Optimal location of non-level tunnels using a new probabilistic approach

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Engkish Extended Abstract

Summary

One of the important issues in designing non-level tunnels is determining the optimal location of tunnels relative to each other. In this research, to optimally locate the two factors of land subsidence and stability (safety factor) of tunnels have been used. Optimal placement of non-level tunnels in various geological conditions should use probabilistic methods and reliability. In this paper, PLAXIS^{3D} finite element software is used to study different states of non-level tunnels. Then, using the harmony search algorithm, two limit state functions are estimated separately for the safety factor and maximum ground surface subsidence. Then, using the two limit state functions obtained from the previous step and the first-order reliability methods and the Monte Carlo simulation in RT software, the best location for excavation of the second tunnel in relation to the previous (existing) tunnel is based on having the highest safety factor and lowest ground subsidence.

Introduction

Due to the complexity of the interaction between the tunnels and also due to the uncertainty in the design parameters, in this paper, using probabilistic analyzes such as the Monte Carlo simulation method and first-order reliability, the optimal stability and placement of non-level tunnels in RT probabilistic software was discussed. Because RT software requires a correct and accurate limit state function, the harmonic search algorithm in MATLAB was used to calculate the stability and also to achieve this limit state function.

Methodology and Approaches

In this paper, using PLAXIS^{3D} software, the tunnel was modeled in 32 different rock masses and the results are different in each of the 32 rock masses due to the inequality in the input parameters (safety factor and maximum settlement). To evaluate the reliability of the new tunnel excavation (existing sub-tunnel), 32 models which were analyzed by PLAXIS^{3D} software were compared with the predicted model to achieve the lowest settlement rate and the highest safety factor by the harmony search algorithm. The comparison showed good consistency between the model predicted by the harmony search algorithm and the model performed by numerical methods. Therefore, due to the proximity of the performed model and the predicted model, the limit state function is accurate to obtain the probability of failure of the new tunnel.

Results and Conclusions

According to the results obtained in both Monte Carlo simulation methods and first-order reliability, the probability of failure (approximately 0.33%) and the high-reliability index are shown and the tunnel position is in very good condition. According to the analysis of tunnel random variables by RT software, it was found that the geological durability index is very important and effective. It should be noted that the results of this study show that the reliability methods used in the RT program to stabilize and locate the new tunnel under the existing tunnel can be used as a high-performance method in analyzing underground space problems.