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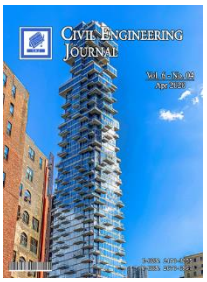

Review Article

Fibers, Geopolymers, Nano and Alkali-Activated Materials for Deep Soil Mix Binders

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Abstract

Ordinary Portland Cement (OPC) and Lime (CaO) have traditionally been used as binder materials for Deep Soil Mix (DSM) ground improvement. Research has been conducted into possible alternatives such as pozzolans to reduce reliance on either cement or lime. However, pozzolans still undergo similar calcium-based reactions in the strengthening process. In this review, further alternative binder materials for soil strength development are explored. These recent developments include fiber reinforcement materials, alkali activation methods, nanomaterials and geopolymers, which can potentially achieve equal or improved performance. Research to date has shown that alkali-activated materials and geopolymers can be equivalent or superior alternatives to pozzolanic supplemented cement binders. The case is made for GP cements which potentially produces 80% less CO2 than conventional portland cement during manufacture. One-part AAM and GP cements are a promising substitute for portland cement in DSM. A combined approach which incorporates both Ca and alkali activated/geopolymer types of materials and hence reactions is proposed.

Keywords: Reinforcement Fibers; Nanomaterials; Alkali-Activated Materials; Geopolymers; Deep Soil Mix.

1. Introduction

The Deep Soil Mix (DSM) method applies soil stabilization principles, which comprises inserting binder materials with other fillers and mixing together with the soil to form strengthened columns of treated soil below ground. The manufacture of the predominant binder materials, cement and lime, impose significant CO_2 emission and high energy demands. Although studied as a potential supplement and/or partial replacement to reduce the usage of OPC and lime, pozzolanic materials still rely primarily on similar calcium (Ca) reaction processes to produce the same calcium silicate hydrate (C-S-H) and calcium aluminate hydrate (C-A-H) gel products for treated soil compressive strength improvement. In addition, pozzolanic binders react incompletely and require a longer time to realize improvements in the treated soil.

This paper reviews several alternatives to Ca type reactions to improve soil properties for DSM, which offer different pathways for strength / soil properties improvement. The primary soil properties of interest for improvement are 1) shear strength (S_u); 2) Compressive strength (q_u); 3) Stiffness (Young's Modulus, E); 4) Dynamic properties (G, D) and 5) Permeability (k).

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