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Analytical Solutions for Tunnel Collapse Mechanisms in Circular Cross-Section Tunnels under Seepage and Seismic Forces

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Abstract : Reliable prediction of tunnel collapse remains a prominent challenge in the field of civil engineering. In this study, leveraging the nonlinear Hoek-Brown failure criterion and the upper-bound theorem, an analytical solution for the collapse surface of shallowly buried circular tunnels was derived, taking into account the coupled effects of surface loads and pore water pressures. Initially, surface loads and pore water pressures were introduced as external force factors, equating the energy dissipation rate to the external force, yielding our objective function. Subsequently, the variational method was employed for optimization, and the outcomes were juxtaposed with previous research findings. Furthermore, we utilized the deduced equation set to systematically analyze the influence of various rock mass parameters on collapse shape and extent. To validate our analytical solutions, a comparison with prior studies was executed. The corroboration underscored the efficacy of our proposed methodology, offering invaluable insights for collapse risk assessment in practical engineering applications.

Keywords : tunnel roof stability, analytical solution, hoek–brown failure criterion, limit analysis
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