

Postprint: Sensitivity and Displacement Correlation Analysis of Stability Influencing Factors for Multi-stage Slopes Reinforced with Frame Prestressed Anchor Bolts

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Abstract

Frame prestressed anchor systems are widely applied in slope engineering, and the stability of multi-level slopes constitutes a core element of construction safety. Conducting research on the sensitivity of influencing factors and the correlation with displacement for multi-level slope stability holds significant theoretical value and practical significance for the optimal design of support systems. This paper investigates a real engineering case using the grey relational analysis method; by calculating the grey relational degree, the sensitivity of each factor is ranked, summarized, and analyzed. Finally, combined with single-factor analysis, the correlation between stability and displacement is explored, and relationship curves between the stability coefficient and displacement within a certain range are obtained. The results indicate that the four most sensitive influencing factors for the stability of multi-level slopes reinforced by frame prestressed anchors are the internal friction angle, unit weight, anchor length, and slope angle. In addition, cohesion, anchor inclination angle, frame beam cross-section side length, vertical spacing of frame beams, horizontal spacing of frame beams, axial stiffness of the free segment, and friction resistance also exert certain influences on stability, whereas platform width, increase/decrease value of the free segment, and anchor diameter have relatively minor influences on the stability of multi-level slopes reinforced by frame prestressed anchors compared with other factors. Further analysis reveals that as the slope stability coefficient increases, the maximum slope displacement decreases accordingly, demonstrating a negative correlation between the two.

Full Text

Analysis of Factor Sensitivity and Displacement Correlation for Multi-stage Slope Stability Reinforced by Frame Prestressed Anchor Bolts

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Abstract

Frame prestressed anchor bolt systems are widely employed in slope engineering, where the stability of multi-stage slopes represents a critical element for construction safety. Investigating the sensitivity of influencing factors on multi-stage slope stability and their correlation with displacement holds significant theoretical and practical value for the optimal design of support systems. This study examines a real-world engineering case using the grey relational analysis method. By calculating grey correlation degrees, the sensitivity of various factors is ranked, summarized, and analyzed. Subsequently, combined with single-factor analysis, the correlation between stability and displacement is investigated, yielding a relationship curve between the stability coefficient and displacement within a specific range.

The results indicate that the four most sensitive factors affecting the stability of multi-stage slopes reinforced by frame prestressed anchor bolts are the internal friction angle, unit weight, anchor length, and slope angle. Additionally, cohesion, anchor inclination angle, frame beam cross-section side length, vertical spacing of frame beams, horizontal spacing of frame beams, axial stiffness of the free segment, and frictional resistance also exert certain influences on stability. In contrast, platform width, variation in free segment length, and anchor diameter have relatively minor impacts compared to other factors. Further analysis reveals that as the slope stability coefficient increases, the maximum displacement decreases, demonstrating a negative correlation between the two parameters.

Keywords: frame prestressed anchor bolt; multi-stage slope; stability; grey relational analysis method; sensitivity

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

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