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Harnessing Microbial-Induced Calcite Precipitation for Sustainable Seepage Control in Cohesionless Soil Channels

Sheikh Abbas Muhammad & Ajay Singh Jethoo

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Abstract

Seepage control in unlined channels is critical for efficient water resource management, as excessive water loss through channel beds and walls leads to inefficiencies. Microbial-induced calcite precipitation (MICP) offers a promising solution to enhance soil stability and reduce seepage in cohesionless soils. This study investigates the application of MICP using *Bacillus subtilis* to mitigate water leakage in sandy soils through controlled

calcium chloride solutions, facilitating calcite precipitation and biocloggIng. pH monitoring and calcium carbonate quantification confirmed the process. Results showed a 26% increase in calcium carbonate content in treated soil, significantly reducing permeability from 6.8×10^{-3} to 1.11×10^{-3} cm/s, as measured by a flexible wall permeameter. Soil strength increased from 234 to 1407 kPa, determined by triaxial compression tests. Validation was achieved using XRD, EDS, and SEM analyses. An interdisciplinary co-occurrence network graph from Scopus data highlighted key concepts like calcium carbonate, calcite precipitation, *B. subtilis*, bioclogging, and soil stabilization. MICP aligns with several UN Sustainable Development Goals (SDGs), notably SDG 6 by enhancing water retention, SDG 9 by promoting sustainable construction, and SDG 13 by improving soil stability against climate-related hazards. Thus, MICP is a sustainable and effective method for constructing impermeable channels, offering significant water management benefits.

Keywords:

Bacillus subtilis bioclogging cohesionless soil sustainable construction unlined channels

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