Time-Dependent Soil Arch Morphology and Structural Response of High-Fill Load-Reduction Open-Cut Tunnels: A Finite Difference Study (Postprint)

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Abstract

Backfill sites are formed through short-term reconstruction, and compared with natural sites, factors such as backfill material significantly influence their structural internal forces. To ensure the long-term safety of high-fill load-reduction open-cut tunnels during service, studies on time-dependent behavior are required. Using the finite difference software FLAC3D, a model of high-fill load-reduction open-cut tunnel was established to analyze the development of soil arch morphology within the overlying soil mass and the time-dependent characteristics of structural responses following construction completion. Results indicate that when the overlying backfill soil exhibits pronounced creep behavior, the soil arch within the soil mass gradually degrades and eventually disappears with time, while structural responses undergo substantial changes characterized by a relatively high change rate in the early stage, a gradual decrease in the middle stage, and approach zero in the later stage. Backfill height and backfill material substantially influence various aspects of time-dependent behavior of high-fill load-reduction open-cut tunnels; increasing backfill height induces significant changes in soil arch morphology and structural responses, but does not affect their overall time-dependent trends. For materials with weak creep properties, the soil arch morphology becomes more pronounced with time, while changes in structural responses are relatively minor. These research findings can provide valuable references for the design of such structures and post-construction safety monitoring.

Full Text

Preamble

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Note: Figure translations are in progress. See original paper for figures.