

Ground-Structure Interaction Analysis of Aged Tunnels

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Abstract : Finding structural demand under various conditions that a structure may experience during its service life is an important step towards structural life-cycle analysis. In this paper, structural demand for the precast concrete tunnel lining (PCTL) segments of Toronto's 60-year-old subway tunnels is investigated. Numerical modelling was conducted using FLAC3D, a finite difference-based software capable of simulating ground-structure interaction and ground material's flow in three dimensions. The specific structural details of the segmental tunnel lining, such as the convex shape of the PCTL segments at radial joints and the PCTL segment pockets, were considered in the numerical modelling. Also, the model was developed in a way to accommodate the flexibility required for the simulation of various deterioration scenarios, shapes, and patterns that have been observed over more than 20 years. The soil behavior was simulated by using plastic-hardening constitutive model of FLAC3D. The effect of the depth of the tunnel, the coefficient of lateral earth pressure as well as the patterns of deterioration of the segments were studied. The structural capacity under various deterioration patterns and the existing loading conditions was evaluated using axial-flexural interaction curves that were developed for each deterioration pattern. The results were used to provide recommendations for the next phase of tunnel lining rehabilitation program.

Keywords : precast concrete tunnel lining, ground-structure interaction, numerical modelling, deterioration, tunnels

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