Hydrogel Stabilization of Construction and Demolition (C&D) Waste with High Fines

ABSTRACT: The escalating volume of construction and demolition (C&D) waste poses a dual challenge of environmental impact and resource management. This study investigates the potential of hydrogel, a distinctive class of three-dimensional networks formed by cross-linking hydrophilic polymer chains within a water-rich environment, to stabilize C&D fines for construction purposes. The exceptional toughness and mechanical strength of hydrogel have sparked interest in improving the ductility and dynamic loading resistance of construction materials. However, limited studies have explored the use of hydrogel in this context. The primary objective of this study was to evaluate the effectiveness of Ca-alginate hydrogel, an environmentally friendly form of hydrogel, in enhancing the ductility and mechanical behavior of C&D fines. Ca-alginate hydrogel was chosen as the stabilizing agent due to its eco-friendly properties. In this study, the study involved incorporating up to 4% (by weight) of hydrogel into C&D fines to investigate the improvement in their mechanical properties and ductility. The influence of reaction time, sodium alginate content, and curing temperature on the mechanical behaviors of hydrogel-stabilized C&D fines was investigated using unconfined compression tests, falling head permeability tests, consolidated undrained triaxial tests and scanning electron microscopy. The results showed that the addition of sodium alginate content significantly increased the unconfined compression strength (UCS) of hydrogel-treated C&D fines, resulting in enhanced load-bearing capacity of the material, but hydraulic conductivity decreased with the increase of sodium alginate content. The UCS of C&D fines treated with 4% hydrogel achieved an impressive 240 kPa after 7 days of curing. Meanwhile, the hydrogel-treated C&D fines indicated significant improvements in the cohesion of the C&D fines. Leaching tests confirm environmental safety, supporting the material's suitability for sustainable construction and geotechnical applications. The study highlights the transformative potential of hydrogel technology in addressing environmental challenges posed by C&D waste in the construction industry.

Keywords: Construction and Demolition Waste, Hydrogel Stabilization, Leaching, Ductility, Mechanical Enhancement