Analysis and Summary of Shield Tunneling Conditions in the Bedrock Protrusion Section of Zhuhai Tunnel Project (Post-print)

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Abstract

The submarine bedrock area is characterized by rugged and undulating topography with alternating peaks and valleys, exhibiting significant discreteness in water depth data. Typically composed of moderately to slightly weathered granite with high rock strength and complex terrain, these features necessitate special technical measures for construction in submarine bedrock protrusion zones to ensure safety and smooth progress. This project runs parallel to the existing Zhuhai Bridge (Class II bridge), precluding offshore blasting pretreatment for the bedrock protrusion section under normal traffic conditions as per the original design scheme. Following approval by all participating construction units and expert review by industry specialists, direct shield tunneling was adopted to traverse the bedrock protrusion section. Using the north line shield machine as the pilot tunnel, this paper investigates the tunneling technology for super-large diameter shield machines directly excavating through bedrock protrusion strata, focusing on issues including abnormal cutter wear, significant fluctuations in tunneling parameters, and difficulties in excavation face stability control. The study addresses cutter management, tunneling parameter control, and slurry circulation management, providing a reference basis for subsequent super-large diameter shield tunneling in similar geological conditions.

Full Text

Analysis and Summary of Shield Tunneling in the Rock Protrusion Section of the Zhuhai Tunnel Project

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Abstract

Seabed bedrock regions are characterized by rugged topography with alternating peaks and valleys, exhibiting significant dispersion in water depth data. These areas typically consist of moderately to slightly weathered granite with high rock strength and complex geological conditions, necessitating specialized technical measures to ensure safe and efficient construction. The Zhuhai Tunnel Project runs parallel to the existing Zhuhai Bridge (a Class II structure), which precludes marine blasting pretreatment of the rock protrusion section under normal traffic conditions as originally planned. Following approval from all participating construction units and expert panel review, a decision was made to advance directly through the rock protrusion section using shield tunneling.

This paper examines the north line shield tunneling as a case study, investigating large-diameter shield tunneling technologies for direct penetration of rock protrusion strata. The study focuses on addressing challenges including abnormal cutter wear, significant fluctuations in tunneling parameters, and difficulties in maintaining excavation face stability. Through systematic analysis of cutter management, tunneling parameter control, and slurry circulation management, this research provides valuable technical references for subsequent large-diameter shield tunneling projects in similar geological conditions.

Keywords: large-diameter shield; rock protrusion strata; cutter management; parameter control

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