Mechanical Performance of Emulsion–Cement Treated Expansive Soil under Static and Dynamic Loading

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Abstract

Expansive soils present significant geotechnical engineering challenges due to their volumetric instability, low strength, and acute sensitivity to environmental moisture variations. This study investigates the efficacy of a dual-binder system, comprising 3% ordinary Portland cement and 3% slow-setting asphalt emulsion—in enhancing the mechanical properties and durability of a representative expansive clay from central Cambodia. A comprehensive laboratory testing program was conducted, including Unconfined Compressive Strength (UCS), Indirect Tensile Strength (ITS), and Resilient Modulus (MR) tests. Specimens were evaluated after 7 and 14 days of curing and under simulated environmental stresses, including elevated temperature exposure (70°C) and repeated wet-dry cycles. The results demonstrate a profound improvement in soil properties. The UCS increased from a baseline of 745.33 kPa to 3202.33 kPa after 7 days, indicating rapid strength development primarily attributed to cement hydration. Similarly, ITS improved from 107.04 kPa to 297.67 kPa. The stabilized soil exhibited exceptional durability, retaining significant strength after thermal and moisture cycling. Furthermore, the resilient modulus of the stabilized soil was three to four times higher than that of the untreated soil, signifying a substantial increase in stiffness critical for pavement applications. The findings confirm a synergistic interaction where cement provides a rigid skeletal matrix and asphalt emulsion imparts water resistance and ductility, mitigating the inherent brittleness of cement stabilization. This dual-stabilization technique presents a robust and practical solution for improving the performance of pavement subgrades and foundations in regions with problematic expansive soils.

Keywords

Asphalt Emulsion, Expansive Soil, Resilient Modulus, Soil Stabilization.

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