Shear Test on Reinforced Clayey Sand

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***Abstract*—**Composite soils have been widely used in civil engineering applications, especially in slopes, embankment dam and landfills. This paper aims to investigate effect of fiber inclusion on shear stress of composite soil (i.e. sand composite). A series of laboratory direct shear tests carried out to evaluate fiber effect on strength behavior of composite sand. Clayey sand was selected as soil part of the composite and natural fiber was used as reinforcement. The fiber parameters differed from one test to another, as fiber length were changed from 10 mm to 35 mm and fiber content were varied from 0.6% and 3%.Normal stress kept constant at 100 kpa. For each test, stress_ displacement graph derived and the results were compared. The results proved that inclusion of fiber affected strength behaviour of sand composite so that increasing in fiber content and length caused increasing in shear stress.

***Keywords*—**Direct shear, Reinforced, Fiber, Sand

I. Introduction

The direct shear test is one of the oldest strength tests for soils. In this study, a direct shear device will be used to determine the shear strength of a fiber reinforced soil. Applications of soil strengthening or stabilization range from the mitigation of complex slope hazards to enhancing the subgrade stability. Together with the many applications for improving soil, there are several widely varied methods. The mixing of randomly oriented fibers to a soil sample may be considered same as other admixtures used to stabilize soil. Material used to make fibers for reinforcement may be obtained from paper, metal, nylon, polyester and other materials having widely varied physical properties. There have been numerous past papers published on the topic of fiber strengthening of soils. Examples include Lee et al., 1973, Hoare,1979, Andersland and Khattac,1979, Freitag,1986, Gray and Ohashi, 1983, Gray and Rafeai, 1986, Maher and Gray 1990, Maher and Ho, 1994, Michalowski and Zhao 2002, Ranjan et al. 1996, Kaniraj and Havanagi 2001, Consoli et al. 2009.

All of the papers listed above have generally shown that; strength of the soil was improved by fiber reinforcement. The investigation on clayey sand is very limited. The purpose of this survey is to evaluate clayey sand behaviour induced by fiber inclusion.

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II. Material

Composite soils consist of two parts. The first part is soil part which can be dealt as normal soil. The second part is reinforcement part which can be made up of any material which helps soil to have better performance.

A. Soil Type

The soil type in this study was Western Australian sand. The properties of clay are presented in table 1. The sand distribution curve is presented in Fig 1. The soil part was reconstituted in lab by using sand with 20% of kaolin clay.

No.	Type	
1	Soil type	Clay
2	Liquid Limit	49
3	Plastic Limit	23
4	Pl. Index	26

Table1. Clay properties

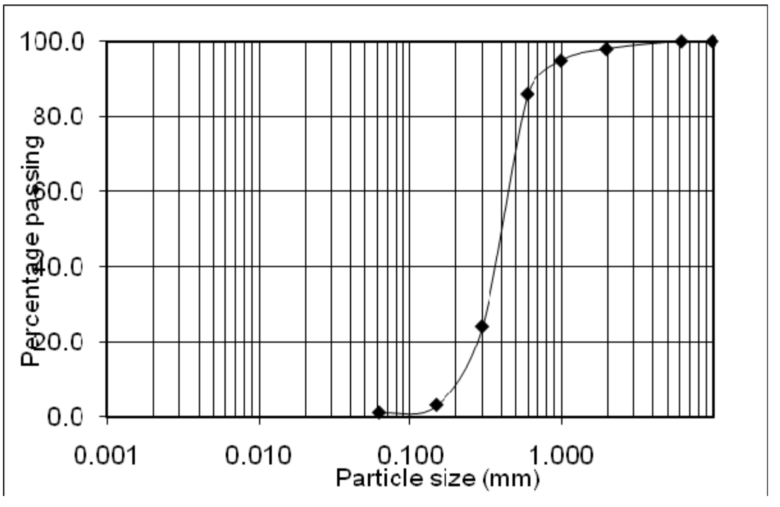

Fig. 1 Sand Particle Distribution

B. Fiber Type

The natural fiber has been used for this investigation. Figure2 shows the used fiber. The used fiber has good potential to absorb energy and good adhesion with soil particle.

Fig. 2 Natural fiber

Figure 3 shows automated direct shear which was used to run shear test. The device is fully automated so the results easily transferred without any user interference.

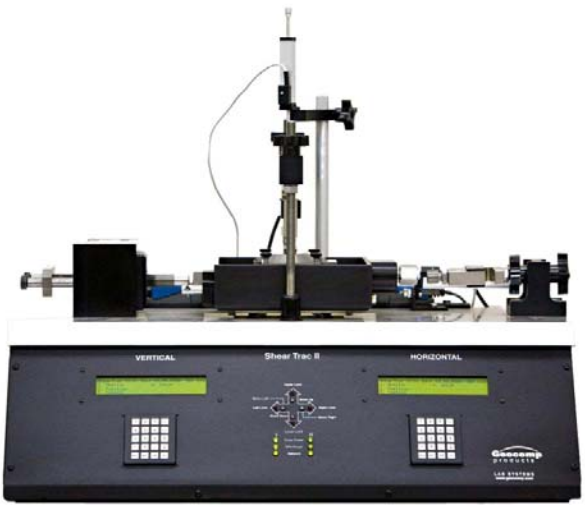

Fig. 3 Direct Shear Test Machine

III. TEST PROGRAM

A series of direct shear tests have been conducted on reinforced sand composite.

A. Direct Shear Test

The test is carried out on either undisturbed samples or remoulded samples. To facilitate the remoulding purpose, a soil sample may be compacted at optimum moisture content in a compaction mould. Then specimen for the direct shear test could be obtained using the correct cutter provided. Alternatively, sand sample can be placed in a dry state at a required density, in the assembled shear box.

A normal load is applied to the specimen and the specimen is sheared across the pre-determined horizontal plane between the two halves of the shear box. Measurements of shear load, shear displacement and normal displacement are recorded. From the results, the shear strength parameters can be determined.

B. Main Equipments

- Direct Shear Test Machine
- Specimen preparation equipment
- fiber
- Balance

IV. SAMPLE PREPARATION

The samples were prepared by mixing clay and three percentage of fiber (i.e. 0.6%, 0.8%, 1.5%, 3%) The soil was first dried under laboratory air-dried conditions then ground and passed through a 2 mm sieve. The dry powder was carefully wetted with a spray gun to the standard optimum moisture content. The moist soil was then put in sealed plastic bags in a humidity room for about two days before use. The moist residual soil was then compacted in a 300 mm x 300 mm shear box mould by machine compaction to the appropriate height and unit weight at the optimum moisture content.

V. TEST METHODOLOGY AND PROCEDURE

1. The shear box was assembled and the specimen was put into the shear box. Special care was made that the alignment screws working well.
2. The shear box was placed into the shearing device.
3. Normal load was applied to the specimen using the load transfer plate and the loading hanger.
4. Set the shearing device the advance at a rate of 0.50 mm/min.

7. The data acquisition system was run.

8. Once data acquisition has begun, the shearing device was started.

9. The Shear Stress-Displacement curve plot used for strength behavior investigation

VI. Results and Discussions

The direct shear tests were performed in order to determine effect of fiber inclusion on shear strength of reinforced clayey sand. Figure 4 showed the stress-displacement curve obtained from the tests at 10mm fiber length and constant normal stress of 100 kpa.

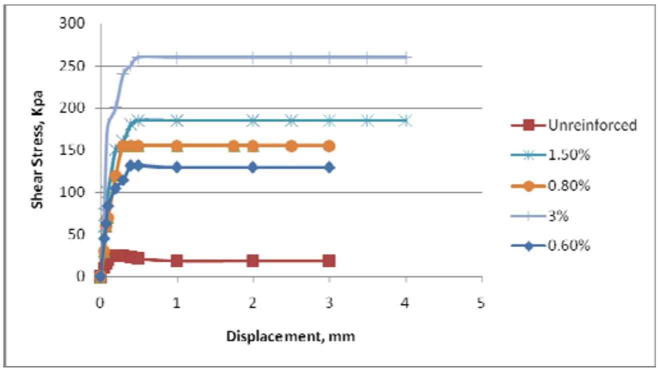

Fig. 4 Results of direct shear test in different fiber content (at 10mm, Normal stress 100 kpa)

Figure 4 proved increasing in fiber content will increase the strength.

Figure 5 shows the effect of fiber length on strength of composite clayey sand at constant fiber content of 0.6% and normal stress of 100 kpa.

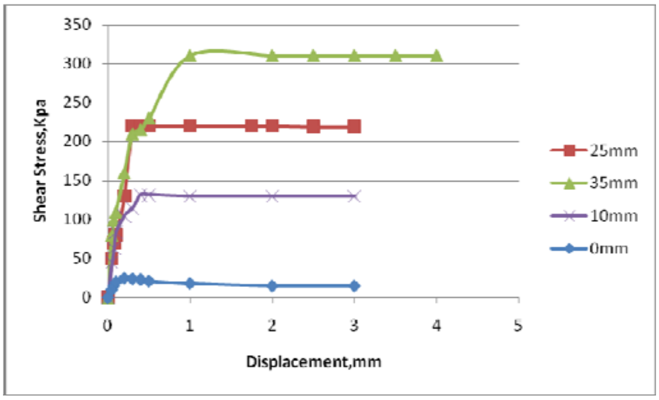

Fig. 5 Results of direct shear test in different fiber length (at 0.6% fiber content, Normal stress 100 kpa)

VII. Conclusion

- Increasing in fiber percentage increased shear strength in clayey sand samples
- During the test, it was observed that ductility behaviour of reinforced sand increased because of fiber inclusion.
- The results proved that with increasing in fiber length, the shear stress of composite clayey sand was increased.
- Short and randomly Fiber inclusion showed to be reliable in industry projects as it helps to minimize the cost of projects.

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