SHEAR STRENGTH IN… SOIL BY USING
POL…

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ABSTRACT

One major problem related to construction on foundation soil is the low shear strength of soil. However previous researcher have shown that the shear strength could increase significantly upon consolidation and hence some improvement methods have been developed to increase the bearing capacity of the foundation soil. The purpose of this project is to evaluate the increase of shear strength of fiber reinforced sand. For this study, the samples were prepared under several consolidation pressures: 136.2kPa, 272.5kPa and 408.8kPa. The shear strength of samples are obtain by conducting the triaxial test which also known as shear box test. The results proved that there is an increase in shear strength due to the fiber reinforcement. The initial value of shear strength developed from the results of Triaxial testing was found to be increase after reinforced with the fiber, however the ratio of strength increase is 0.08 which is lower as compared to published data.

ABSTRAK

Satu masalah utama yang berkaitan dengan pembinaan atas tanah asas ialah kekuatan ricih tanah yang rendah. Walau bagaimanapun, pengkaji terdahulu telah menunjukkan bahawa kekuatan ricih boleh meningkat dengan ketara semasa penyatuan dan oleh itu beberapa kaedah penambahbaikan telah dibangunkan untuk meningkatkan keupayaan galas tanah asas. Tujuan projek ini adalah untuk menilai peningkatan kekuatan ricih pasir bertetulang gentian. Untuk kajian ini, sampel telah disediakan di bawah tekanan penyatuan beberapa: 136.2kPa, 272.5kPa dan 408.8kPa. Kekuatan ricih sampel mendapatkan dengan menjalankan ujian tiga paksi yang juga dikenali sebagai ujian kotak ricih. Keputusan ini membuktikan bahawa terdapat peningkatan dalam kekuatan ricih akibat tetulang gentian. Nilai awal kekuatan ricih yang dibangunkan daripada keputusan ujian tiga paksi telah didapati meningkat selepas diperkukuh dengan gentian, bagaimanapun nisbah peningkatan kekuatan ialah 0.08 yang lebih rendah berbanding dengan data yang diterbitkan.

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σ	Stress in kn/m^2
ε	Strain (%)
F	Load in kN
L_r	Peak load on piston for fiber-reinforced sand fill
L_u	Peak load on piston for unreinforced sand fill
d	Diameter of mould (m)
ϕ_c	Critical-state friction angle
W	mass soil in kN
V	volume of soil in m^3
m	Moisture content (%)
W_s	mass of the dry soil
W_w	mass of water
ρ	Density of sand in kn/m^3

CHAPTER 1

INTRODUCTION

1.1 Introduction

Soil reinforcement is an effective and reliable technique which used in construction to increase the stability and strength of soils. This kind of soil can be widely used in many types of construction work like embankments and retaining structures to strengthen the subgrade. In Europe, the texsol fiber reinforced soil will use to build retaining wall shortly after construction. For the material that uses to reinforce the sand, used tyre and plastic bottle which are polyporpylene and polyethylene terephalate (PET) are one of those suitable material. The fibers can be made of different shapes and lengths.

Soil reinforcement has been introduced into the field of geotechnical engineering for many years in order to improve the properties of ground soil in specific engineering projects. Traditional geosynthetics, such as geotextiles, geogrid etc. have been proved to be efficient and they being increasingly used in geotechnical engineering and other fields. One of the primary advantages of randomly distributed fibers is the absence of potential planes of weakness that can develop parallel to oriented reinforcement (Maher and Gray, 1990).

In this project, the strength of the fiber reinforced sand will be tested base on the percentage of mixed fiber and the characteristic of the sand. The stress-strain-strength response will be evaluated by a compression tests. Emphasis was on the influence of the fiber length and fiber content on the basic soil properties, such as the porosity, particle size and specific gravity.

The main objective of this study was to determine the contribution of fiber reinforcement to the shear strength of sand. A series of triaxial test will be carry out to investigate the effect of fiber content on the behaviour of sand at all stages: pre-failure, failure and post-failure.

1.2 Problem Statement

Nowadays the good land being lesser and lesser due to the development, therefore people do starting to build on sandy soil. But this kind of soil is low in shear strength. Initial stability of construction on peat is the most critical problem due to low undrained shear strength of peat in normally consolidated state and hence low bearing capacity of foundation soil.

From the comparison with systematically reinforced soil, randomly distributed fiber reinforced soils exhibit some advantages. One of the advantages of this kind of reinforcement soil is the maintenance of strength isotropy and the absence of potential planes of weakness can develop parallel to the oriented reinforcement.

However some researchers found that shear strength could increase significantly upon consolidation. This study evaluates the increase of shear strength of using fibers by comparing the results of direct shear test done on samples.

1.3 Objectives of the Study

The objectives of the study are:

(i) To investigate relationship between density of sand with percentage of fiber.

(ii) To study the behaviour of sand after mix with the fiber reinforced plastic.

(iii) To investigate the relationship of coarse sand with the increasing percentage in fiber.

(iv) To check the stress-strain behaviour of the fiber reinforced sand.

1.4 Scope of Study

The scope of study of this project will be the sand that will be mix with the fiber is the coarse sand. Then followed by the test we run to test the shear strength of fiber reinforced sand is triaxial compression test. For the reinforcement material, I will be only using the nylon fishing. The fiber content which will be mix with the sand will be various from 0.25% to 1% by weight if the sand. For the moisture content of the tested sand will be vary from 6% to 12 %.

1.5 Significant of Study

The significant of this study is to investigate the problem of the low bearing capacity of sand as soil foundation. In this study, the basic properties of sand will be first to determined then follow by the shear strength of sand. To test the basic properties of sand, pycnometer test, and standard proctor test and particle analysis will be carrying out. For the shear strength test, the triaxial test which also known as shear box test will be conducted. Hopefully the result from this study can use as reference by the future engineers as useful guideline.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

In this chapter, reader will understand about the whole research methodology, findings and the material used in the fiber reinforced sand. Besides that, I will explain the advantageous of using the fiber reinforced sand.

2.2 Fiber Reinforced Sand

Fiber reinforced sand is a mixture of synthetic fiber material randomly mix with the sand. Synthetic fibers can be made of different materials, shapes and lengths. Normally polypropene and polyester are the most common materials used to manufacture fibers, but for this project, the fiber that being choose to use is nylon fiber. The fibers can be any shape like flat or round according to the researcher's interest. In this project, the chosen shape is discrete fiber. The fiber which is fishing line was cut into 4mm in length and randomly distributed in the sand (Raghavendra R. Hedge, 2004).

2.2.1 Type of fiber Reinforcement

Reinforced soils can be obtained by either incorporating continuous reinforcement inclusions (e.g., sheet, strip or bar) within a soil mass in a certain pattern (i.e., systematically reinforced soils) or mixing discrete fibers randomly with a soil fill (i.e., randomly reinforced soils). The concept of reinforcing soil with natural fiber materials originated in ancient times.

In comparison with systematically reinforced soils, randomly distributed fiber-reinforced soils exhibit some advantages. Preparation of randomly distributed fiber-reinforced soils mimics soil stabilization by admixture. Discrete fibers are simply added and mixed with the soil, much like cement, lime, or other additives. Randomly distributed fibers offer strength isotropy and limit potential planes of weakness that can develop parallel to oriented reinforcement. Unlike systematically reinforced soils, limited information has been reported on randomly distributed fiber-reinforced soils in the literature.

2.3 Sand

Sand is a naturally occurring granular material composed of finely divided rock and mineral particles. The composition of sand is highly variable, depending on the local rock sources and conditions, but the most common constituent of sand in inland continental settings and non-tropical coastal settings is silica(silicon dioxide, or SiO2), usually in the form of quartz.

The second most common form of sand is calcium carbonate, for example aragonite, which has mostly been created, over the past half billion years, by various forms of life like coral and shellfish. For example, the primary forms of sand apparent in areas where reefs have dominated the ecosystem for millions of years.

2.3.1 Composition of Sand

In terms of particle size as used by geologist, sand particles range in diameter from 0.0625mm to 2mm. an individual particle in this range size is termed a sand grain, Sand grain are between gravel (with particles ranging from 2mm up to 64mm) and silt (particles smaller than 0.0625mm down to 0.004mm). The size specification between sand and gravel has remained constant for more than a century. ISO 14688 grades sands as fine, medium and coarse with ranges 0.063mm to 0.2mm to 0.63mm to 2.0mm.

The composition of sand is highly variable depending on the local rock sources and conditions. The bright white sands found in tropical and subtropical coastal settings are eroded limestone and may contain coral and shell fragments in addition to other organic or organically derived fragmental material suggesting sand formation depends on living organisms too.

2.3.2 Shear Strength of Sand

Shear strength of sand can be defined as the maximum shear that can be sustained by the sand. Therefore the shear strength of sand plays a vital role when it became the foundation. In geotechnical engineering, the shear strength of soil is an important property to evaluate for many cases, such as foundations, earth slopes, retaining walls and road bases.

In general, a loose sand contracts and a dense sand expands as it approaches the critical state, usually defined as the state at which sand is sheared without changes in either shear strength or volume. However, whether a sample of sand is contractive or dilatant depends not only on density but also on effective confining stress. According to the critical-state model, when a loose sample is sheared under high effective confining stress, the shear stress increases mononically until it reaches a plateau, after which the sample continues to undergo shear straining without any change in shear stress or sample volume. The sample is then said to have reached the critical state and the corresponding friction angle is known as the critical-state friction angle ϕ_c.

During the shearing of dense sand, the sample contracts initially then dilates. The effective principal stress ration reaches a peak, associated with a peak friction angle, at which the dilation rate is a maximum. Further loading causes the shear stress to drop until it reaches the critical state. For practical purposes, the critical-state friction angle obtained from triaxial tests is commonly taken as unique value for a given granular soil, regardless of the initial relative density and initial confining stress. Such an approach is well justified by results found in the literature (Rowe 1962, 1971; Bolton 1986; Negussey et al. 1986; Been et al. 1991; Schanz and Verner 1996), which support the concept that ϕ_c is unique for silica sands and may be taken as an intrinsic variable of the sand. (R. Salgado, Member; ASCE)

2.4 Shear Strength of Fiber Reinforced Sand

Gray and Ohashi (1983) conducted a series of direct shear tests on dry sand reinforced with synthetic, natural and metallic fibers to evaluate the effect of parameters such as fiber orientation, fiber content, fiber area ratio and fiber stiffness. Maher and Gray (1990) conducted triaxial compression tests on sand reinforced with randomly distributed fibers and observed the influence of various fiber properties, soil properties and other test variables.

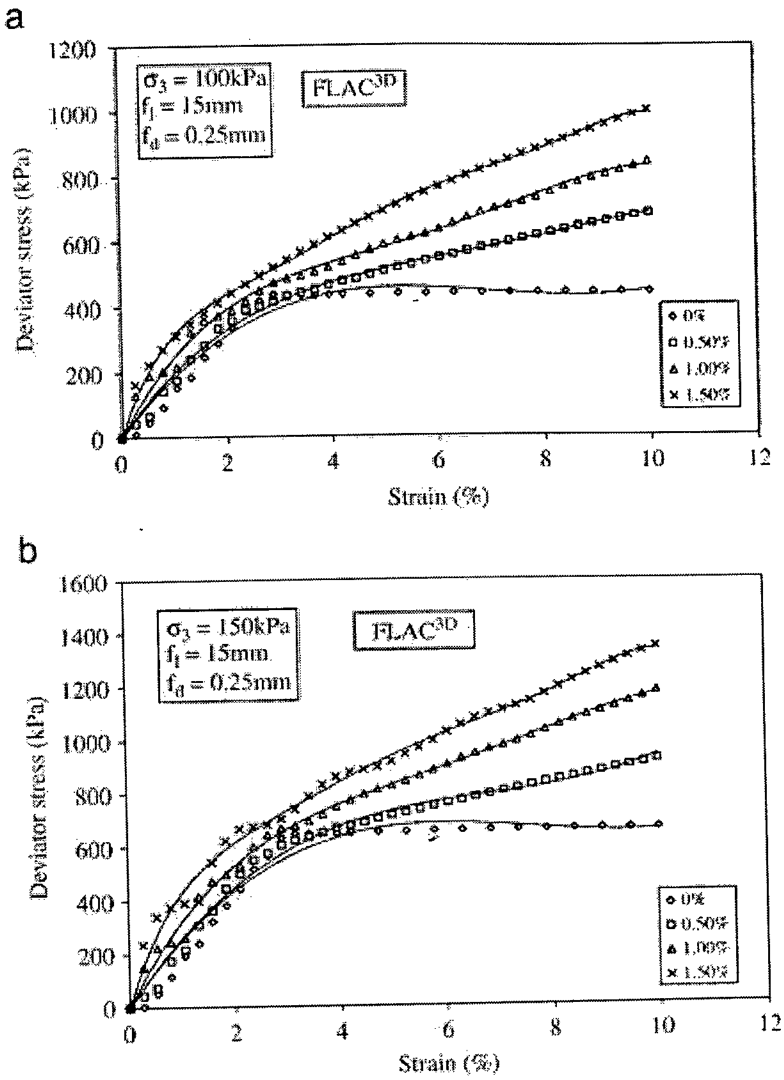

Figure 2.1 Stress vs. strain curves for various fiber contents

Babu, Vasudevan, and Haldar (2007) proves that with using different percentage of fiber will affect the final shear strength of the reinforced soil.

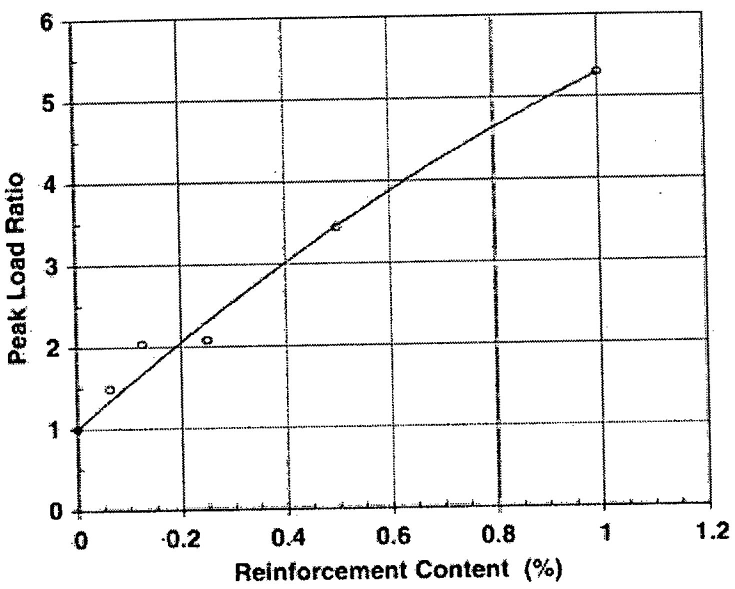

Figure 2.2 Variation of peak load ratio with reinforcement content

From the research of G.L. Sivakumar Babu, , A.K. Vasudevan, and Sumanta Haldar (2007), they find out that the peak load ratio of a soil will be increase if the reinforcement content increase. Figure 2.2 shows the relationship between the peak load ratio and reinforcement content.

Reinforced soils can be obtained by either incorporating continuous reinforcement inclusions (e.g., sheet, strip or bar) within a soil mass in a defined pattern or mixing discrete fibers randomly with a soil fill. This concept of reinforcing soil with natural fiber materials originated in ancient times. Freitag (1986) has done an experiment by mixing fibers in compacted fine grained soil and he found out that could result in greater shear strength and stiffness. Michalowski and Zhao (1996), based on triaxial test results, indicated that the steel fibers led to an increased in the peak shear stress and the stiffness prior to reaching failure.

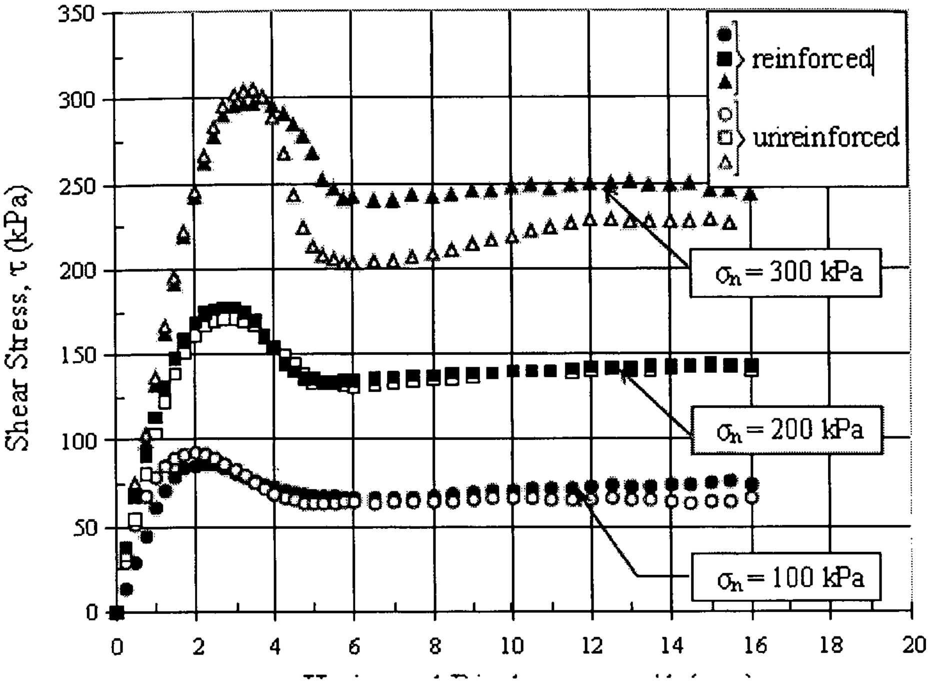

Figure 2.3 A sample of shear stress horizontal displacement response profile

Source: Temel Yetimoglu, 2002

The general characteristics of granular soils reinforced with discrete fiber reported in previous studies were reviewed by Morel and Gourc (1997). Their review shows that the inclusion of fiber definitely provides an increase in material strength and ductility. The composite's behaviour is governed by the content and the mechanical and geometrical properties of the fiber.

In general, fiber inclusion improves the overall engineering behaviour of soils by increasing the tensile and compressive strength, shear strength, peak friction angle and cohesive intercept, while also contributing to an increase in ductility and resistance to impact and cyclic loading.

Figure shows the stress-strain graphs resulting from drained shear tests on the specimens of the same dense coarse soil at three different normal stresses. Each curve presents a maximum shear and the shear that can be resisted by the soil at higher strain level. These are termed as the peak and residual stresses respectively.

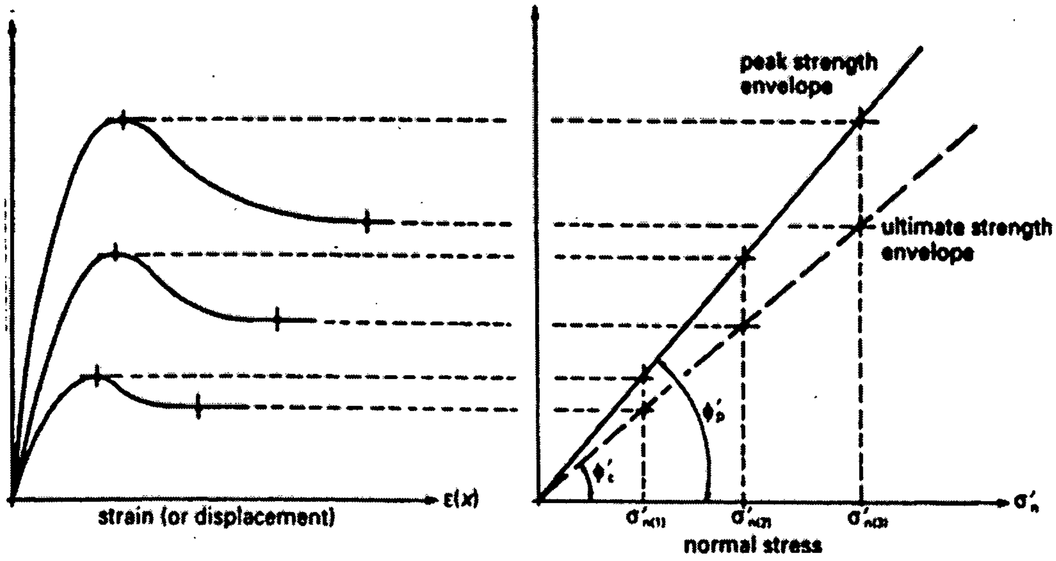

Figure 2.4 Graph resulting from drained shear tests

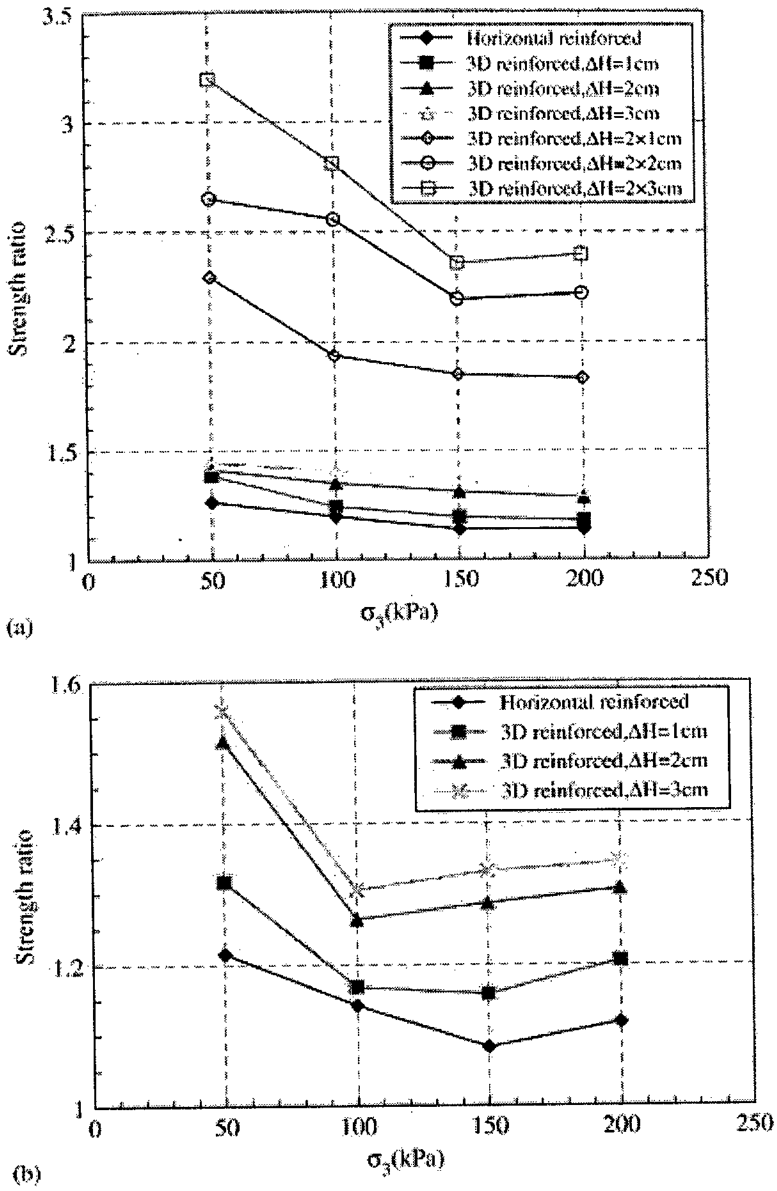

Figure 2.5 Strength ratios versus confining pressures: (a) reinforced with galvanized iron sheet and (b) reinforced on single-sided with hard plastic sheet.

A series of triaxial test have been done by Mx zhang, A.A. Javadi, X. Min (2006). They have performed a new concept of soil reinforced with three-dimensional reinforcing elements and he stated that for sand reinforced with 3D inclusions, the greater the height of the vertical reinforcements, the greater is the increase in shear strength in comparison with unreinforced sand. With the same height of vertical reinforcements and for the same reinforcement material, the strength ratio of reinforced sand will generally be decreased with the increase of confining pressure. So the 3D reinforcements are also more effective for specimens at low confining pressures, as is the case for the conventional horizontal reinforcements.

By comparing the strength ratios of sand reinforced with 1 cm high vertical reinforcements on both sides with that of 2cm high vertical reinforcements on one side only, (both at the same confining pressure), it is realized that the strength ratio of the former is considerably greater than the latter. This is because of the unsymmetrical distribution of reinforcing elements about the horizontal reinforcing plane for the latter case.

This is why, with the same vertical height of the total reinforcements, the reinforcing effect of double-sided reinforcement is much greater than that of single-sided reinforcement. In the case of the single-sided reinforcement, the two parts of the soil sample are separated by the horizontal reinforcing plane; the upper (vertically reinforced) part belongs to the area of 3D reinforcement, while the lower part is horizontally reinforced and its behavior is close to that of the conventional horizontally reinforced soil. When the whole specimen approaches failure, the sand in the area below the horizontal reinforcement will fail earlier than that in the 3D reinforced area above the horizontal reinforcing plane.