Ain Shams University
Faculty of Engineering
Department of Structural Engineering

Behaviour of Soil Reinforced with Randomly Distributed Fibers

A THESIS
Submitted in Partial Fulfillment for the Requirements of the Degree of
MASTER OF SCIENCE IN CIVIL ENGINEERING

Submitted by

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Statement

This dissertation is submitted to Ain Shams University for the degree of Master of Science in Civil Engineering (Structural Eng.)

The work included in this thesis was carried out by the author in the Department of Structural Engineering, Faculty of Engineering, Ain Shams University, Cairo, Egypt.

No part of this thesis has been submitted for a degree or qualification at any other university or institution.

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Abstract of M.Sc. Thesis

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The use of reinforcement to increase the stability of earth structures has increased in the past decades. Most of these projects are constructed using traditional planar reinforcement which provides tensile resistance in their direction only. Continuous planes of weakness may be introduced at the interface between reinforcement and the soil. On the other side, the use of randomly-distributed short fibers within the soil mass provides an isotropic increase in the shear strength without introducing planes of weakness.

Soil reinforcement with randomly-reinforced fibers seems to be a very promising soil improvement technique. However, the researches in such field are limited. The fiber-reinforced soil behaviour is complicated, and is affected greatly by the used materials in addition to other factors such as preparation techniques. More researches are required in this field to help understanding its behaviour and the factors affecting it.

A laboratory testing program is conducted in this study in order to achieve such goal. The program purpose is to evaluate the fibers inclusion effect on the soil shear strength, deformation behaviour and volumetric response. The reinforced soil behaviour is evaluated using direct shear tests, confined compression tests and plate load tests.

The study also directed to investigate the possibility of using the fiber-reinforced soil as an alternative to the conventional unreinforced compacted sand. Therefore, the effects of other parameters such as the moisture content and relative density are investigated. The test specimens are prepared at different relative densities (25%, 60% and 90%). The moisture contents adopted in this study are chosen to be dry of the optimum moisture content determined from the modified proctor test.

The study introduces the preparation techniques for both the reinforced direct shear specimens and the reinforced test pit for the plate load test. Both the strength and deformation behaviours are assessed from the laboratory and in-situ tests. The results show that the reinforced loose dry sand has the same shear strength as the unreinforced moist very dense one. The laboratory and in-situ tests results suggest that the fibers inclusion improves the sand shear strength in comparison to the effect of increasing the soil relative density by compaction. However, increasing the relative density enhances the settlement more than the fibers inclusion does.

Keywords: Fiber-reinforced soil, randomly-distributed fibers, direct shear test, plate load test, shear strength of fiber-reinforced sand, dilatancy of fiber-reinforced sand.

Summary of M.Sc. Thesis

A series of laboratory and filed tests are conducted in this research study to investigate the effect of the inclusion of discrete randomly-distributed short fibers on the mechanical behaviour of sand. Direct shear tests are conducted on both reinforced and unreinforced sand specimens. The direct shear test results are utilized to investigate the effect of fibers incusion on the shear strength and volumetric change behaviours. The deformation behaviour is investigated through a series of confined compression tests carried out in the direct shear apparatus. Plate load tests are conducted to study the beahviour of fiber-reinforced soil over large scale.

This thesis consists of six chapters. The contents of each chapter are summarized as follows:

Chapter one covers an introduction to the research study, a statement of the problem followed by the research objectives and the thesis outline.

Chapter two presents a review of the results and the theories described in previous studies that dealt with the fiber-reinforced soil behaviour.

Chapter three shows descriptions of all the experimental work conducted on unreinforced and reinforced sand specimens to study effect of the different parameters on the strength and deformation behaviour. Definitions for the fiber-reinforced soil basic parameters are also presented.

Chapter four analyise the laboratory tests results. A discussion on the effect of the fibers inclusion on the mechanical behaviour of sand is presented.

Chapter five provides a description of the in-situ plate load tests setup and results adopted in this study. A comparison between the laboratory and filed behaviours is also provided in this chapter.

Chapter six summarizes the outcome of the laboratory and filed investigation, in addition to the research conclusions. Recommendations for future research are presented regarding the fiber-reinforced soil behaviour.

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