

Innovating the Underground: AI and Digital Transformation in Tunnelling

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Underground construction has long been constrained by three chronic challenges schedule delay, cost overrun, and safety risk problems that are intensified by inherent ground uncertainty and heavy reliance on operator experience. This presentation examines how artificial intelligence and digital transformation are reshaping tunnelling practice, drawing on the global smart construction market's projected growth from USD 3.5billion on 2024 to USD 12.7 billion by 2032(CAGR 17.4%), and presents four proprietary technologies developed and field verified by Hyundai Engineering & Construction (HDEC) across the full underground construction lifecycle. First, the Automated Rock Evaluation System (ARES) applies LiDAR scanning and CNN based image analysis to replace subjective, manual face mapping with objective, real-time rock mass classification achieving RMR score agreement within 4 points of conventional assessment. Second, the TBM Advanced Driving Assistance System (TADAS) collects and analyzes TBM machine data in real time, the system derives optimal operating parameters based on equipment specifications. Third, and AI based maintenance system for deep underground stormwater storage utilizes an indoor drone to acquire image and multi-sensor data, followed by AI-based analysis for automated facility condition assessment. Fourth, a discrete-event TBM simulation model incorporating probabilistic downtime distributions predicts construction duration within approximately 1% deviation from actual data. The presentation concludes that implementation at scale, not invention, remains the industry's central challenge.

Keywords: Smart construction; Tunnelling; Digital Transformation; TBM (Tunnel boring machine).

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