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3D Numerical simulation of adit excavation influence on the main tunnel

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Abstract

This paper investigates an adit excavation influence on the development of the strain at the main tunnel by 3D numerical simulation. For this purpose, a parametric study was conducted through categorizing different rocks and tunnel depths into five squeezing potential groups, and considering four adit intersection angles. According to the results, a formulation is introduced to predict the maximum extra strain of the main tunnel in terms of the tunnel squeezing potential and the intersection angle. The results show that for extreme and very severe squeezing problem (in which the uniaxial rock mass strength to the in-situ stress field ratio is less than 0.20), it is necessary to pay a specific attention to the adit construction process such as the excavation method and the intersection angle meanwhile, for the other cases, these factors are not case, and insignificant treatment can be sufficient.

Key words: Adit Tunnels, Numerical modelling, Rocks mechanics, squeezing rock.

1. Introduction

Adits are constructed for the emergency access and for the transit of the ventilation devices in long tunnels. The intersection part of an adit and a main tunnel is a challenging problem in the tunnel engineering, since excavation of an adit imposes extra strains to the main constructed tunnels, and therefore, the supporting system may need to be improve.

According to the previous studies, the excavation of an opening in the underground space leads the stress to be redistributed within its zone of influence [1-9]. That is, the excavation of an adit near the intersection causes the equilibrated stresses around the main supported tunnel redistribute again, and it may cause further breaking of the rock mass which induces the extra strains.

To access the problem, the first attempts were conducted using the theory of elasticity. Some researchers investigated variation of the stress around the main tunnel due to the adit excavation and tunnel wall closure [10-13]. Thareja et al. and Takino et al. simulated the problem and obtained the properties of the intersection area for the various rock mass properties and for the several intersection angles [14-16].

The excavation of an access tunnel with an oblique angle of 45 degree was studied with 3D numerical analysis by [17]. In the other investigation by Nonomura et al., an additional support/reinforcement was suggested to the main tunnel in limited part of the intersection area [18]. Chen et al. and Hsiao et al. works are the other attempts but were limited on the case study [19-20]. Through numerical simulation, Golshani et al. and Liu et al. deduced the