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NUMERICAL ANALYSIS OF TUNNEL DISPLACEMENT PROFILES WITH PIPE UMBRELLA SUPPORT: IMPLEMENTATION OF THE HOEK-BROWN FAILURE CRITERION

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The objective of presented research is to investigate the influence of pipe umbrella support on the displacement profile during tunnelling operations. A numerical simulation was performed using ZSoil software, employing a simplified axisymmetric model of the tunnel excavation. The study advances previous research by directly incorporating the Hoek-Brown failure criterion for rock mass behaviour within the finite element model (FEM), offering a more accurate representation of the rockmass response to tunnelling.

The research focuses on the longitudinal displacement profile (LDP) as the key measure of the pipe umbrella's effectiveness. In addition to the comparison of the LDP between supported and unsupported tunnels, a parametric study was conducted to examine the effect of key pipe umbrella parameters, such as the length of each umbrella segment, the overlap between consecutive segments, and the mechanical properties of the support system.

Results clearly indicate that the inclusion of the pipe umbrella support significantly reduces the tunnel's radial displacement, particularly near the tunnel face. The displacement profile without the umbrella exhibits sharper radial deformation, suggesting that pipe umbrella systems effectively mitigate the deformation of the tunnel crown and enhance overall stability. The parametric analysis further refines these findings, providing insights into the optimal design of umbrella support systems.

The study contributes to tunnelling engineering by offering a more detailed understanding of how pipe umbrella systems can improve tunnel stability, using advanced numerical methods and incorporating realistic material behaviour. Presented research expands upon these findings with a comprehensive parametric analysis.