Evaluating Tunnel Stability in Challenging Terrains: A Comprehensive Study of Geological Factors and Support Systems -The Lowari Tunnel Case

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Tunnel construction success hinges on navigating geological hazards, excavation techniques, and robust support systems. This study explores the intricate dynamics of these elements, emphasizing the need for sustainable tunnel infrastructure. Geological factors, including overburden depth, rock characteristics, and groundwater presence, significantly impact tunnel construction. Notable incidents, such as the Hanekleiv tunnel collapse, underscore the importance of precise tunnel face mapping in mitigating risks. Tunneling techniques selection depends on encountered strata, and controlled blasting is crucial for stress concentration prevention. Support systems, categorized into primary and secondary, play a pivotal role in ensuring stability. The Required Excavation Support Sheet (RESS) guides support installation after each blast. Focusing on the Lowari Tunnel in the Himalayan terrain, the New Austrian Tunneling Method (NATM) was employed. Extensive tunnel face mapping involved post-blasting assessments, identifying rock mass characteristics, and predicting deformations. Geological features, including color, texture, and luster, guided rock type identification. Excavation classes and support sheets were determined based on this mapping. Monitoring stations, strategically placed at 30 m intervals, employed 3D coordinate systems for precise measurements. The Lowari Tunnel, spanning 8.509 km, traverses diverse rock types with varying weathering conditions. Geological mapping identified rock mass behavior types, aiding in categorizing deformations. Incidents, such as cracking sounds and rock spalling, emphasized the impact of geological factors. Monitoring stations revealed inside (-) deformations dominating, validating NATM's efficacy. Geological

incidents at specific changes highlighted the need for strategic support. Shotcrete, rock bolts, wire mesh, and lattice girders constituted primary support. Shotcrete adhered to guidelines, with high strength attributed to admixtures. Rock bolts underwent pre- and post-installation testing, meeting specifications. Wire mesh and lattice girders passed quality tests, ensuring compliance with standards. The findings contribute to best practices, applicable across diverse terrains, prompting further research on support system performance and economic implications.