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Short Communication

Efficiency of different methods for calculating the mechanized tunnels face pressure considering an earth pressure balance

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Abstract

Different methods for calculating and estimating a safe face pressure were proposed by researchers, which have some advantages and disadvantages. In each of these methods, some related parameters such as soil geotechnical parameters, dimensions of the tunnel, and geological conditions are used. In these methods, using a series of mathematical or empirical functions, the face pressure is calculated. In this study, the face displacements were obtained using the finite difference numerical FLAC^{3D}, the COB (Netherlands Underground Science Center) empirical, and the Leca and Dormieux (1990) analytical methods. The impact of the COB method on different ground stiffnesses is studied and evaluated. The reference case of this research is the Tehran Metro Line 6 tunnel (excavation radius: 4.6 m).

More Information

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Introduction

In tunneling when dealing with Earth Pressure Balance (EPB) tunnel boring machines (TBM), three zones around the tunneling machine can create ground movements. The first one is at the tunnel face due to the difference between the applied TBM pressure and the soil one. The second one is located around the TBM shield due to the shield conicity (the cutter head's outer diameter is larger than the shield end). In the last zone, the movements at the shield end are due to the tail void gap (difference between the shield outer diameter and the tunnel lining [1-4]). Meanwhile, the surface settlement contribution due to the face displacements is commonly in the range of 25% to 30% [1] and applying optimal face pressure prevents excessive deformations of these areas. TBMs have great abilities for excavations in unstable grounds like sandy ones under the groundwater table. By increasing the urban tunnel size, a precise estimate of the amount of variation of the tunnel face pressure on the different grounds to reduce the risk of damage to ground-level buildings is necessary. This essential and critical parameter is essential for preventing the tunnel face instabilities and ground settlements. The face pressure will directly impact the machine's performance and the number of settlements or uplifts of the tunnel excavation path.

Results and discussion

Figure 1 shows the horizontal deformation values of the tunnel face by the two methods of the COB and Leca & Dormieux. As can be seen, the face pressure obtained from the COB method shows smaller horizontal deformations than the Leca & Dormieux one. The case without face pressure is also presented. In both methods, the maximum horizontal

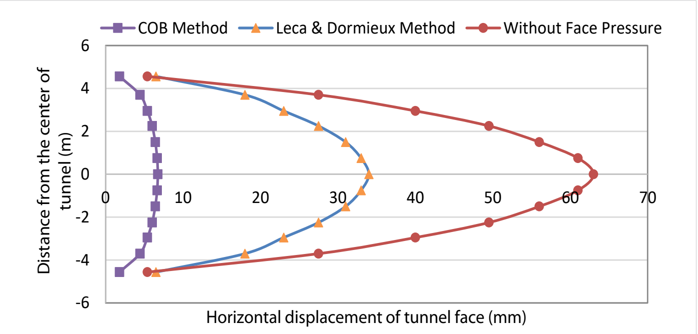

Figure 1: Horizontal displacement of tunnel face with the COB method, the Leca and Dormieux one and the 3D numerical modelling.

deformations value is smaller than 1% of the excavation radius. The results show that the number of face deformations produced by the analytical and empirical methods differ. Also, according to Figure 2, with the decrease of Young's Modulus of the ground, the face's horizontal deformation increases and exceeds the permissible value of 1% of the excavation radius. Using analytical and empirical methods considering a ground Young's Modulus smaller than 50 MPa is incorrect as the horizontal movements are in this case greater than in the case without face pressure.

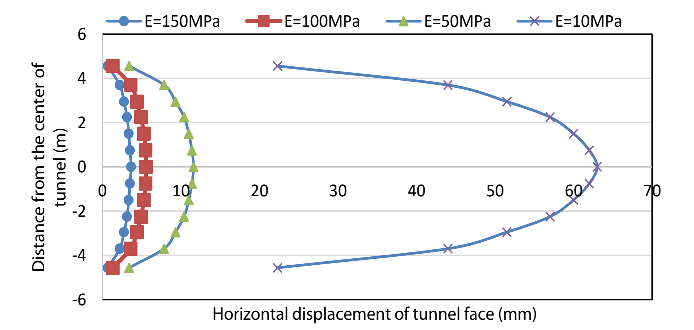

Figure 2: Horizontal displacements of the tunnel face with the COB method considering different ground Young's Modulus (obtained with the 3D numerical modelling).

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