Research on the Theoretical Method for Rockburst Prevention and Control Based on Prestressed Optimal Axial Ratio Elliptical Tunnels Postprint

Authors: Zhang Boyi, Zhao Cheng, Qian Yuan, Sun Zeyuan, Xing Jinquan, Luo Yinfeng, Luo Qinyuan

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Abstract

Rockburst, as a severe geological hazard, frequently poses significant threats to tunnel stability and construction safety. Conventional circular tunnels under non-hydrostatic pressure conditions are prone to forming localized stress concentration zones in the surrounding rock mass, thereby readily inducing rockburst. Elliptical tunnels with specific axis ratios, however, possess the potential to mitigate this issue and have emerged as a focal point in rockburst prevention research. This study analyzes the stress distribution and characteristics of local tangential stress concentration in conventional circular and elliptical tunnels, and proposes a theoretical methodology for rockburst prevention based on prestressed elliptical tunnels with optimal axis ratios, providing a theoretical solution for the optimal axis ratio. Using a plateau tunnel as an engineering case study, numerical calculation results demonstrate that designing the prestressed tunnel geometry according to the optimal axis ratio can completely eliminate local tangential stress concentration, achieve a uniform stress distribution, and substantially reduce the overall tangential stress level of the tunnel. Furthermore, this approach theoretically offers the advantage of excavation stress compensation. This provides a theoretical reference for stress control and rockburst mitigation in high in-situ stress tunnel engineering projects.

Full Text

Research on the Rockburst Prevention Theory and Method for Elliptical Tunnels with Optimal Aspect Ratio Based on Prestress

Boyi Zhang[1], Cheng Zhao[123]*, Yuan Qian[4], Zeyuan Sun[1], Jinquan Xing[1], Yinfeng Luo[1], Qinyuan Luo[1]

[1] Department of Geotechnical Engineering, Tongji University, Shanghai 200092, China
[2] Key Laboratory of Geotechnical and Underground Engineering of Ministry of Education, Tongji University, Shanghai 200092, China
[3] School of Engineering, Tibet University, Lhasa, Tibet 850000, China
[4] Key Laboratory of Geotechnical Mechanics and Engineering of Ministry of Water Resources, Changjiang River Scientific Research Institute, Wuhan, Hubei 430010, China

Abstract

Rockburst, as a severe geological hazard, poses significant threats to tunnel stability and construction safety. Traditional circular tunnels under non-hydrostatic pressure conditions are prone to forming localized stress concentration zones in surrounding rock, which can easily trigger rockbursts. In contrast, elliptical tunnels with specific aspect ratios have the potential to avoid this problem, making them a focal point in rockburst prevention research. This paper analyzes the stress distribution and characteristics of localized tangential stress concentration in conventional circular and elliptical tunnels. Building upon this analysis, we propose a theoretical method for rockburst prevention based on prestressed elliptical tunnels with optimal aspect ratio and provide a theoretical solution for determining this optimal ratio. Using a high-altitude tunnel project as a case study, numerical results confirm that designing the prestressed tunnel geometry according to the optimal aspect ratio can completely eliminate localized tangential stress concentration, achieving a uniform stress distribution while substantially reducing the overall tangential stress level in the tunnel. The approach also theoretically offers the advantage of excavation stress compensation. These findings provide a theoretical reference for stress control and rockburst prevention in high-stress tunnel engineering.

Keywords: high-stress tunnels; rockburst prevention; tunnel cross-section shape; optimization design

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