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Numerical solutions for tunnels excavated in strain-softening rock masses considering a combined support system. (English) Zbl 1481.74546

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Summary: In this article, an alternative numerical procedure to calculate displacements and stresses of supported circular tunnels is proposed, considering the whole process of tunnel advancement, and sequential installation of the primary and secondary support systems. In the derivation, the plastic area of the rock mass is divided into a large number of annuli around the tunnel, and then the Finite Difference Method is employed. First, the strain-softening behaviour model is taken to simulate the post-failure behaviour of the rock mass. Furthermore, the Mohr-Coulomb or the Hoek-Brown failure criteria can be chosen, a non-associated plastic flow rule is assumed and the dilatancy of the rock mass is considered. After that, the fictitious support forces concept is used to simulate the process of tunnel advancement, and thus, the three-dimensional effect of the tunnel face is considered. Finally, the solutions of displacements and stresses for the rock mass and the supports can be obtained, by using the compatibility conditions of stresses and displacements at both rock-support and support-support interfaces. The results obtained from these solutions agree well with those of the self-similar solutions for circular openings, and the compatibility conditions of supported tunnels were verified. The proposed method has been compared with the convergence-confinement method. Parametric analyses are then carried out to investigate the sensitivity of support forces and displacements to the rock mass behaviour model selection. Then, the application of the proposed solutions in the design of tunnels is presented. The proposed method provides a convenient alternative method for the preliminary design of tunnels.

MSC:

74L10 Soil and rock mechanics
86-08 Computational methods for problems pertaining to geophysics
86A04 General questions in geophysics

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strain-softening; supported tunnels; tunnel advancement; numerical solutions; ground reaction curves; combined support system

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