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The Effects of Freezing and Thawing Cycles on Mechanical Properties of Fine-grained Soils Stabilized with Lime and Reinforced with Polypropylene Fiber

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ABSTRACT

Due to the positive effects of adding lime in fine-grained soils and reinforcing these soils with polypropylene fiber, durability evaluation of stabilized or reinforced soils especially in cold regions where are more exposed to periodical freezing and thawing cycles is still necessary. In this research, 12 different treatments were prepared by using three levels of lime (0, 2 and 4 percent by weight of dry soil) and four levels of polypropylene fiber (0, 0.25, 0.5 and 1 percent by weight of dry soil). Each treatments with three replications has been cured for 28 days and undergoes numerous cycles of freezing and thawing including 0, 1, 4, 7 and 10 cycles, then unconfined compressive strength of the specimens were determined. According to results of various tests, it was found that using 4% lime with 0.5% polypropylene fibre is the most appropriate combination for making strongest and most durable mixture, as unconfined shear strength of test samples do not change after taking numerous cycles of freezing and thawing.

KEYWORDS

Clay Soil, Stabilizing with Lime, Reinforcing with Polypropylene Fiber, Freezing and Thawing Cycles

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1- BRIEF INTRODUCTION

Soil stabilization and reinforcement are the most effective techniques for site improvement. Stabilizing with Lime and reinforcing with Polymer fiber such as polypropylene are commonly used for improving the mechanical properties of soils. Because of frequent changes of climate conditions in dry and cold areas, it is necessary to evaluate the effects of freezing and thawing cycles on mechanical properties of improved soils. According to results of previous investigations, adding lime improves strength properties of soil, but has inverse effects on its plasticity properties [5]. Also adding discrete polypropylene fiber in clayey soil leads to considerable increasing in shear strength, hardness and plasticity of soil [3][4]. Kumar et al. (2006) presented that adding polyester fiber to clayey soil leads to important increasing in compressive strength of soil [2]. Ghazavi and Roustaie (2009) showed that polypropylene fiber increases the compressive strength and decreases the swell potential of soils under freezing and thawing cycles[1]. In this research the effects of lime and polypropylene fiber were investigated on strength and plasticity properties of clayey soil under different freezing and thawing cycles.

2- METHODOLOGY

In order to assess the effects of lime and polypropylene fiber on mechanical properties of clayey soil, 12 different treatments were prepared by using three levels of lime (0, 2 and 4 percent by weight of dry soil) and four levels of polypropylene fiber (0, 0.25, 0.5 and 1 percent by weight of dry soil). Each treatment with three replications were cured for 28 days and undergoes numerous cycles of freezing and thawing including 0, 1, 4, 7 and 10 cycles. Then unconfined compressive strength tests were conducted on the specimens for determination of mechanical characteristics of the samples.

3- MAIN CONTRIBUTIONS

Some of the important achievements of this research are listed as following:

Optimum water content of clayey soils increases about 4% by adding polypropylene fiber up to 1% and lime up to 4% to clayey soil.

The compressive strength of stabilized soil with lime could be decreased up to 40% under frequent freezing and thawing cycles.

By increasing in percentage of polypropylene fiber, failure of samples occurs at higher strains along with behaves as soft materials.

According to this tip that fiber just increases the tensile strength, with increasing the amount of fiber from an optimum level in mixes, fibers are replaced with soil and lime particles and causes considerable loss in compressive strength.

A specific percent of lime along with polypropylene fiber exist so that failure behavior of specimen is not brittle and nor soft, otherwise on that case the specimen have a specific stability that increasing in number of freezing and thawing cycles doesn't change failure behavior of specimen and doesn't reduce in strength.

Clayey soil which is stabilized with 4% and reinforced with 0.5% polypropylene fiber has a partly resistant combination against freezing and thawing cycles. This combination was found to be an optimum mix having strength and durable behavior.

4- SIMULATION REESULTS

How the freezing and thawing cycles influence on the compressive strength and plasticity of specimens which are stabilized with lime and reinforced with polypropylene fiber, are represented in the following Figures:

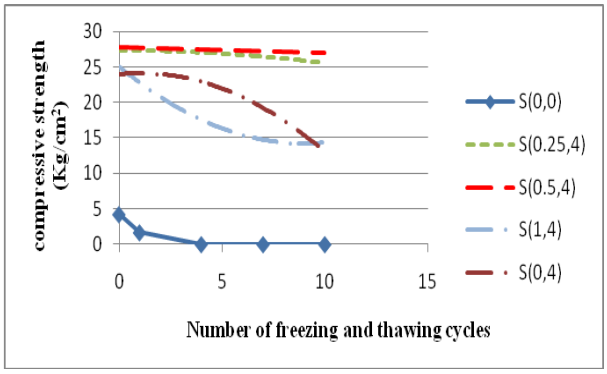

Fig.1 variation of unconfined compressive strength versus freezing and thawing cycles.

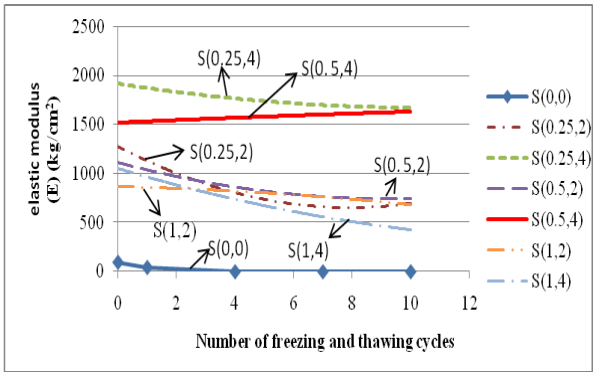

Fig.2- variation of elastic modulus versus freezing and thawing cycles for the stabilized with lime and reinforced with polypropylene fiber treatments.

According to Fig. 1 it seems stabilized with 4% lime and reinforced with 0.5% polypropylene fiber specimen has a partly resistant combination against freezing and thawing cycles, so that in any of cycles strength loss doesn't happen. Also Fig.2 represents that elastic modulus of mentioned treatment against freezing and thawing cycles is partly stable, so that in any of cycles elastic modulus loss doesn't happen. So using 4% lime with 0.5% polypropylene fiber have been introduced as the most appropriate combination for making strongest and most durable mixture for improving clayey soils in cold climates.

5- MAIN REFERENCES

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