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Simultaneous stabilization by lime and reinforcement by Polypropylene fiber of poorly graded sand

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Abstract

This paper presents the results of applying lime-stabilization and fiber-reinforcement methods, separately and simultaneously, in improving the properties of a poor sandy soil. The effects of adding lime and discrete polypropylene fiber of various lengths, solely and in combination, were investigated. Untreated and treated specimens, organized into 64 groups, were first subjected to tests for optimum moisture contents; and at the optimum moisture contents were they tested for unconfined compressive and direct shear strengths. Amount of lime, length of fiber, amount of fiber, and curing period were the varied parameters. The results show that optimum moisture content increased, thus maximum dry density decreased, with increasing lime content, with increasing fiber content, and with increasing fiber length. Although, shear strength increased with increasing lime content, better results were realized after increasing the curing period, with 2 percent lime content and 7 days curing period considered optimum. However, when stabilized using lime alone, the specimens were found prone to brittleness. This drawback was improved with addition of the fiber, with 0.3 percent fiber content considered optimum, thus demonstrating the merit of using lime and fiber simultaneously. Unconfined compressive and shear strengths also increased with increasing fiber length. Finally, the sudden loss of post-peak strength due to brittle failures was avoided, suggesting a change of failure mode from brittle to ductile, due to the fiber reinforcement.

Keywords: poorly graded sand, lime-stabilized, fiber-reinforced, polypropylene fiber

1. INTRODUCTION

Chemical stabilization has been widely carried out in improving the performance of weak materials for foundations, embankments, infrastructures, and roadbeds [1,2].

Lime is a popular additive for stabilization. Lime generally causes notable increase in stiffness, as measured by the unconfined compressive strength (UCS), but the brittleness of lime-stabilized soil is a well known drawback [3,4].

The improvement in lime-stabilized soil could be attributed to certain reactions that form strong bonds between soil particles [4,5]. These bonded particles tolerate applied forces effectively due to the increased shear strength [6].

The addition of discrete fiber is a form of soil reinforcement and has been widely used in recent years in improving the performance of weak soils. Fiber could be easily mixed and distributed randomly and uniformly within the soil matrix. Since the soil is reinforced in all directions by the embedded fiber, the presence of weak planes could be avoided [7-13].

Reinforcing with fiber generally improves soil strength and decreases soil brittleness; such is a well known fact. In comparison with an un-reinforced soil, more toughness and ductility could be realized in a soil reinforced as such. Thus, discrete fiber is an appropriate additive for improving weak soils [14].

Chemical stabilization and fiber reinforcement have been carried out simultaneously. Kalantari and Haut [15] reported increase in shear strength for soil stabilized with cement and reinforced with discrete fiber. Simultaneous improvement by lime-stabilization and fiber-reinforcement however has been attempted for clayey soils more than for sandy soils. The effects of adding waste products from tyre making industry on mechanical properties of stabilized and un-stabilized clayey soils were investigated by Jafari and Esna-ashari [16] through UCS tests where reinforcing with fiber was determined as more effective than stabilizing with