, constitutive model, elastoplasstic, viscoplastic, FLAC 2D.

1. INTRODUCTION

In order to study the stability of the underground structures and designing their support system, time dependent deformations should be highly considered [13,15]. On the other hand, time-dependent behavior of underground structures as well as predicting its long-term behavior is of great importance. Realistic prediction of tunnel behavior necessitates the use of reliable constitutive model in numerical code. Engendered deformation due to tunneling may be idealized in two parts instantaneous (time-independent) and time-dependent [10]. In the excavation phase the majority of deformation is elastoplastic and time doesn't present an important effect on the tunnel behavior. For life time phase of tunnel, time-depended deformation occurs during the time. The nature of such deformation is viscoplastic. Therefore an elastoplastic-viscoplastic is a proper alternative for prediction of general behavior of tunnel. Choice of constitutive model depends on type of problem to analyzing and the experimental information for identification of model parameters. For the complex model there are necessary a large number of constant parameters and this lead to executing different tests under divers stress paths. In the certain case by application of back analysis techniques using accessible field information we can identify the constitutive model. Back analysis based on displacement, strain and stress measurements have been used for solving various geomechanical problems [1,3,4,12,14,16]. In fact back analysis process allows us to know general validity of model. On the other part the identified model can be used for prediction of tunnel behavior under different loading paths.

In this work using back analysis technique validation of a simple elastoplastoc-viscoplastic constitutive model is evaluated. For this the field results of Towheed tunnel was used.

2. Geometry, Material and construction method of tunnel

Towheed tunnel project is a 3003m urban underground structure situated in Tehran city. It comprises an adjacent twin tunnel structure, shared by a middle interface wall, and a set of piles. The height and width of the each of tunnels for the passage of the vehicles are 5 and 11m respectively. In this study a section of Towheed tunnel at kilometer (1+917) is selected as case study. Geometry and boundary of section have been shown in figure 1. Due to shortage in experimental results ground media is assumed to be homogenous. Soil is modeled in dry situation because of water table is not existed in soil layers up to 80 meter depth from ground surface. According to geotechnical studies report, some of mechanical parameters of ground material are presented in table 1. The boundary conditions in the numerical simulation have affected on instantaneous and long-term of tunnel behavior. A free displacement boundary condition was adopted at the ground surface. Neither horizontal nor vertical displacement takes place at the lower boundary because of bed rock existence with high density and SPT number (SPT higher than 60) [9]. The lateral displacements at left- and right- hand boundary are both fixed as zero, but vertical displacement is free to be done.