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Hydro-mechanical analysis of tunneling in anisotropic ground: Effect of face advance on pore pressure evolution.

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Abstract:

Hydro-mechanical analysis of tunneling in low permeability anisotropic ground is a key issue for the assessment of the tunnel design. During the excavation progress, overpressures may be observed before and after the passage of the tunnel face: the amplitudes of pore pressure change depend upon the distance to the face and also upon the distance to the drift wall. Furthermore, as shown in recent analysis of excavation works in a claystone formation[1] [2], the response of the rock mass to the excavation progress exhibits a strong interplay between the pore pressure evolution and the development of the induced fractured zone around the tunnel. Nevertheless, the understanding of this interplay remains a challenging topic. Thus a careful evaluation of the excavation induced overpressures and the understanding of the physical mechanisms that control their evolution in time is of key importance.

The pore pressure evolution induced by tunnels excavation is investigated using a 3D fully coupled hydro-mechanical finite element simulation, in the framework of a poroelastic analysis. The analysis is performed by taking into account different features that can influence the pore pressure evolution such as: the excavation rate, the permeability of the ground, the anisotropy of the material and of the initial stress state. It is observed that overpressures can be induced[3]: before the passage of the face, depending on the anisotropy of the initial stress state and on the ratio between the excavation rate and the consolidation time of the rock mass formation; after the passage of the face, anisotropic pore pressure field is mainly related to the anisotropy of the elastic stiffness of the ground.

Finally, a comparison between 3D and 2D numerical simulations is performed. A pore pressure release rate at the tunnel wall is proposed in an attempt to take into account the pore pressure evolution in a 2D model. This aims to propose a simplified numerical approach that accounts for the influence of the face advance and that can be directly used in engineering practice.

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[3] Guayacán-Carrillo, L.M., Sulem, J. and Ghabezloo, S. (2020). *Main insights from 2D/3D poroelastic analysis of tunnel excavation in low permeability anisotropic ground*. Comp. & Geotech. https://doi.org/10.1016/j.compgeo.2020.103935.