Experimental Study on Shear Mechanical Properties of Rough Filled Joints Under Wet-Dry Cycles: Postprint

Authors: Zheng Yun, Li Xiang

Date: 2025-07-21T00:00:00+00:00

Abstract

Damage and deterioration of rock mass in the water-level fluctuation zone due to water-rock interaction constitute a key factor inducing deformation and failure of reservoir bank slopes in the drawdown area. To investigate the degradation laws of mechanical properties of filled jointed rock mass under water-rock interaction, typical sandstone from the Three Gorges Reservoir area was selected as the research object. Regular tooth-shaped joint specimens with undulation angles of 0°, 10°, and 15° were prepared and filled with clay. Direct shear tests were conducted under varying numbers of wet-dry cycles, and the mechanical response characteristics were analyzed through techniques such as three-dimensional optical scanning and image processing. The research results indicate that the shear stress-displacement curves of smooth filled joints can be divided into three stages: elastic deformation, transition, and sliding; whereas those of rough filled joints can be divided into five stages: elastic deformation, transition, ascending, pre-peak softening, and post-peak failure. Wet-dry cycles exhibit differential degradation effects on the peak shear strength of filled joints with varying roughness. With increasing cycle numbers, the peak shear strength of smooth filled joints gradually decreases, while the shear strength of rough filled joints displays non-monotonic variation characteristics, with its evolution process being jointly controlled by filling medium degradation and the interlocking effect of sandstone joint surfaces. When the number of wet-dry cycles is relatively small, the joint roughness coefficient after shearing does not show a significant changing trend; however, when the wet-dry cycle number increases from 5 to 10, the joint roughness coefficient after shearing exhibits a marked decreasing trend. This study reveals the evolution laws of filled joint mechanical properties under the coupling effect of wet-dry cycles and joint roughness, which can provide an important reference for long-term stability analysis of reservoir bank engineering rock mass.

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Full Text

Experimental Study on Shear Mechanical Properties of Rough Filled Joints under Drying-Wetting Cycles

ZHENG Yun[1], **LI Xing**[2]
(1. Institute of Rock and Soil Mechanics, Chinese Academy of Sciences, Wuhan 430071; 2. School of Civil Engineering and Architecture, Wuhan University of Technology, Wuhan 430070)

Abstract

Damage and deterioration of rock mass in the water-level fluctuation zone under water-rock interaction represent a critical factor inducing deformation and failure of reservoir bank slopes. To investigate the deterioration patterns of mechanical properties in filled jointed rock masses under such conditions, this study utilizes typical sandstone from the Three Gorges Reservoir region. Regular tooth-shaped joint specimens with asperity angles of 0°, 10°, and 15° were prepared and filled with clay. Direct shear tests were conducted under varying numbers of drying-wetting cycles, and mechanical response characteristics were analyzed using three-dimensional optical scanning and image processing techniques.

The research findings indicate that shear stress-displacement curves for smooth filled joints exhibit three distinct stages: elastic deformation, transition, and sliding. In contrast, rough filled joints display five stages: elastic deformation, transition, ascending, pre-peak softening, and post-peak failure. The deterioration effect of drying-wetting cycles on peak shear strength varies with joint roughness. As the number of cycles increases, smooth filled joints demonstrate a gradual reduction in peak shear strength, whereas rough filled joints exhibit non-monotonic strength variation. This evolution is controlled jointly by degradation of the filling medium and interlocking effects of the sandstone joint surfaces. When the number of drying-wetting cycles is small, the joint roughness coefficient after shearing shows no significant trend; however, as cycles increase from 5 to 10, the post-shearing joint roughness coefficient decreases markedly.

This study reveals the evolution patterns of mechanical properties of filled joints under the coupled action of drying-wetting cycles and joint roughness, providing an important reference for long-term stability analysis of rock masses in reservoir bank engineering.

Keywords: Rock mechanics; Filled joints; Drying-wetting cycles; Shear failure; Mechanical properties

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