Study on the Rheological Properties of Foam-Bentonite Conditioned Shield Muck in Sandy Strata (Post-Print)

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Date: 2025-07-29T19:11:11+00:00

Abstract

Soil conditioning is a critical technology in Earth Pressure Balance (EPB) shield tunneling for ensuring face stability and advancing efficiency. Commonly used conditioning agents currently include water, foam, bentonite slurry, polymer, and other materials. Existing research has experimentally investigated foam-conditioned soil and bentonite-conditioned soil separately, while studies on the combined application of foam and bentonite slurry and its effects on conditioned soil properties are lacking. This study utilizes a self-developed laboratory testing apparatus to conduct rheological and compressibility tests on conditioned sandy soils using a combination of foam and bentonite, deriving the rheological constitutive equation of conditioned soil and the variation patterns of parameters including void ratio and compression. Based on the laboratory test results, optimal mix proportions for conditioned soils in cobble, gravelly sand, and medium-coarse sand strata were determined, and assessment criteria for soil conditioning in sandy formations were proposed. This research will provide technical support and theoretical guidance for soil conditioning technology in sandy strata, and offer assessment criteria for practical construction applications.

Full Text

Preamble

Study on Improving the Flow Plasticity of Shield Muck in Sandy Strata Using Foam-Bentonite Synergistic Amendment

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Abstract

Muck conditioning is a critical technique in earth pressure balance (EPB) shield construction to ensure face stability and excavation efficiency. Commonly used conditioning agents include water, foam, bentonite slurry, polymers, and other materials. While existing research has experimentally investigated foam-conditioned soil and bentonite-conditioned soil separately, studies on the combined use of foam and bentonite slurry and its effects on conditioned muck properties remain scarce. This study employs a self-developed laboratory testing apparatus to investigate the rheological and compressibility characteristics of sandy soil conditioned with a foam-bentonite combination. The research yields the rheological mechanical equation for conditioned soil and reveals the variation patterns of key parameters including void ratio and compressibility. Based on the laboratory test results, optimal mix proportions for conditioned soil in three geological strata—cobble, gravelly sand, and medium-coarse sand—are determined, and evaluation criteria for muck conditioning in sandy strata are proposed. This research provides technical support and theoretical guidance for muck conditioning technology in sandy strata, along with practical evaluation criteria for field construction.

Keywords: EPB shield; muck conditioning; sandy strata; foam agent; bentonite slurry

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