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Numerically Optimized Grouting for Minimizing Water Inflow in Tunnels Affected by Excavation Damage Zones

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ABSTRACT

Utilizing efficient grouting through a numerical approach reduces groundwater inflow into tunnels with Excavation Damage Zones (EDZs). EDZs, resulting from stress redistribution during tunnel excavation, significantly increase the permeability of the surrounding rock and present a substantial risk to tunnel stability. A hybrid method uses PLAXIS 2D software to combine analytical and numerical methods and evaluate the impact of different grouting thicknesses and permeabilities across various rock domains. We use empirical methods to estimate the EDZ thickness, which we then apply in simulations to determine water inflows before and after grouting. The results show that effective grouting can decrease inflow water volumes by over 90% with low-permeability grout. Moreover, this research suggests that lower-grade rock types require greater quantities of grout for effective sealing. Analytical models offer reasonable preliminary estimates; however, numerical simulations are more reliable and relevant to the actual site conditions. This establishes a practical and optimized framework for grouting design throughout the process, enhancing tunnel safety in water-burdened construction scenarios.

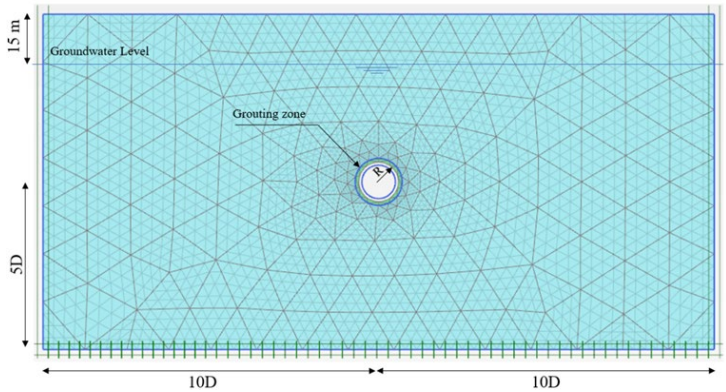

Fig. 1 Modeling for numerical analysis

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