Study of Mechanical Properties of Sand Layer Grouting Reinforcement under Seawater Erosion: Postprint

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Abstract

Grouting serves as an effective method for mitigating geotechnical disasters in subsea tunnels. However, current theories and designs, primarily based on terrestrial tunnel contexts, seldom address the long-term effects of seawater ion erosion on reinforcement. An improved sand permeation grouting simulation test system was employed to examine the mechanical property evolution of sand layer grouting reinforcement under seawater erosion, utilizing various grout types. The mechanical properties of grouting reinforcement, under varying curing conditions, were analyzed using uniaxial compression test, permeability test, and scanning electron microscope (SEM) test. Test results indicate that seawater curing conditions initially enhance the strength and impermeability of grouting reinforcement; however, prolonged curing diminishes these mechanical benefits. The onset of this process occurs significantly sooner in cement-sodium silicate grout (28d to 56d) compared to cement grout (56d to 90d). For cement grouting reinforcement, the deformation modulus increases over time, albeit at a decreasing rate. The deformation modulus of cement-sodium silicate grouting reinforcement follows an increase-decrease-increase pattern, correlating with the volume ratio over time. The decline in mechanical properties of grouting reinforcement during the test' s mid to late stages under seawater conditions results from the interplay between erosive ions, which inhibit mechanical growth and accelerate deterioration.

Full Text

Preamble

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Abstract

Grouting serves as an effective method for mitigating geotechnical disasters in subsea tunnels. However, current theories and designs, primarily based on terrestrial tunnel contexts, seldom address the long-term effects of seawater ion erosion on reinforcement performance. This study employed an improved sand permeation grouting simulation test system to investigate the evolution of mechanical properties in sand layer grouting reinforcement under seawater erosion, utilizing various grout types. The mechanical characteristics of grouted specimens under different curing conditions were analyzed through uniaxial compression tests, permeability tests, and scanning electron microscopy (SEM). Test results indicate that seawater curing conditions initially enhance the strength and impermeability of grouting reinforcement, yet prolonged exposure progressively diminishes these mechanical benefits. The onset of this deterioration occurs significantly earlier in cement-sodium silicate grout (between 28 and 56 days) compared to cement grout (between 56 and 90 days). For cement grouting reinforcement, the deformation modulus increases over time, albeit at a decreasing rate. Conversely, the deformation modulus of cement-sodium silicate grouting reinforcement exhibits an increase-decrease-increase pattern that correlates with the volume ratio over time. The decline in mechanical properties observed during the mid-to-late stages of testing under seawater conditions results from the interplay between erosive ions, which inhibit mechanical growth and accelerate material deterioration.

Keywords: sand layer, grouting reinforcement, seawater erosion, mechanical properties, curing time

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