Postprint: Precise Grouting Technology for Underlying Voids in Roadbeds Based on Conductive Grout Tracking

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Abstract

For roadbed engineering in karst areas and over mined-out zones, improper remediation of underlying voids can readily induce distresses such as subsidence. Grouting reinforcement represents one of the common measures for treating karst cavities. The typical grouting process comprises drilling, hole sealing, and grouting. Influenced by factors including topography, strata, geological structure, hole sealing quality, and grouting pressure, issues such as grout leakage and channeling frequently arise during construction. The phenomenon of "blind injection and blind evaluation" is pervasive at engineering sites, resulting in unsatisfactory filling effectiveness, material waste, and environmental pollution. The core challenge of grouting reinforcement lies in determining the distribution and migration of grout, as well as conducting precise evaluation of filling effectiveness. To address these issues, this study developed a novel conductive grout material. While satisfying conventional requirements including fluidity, initial setting time, and bleeding characteristics, this material exhibits resistivity significantly different from limestone. By leveraging the inherent conductive properties of the grout in conjunction with the high-density electrical method, precise tracking and monitoring of grouting construction can be realized, effectively preventing grout channeling and leakage. Employing the GIN (Grouting Intensity Number) method for grouting control, GIN standards are established based on geological conditions. Real-time monitoring of the grouting process through P-V curves and F/P-V curves enables visualized control throughout the entire grouting operation. Combined with the high-density electrical method and transient Rayleigh wave method, rapid detection of grouting reinforcement effects is conducted to quantitatively evaluate both the grouting extent and degree of reinforcement. Application of these research findings contributes to advancing the theory and methodology for treating concealed roadbed defects, fills relevant technical gaps domestically and internationally, and holds significant theoretical importance and practical engineering value for

the development of new road construction technologies, design theories, and construction techniques in China.

Full Text

Precise Grouting Technology for Treating Underlying Cavities in Subgrade Based on Conductive Slurry Tracking

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Abstract

For subgrade projects constructed in karst regions and over mined-out areas, improper treatment of underlying cavities can readily induce distresses such as subsidence. Grouting reinforcement represents one of the most common remediation methods for karst cavities. However, the conventional drilling-sealing-grouting process frequently encounters problems like grout leakage and channeling during construction due to influences from landform, strata, geological structure, hole sealing quality, and grouting pressure. The pervasive phenomenon of "blind injection and blind evaluation" at construction sites consequently leads to unsatisfactory filling effectiveness, material waste, and environmental pollution. The fundamental challenges in grouting reinforcement lie in determining the distribution and flow path of grout, and in conducting accurate assessment of filling effectiveness.

To address these issues, this study developed a novel conductive slurry material that, while meeting conventional performance indicators including fluidity, initial setting time, and water separation, exhibits resistivity significantly different from limestone. By leveraging the inherent conductive properties of the slurry combined with the high-density electrical method, precise tracking and monitoring of the grouting construction process can be achieved, effectively preventing grout channeling and leakage. The GIN (Grouting Intensity Number) method is employed for grouting control, where GIN standards are established based on geological conditions. Real-time monitoring through P-V curves and F/P-V curves enables visual control of the entire grouting process.

Furthermore, combining the high-density electrical method with the transient Rayleigh wave method allows for rapid detection of grouting reinforcement effectiveness and quantitative evaluation of both grouting extent and degree of improvement. The application of these research findings contributes to advancing the theory and methodology for treating hidden subgrade diseases, fills relevant technical gaps domestically and internationally, and holds significant theoretical

and practical engineering value for the development of new road construction technologies, design theories, and construction techniques in China.

Keywords: conductive slurry; subgrade; underlying cavity; grouting

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