Experimental Study on the Properties of Double-Liquid Slurry Prepared from Slurry Shield Slurry Using Response Surface Methodology: Postprint

Authors: Guo Fei

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Abstract

Large-diameter slurry shield tunneling generates substantial amounts of slurry during construction. To reduce the disposal costs of waste slurry from slurry shield tunneling and achieve resource utilization, while also addressing the grouting reinforcement requirements in silt strata, a systematic investigation was conducted combining response surface methodology and various analytical methods on the influence of waste slurry content and AB liquid volume ratio on grout performance. The study reveals the effects of slurry content and AB liquid volume ratio on the properties of double-liquid grout: increasing waste slurry content decreases grout density while increasing viscosity, causing bleeding rate and fluidity to first decrease then increase, while initial setting time first increases then decreases; increasing the AB liquid volume ratio enhances fluidity and viscosity, and prolongs initial setting time. The interaction effects between slurry content and AB liquid volume ratio on grout performance were elucidated. A practical mix proportion suitable for silt strata was proposed: Solution A: cement 123.46 kg/m^3, fly ash 100 kg/m^3, sand 210.05 kg/m^3, water 135.19 kg/m^3, slurry 58.1 kg/m^3; Solution B: 40°Bé sodium silicate; the volume ratio of Solution A to Solution B is 30:1.

Full Text

Experimental Study on the Performance of Double-Fluid Grout Prepared with Waste Slurry from Slurry Shield Tunneling Using Response Surface Methodology

Guo Fei (China Railway Guangzhou Group Co., Ltd., Guangzhou 510088, China)

Abstract

Large-diameter slurry pressure balance shield tunneling generates substantial volumes of waste slurry. This study aims to reduce disposal costs and promote resource utilization of this waste material while simultaneously addressing the need for grouting reinforcement in soft, silty soil strata. Using response surface methodology combined with various analytical techniques, we systematically investigated the effects of waste slurry content and the A/B fluid volume ratio on grout performance.

The research reveals that increasing waste slurry content decreases grout density while increasing its consistency. Bleeding rate and fluidity initially decrease then increase with higher slurry content, whereas initial setting time first increases then decreases. Conversely, an increased A/B fluid volume ratio enhances both fluidity and consistency while prolonging the setting time. The study also clarifies the interactive effects between waste slurry content and the A/B fluid ratio on overall grout performance.

Based on these findings, a practical mix design optimized for silty soil conditions is proposed: Solution A contains cement (123.46 kg/m^3), fly ash (100 kg/m^3), sand (210.05 kg/m^3), water (135.19 kg/m^3), and waste slurry (58.1 kg/m^3); Solution B comprises 40°Bé sodium silicate; with an A/B volume ratio of 30:1.

Keywords

slurry shield; waste slurry; double-fluid grout; response surface methodology; mix ratio experiment

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