Rapid Excavation and Bench Parameter Optimization Using Micro-Bench Method in Cold Region Tunnels (Postprint)

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Abstract

The bench method exhibits significant advantages in reducing construction time and improving mechanized operation levels, yet presents certain limitations in controlling surrounding rock stability and preventing deformation. To mitigate the deformation effects of bench method excavation on tunnel surrounding rock, this study, based on the Chongli Tunnel project, elaborates the rapid excavation technology of the micro-bench method for cold-region tunnels; and through finite element simulation, optimizes the bench length and height during construction to determine the appropriate bench parameters for single-track railway tunnel excavation in surrounding rock using the bench method. The results indicate that: during micro-bench method construction, the processes in each working area of the tunnel face proceed simultaneously and independently without mutual interference, effectively enhancing construction speed; for Grade IV surrounding rock, an upper bench height of 4 m is deemed appropriate, yielding minimal crown settlement and peripheral convergence while maintaining tunnel face extrusion deformation within controllable limits; increasing bench length can preserve tunnel face stability but concurrently increases crown settlement and peripheral convergence, thus the upper bench length should not be excessive, and for Grade IV surrounding rock, the upper bench length should be controlled at 3 m.

Full Text

Preamble

Study on Rapid Excavation by Micro-Step Method and Step Parameters Optimization in Cold-Region Tunnels

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Abstract

The bench excavation method demonstrates significant advantages in reducing construction time and enhancing mechanization levels, yet exhibits certain limitations in controlling surrounding rock stability and preventing deformation. To minimize the deformation impact of bench excavation on tunnel surrounding rock, this study investigates the rapid excavation technology using the micro-step method in cold-region tunnels, based on the Chongli Tunnel project. Through finite element simulation, the step length and height parameters are optimized to determine suitable bench parameters for single-track railway tunnel construction in Grade IV surrounding rock. The results indicate that the micro-step method allows simultaneous and independent operation of various working zones at the tunnel face without mutual interference, thereby effectively improving construction speed. For Grade IV surrounding rock, an upper bench height of 4 m proves appropriate, yielding minimal crown settlement and peripheral convergence while keeping tunnel face extrusion deformation within acceptable limits. While increasing bench length can enhance tunnel face stability, it also increases crown settlement and peripheral convergence; consequently, longer bench lengths are not necessarily better, and the upper bench length for Grade IV surrounding rock should be limited to 3 m.

Keywords: cold-region tunnel; micro-step method; surrounding rock deformation; parameter optimization

Note: Figure translations are in progress. See original paper for figures.