Key Technologies for Auxiliary Rescue and Deviation Correction of Shield Machines (External to the Shell) in Composite Strata: Post-Print

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Abstract

As a professional tunnel excavation tool, the shield tunneling machine offers advantages of high efficiency, safety, and rapid construction, and is widely employed in urban rail transit and railway tunnel projects. However, during shield construction, excavation trajectory exceedance (including horizontal/vertical deviation and cross-section over-excavation) frequently occurs due to factors such as sudden geological condition changes, improper equipment selection and parameter settings, or human operational errors. This paper addresses the challenge of controlling shield tunneling attitude in composite strata, where difficulties can lead to shield machine entrapment. It summarizes the self-regulating and external intervention measures adopted for shield rescue or vertical attitude exceedance, and analyzes their respective advantages and disadvantages. This project pioneers an innovative methodology utilizing ultra-high pressure fluid to assist in-situ attitude axis correction of shield machines, successfully overcoming the technical challenge of precise obstacle removal in confined spaces, and achieving the first efficient application of ultra-high pressure fluid technology in the complex environment outside the shield shell. This technology features low labor intensity, extensive operating range, precise removal location, absence of violent vibration, no stress diffusion, and the capability for layer-by-layer fragmentation at arbitrary depths, making it particularly suitable for targeted removal operations in confined spaces. By adopting the integrated equipment system for "Precise Obstacle Removal with Ultra-high Pressure Fluid in Enclosed Spaces," establishing shield body safe opening/closing technology, and optimizing low-damage opening and restoration techniques, the stability of the shield shell during the opening process is ensured while structural performance is fully restored. The successful application of ultra-high pressure fluid technology enables precise obstacle removal in the narrow space outside the shield, achieving in-situ attitude recovery of the shield machine, breaking through the limitations of traditional mechanical correction methods, and enabling dynamic

correction of shield vertical attitude, thereby providing valuable reference for solution measures when similar problems arise in the industry.

Full Text

Preamble

Title: Research on Key Technologies for Auxiliary Unsticking and Deviation Correction of Shield Machines in Composite Strata (Outside the Shield Shell)

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Abstract

Shield machines, as specialized tunnel excavation tools, offer significant advantages in efficiency, safety, and speed, making them widely employed in urban rail transit and railway tunnel construction. However, during shield tunneling operations, various factors—including sudden geological condition changes, improper equipment selection and parameter settings, and human operational errors—can result in excessive excavation trajectories (encompassing horizontal and vertical deviations, cross-section over-excavation, etc.). This paper specifically addresses the challenges of controlling shield tunneling attitude in composite strata, where machines may become trapped, by systematically summarizing and evaluating the self-adjustment and external intervention measures employed for shield unsticking and vertical attitude limit exceedance. This research pioneers an innovative methodology utilizing ultra-high pressure fluid to assist in-situ attitude and axis correction of shield machines, successfully overcoming the technical challenge of precise obstacle removal within confined enclosed spaces and marking the first successful application of ultra-high pressure fluid technology in the complex environment outside the shield shell. The proposed technology offers numerous advantages, including low labor intensity, large operational range, precise removal location, absence of violent vibration, no stress diffusion, and the capability to progressively break materials at arbitrary depths, rendering it particularly suitable for targeted clearance operations in confined spaces. By implementing a complete set of equipment for "precise obstacle removal using ultra-high pressure fluid in enclosed spaces," establishing safe opening and closing technologies for the shield body, and optimizing low-damage opening and restoration techniques to ensure shield shell stability and fully restore structural performance, this work successfully achieves precise obstacle removal in the narrow space outside the shield. This enables in-situ recovery of shield machine attitude, overcomes the limitations of traditional mechanical deviation correction, achieves dynamic correction of shield vertical attitude, and provides valuable reference for addressing similar challenges in the industry.

Keywords: shield deviation correction; ultra-high pressure fluid cutting; vertical attitude control; in-situ treatment

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