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Theoretical Analysis and Validation of the Load-Bearing Capacity of Weak Rock Foundations for the Fifth Yangtze River Bridge

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Abstract : The Lantian Fifth Yangtze River Bridge is situated in Luzhou City, Sichuan Province, China. Spanning a total length of 1,355 meters, the main bridge crosses the river with a span of 612 meters, while the calculated span of the main arch measures 578.4 meters, making it the world's largest medium-span steel box arch bridge. Current design criteria tend to significantly underestimate the bearing capacity of weak rock foundations, resulting in overly conservative engineering designs. Clarifying the stress distribution and failure mechanisms of weak rock foundations at varying depths is crucial for accurately determining their bearing capacity in practical geotechnical engineering. A mathematical model of weak rock foundations is established based on the Mindlin strength criterion and generalized three-dimensional Hoek-Brown criterion. This model proposes quantitative parameters to determine the failure limit state of weak rock foundations. Using numerical analysis software such as MATLAB, the theoretical calculation of the ultimate bearing capacity of weak rock foundations at different depths can be completed with reasonable accuracy, and the results are similar to the field test results. The results indicate that the bearing capacity of weak rock foundations is linearly positively correlated with depth, and the depth correction coefficient is 5.733, which falls within the recommended range for formula inversion. This confirms that the bearing capacity of weak rock foundations can be adjusted based on depth, providing valuable reference and guidance for engineering practice. The proposed method significantly enhances confidence in the practical application of weak rock foundations in major geotechnical engineering projects.

Keywords : Hoek-Brown strength criterion, foundation bearing capacity, displacement control, deep plate loading test, soft rock
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