Laboratory Study on Strength of Reinforced Clayey Sand

Amin Chegenizadeh[1], Prof. Hamid Nikraz [2]

***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 fibre inclusion on Unconfined Compressive Strength of composite soil (i.e. sand composite). A series of laboratory Unconfined Compression tests carried out to evaluate fibre effect on strength behavior of composite sand. Clayey sand was selected as soil part of the composite and plastic fibre was used as reinforcement. The fibre parameters differed from one test to another, as fibre length were changed from 10 mm to 40 mm and fibre content were selected as 0.6% and 3.5%. For each test, stress_strain graph derived and the results were compared. The results proved that inclusion of fibre affected strength behaviour of sand composite so that increasing in fibre content and length caused increasing in Unconfined Compressive Strength (UCS).

***Keywords*—**UCS, Reinforced, Fibre, Sand

I. Introduction

The paper presents the effect of fibre inclusion on unconfined compressive strength of clayey sand. 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 fibre inclusion.

[1]F. A. Author is with the Curtin University of Technology, Perth, Australia Tel: +61-413165961;Email: amin.chegenizadeh@postgrad.curtin.edu.au

[2]S. B. Author, Head of the Department of Civil Engineering, Curtin University of Technology, Perth, Australia; Tel: +61 8 9266 7573; Fax: +61 8 9266 2681; Email: H.Nikraz@curtin.edu.au

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 15% of kaolin clay.

Table1. Clay properties

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

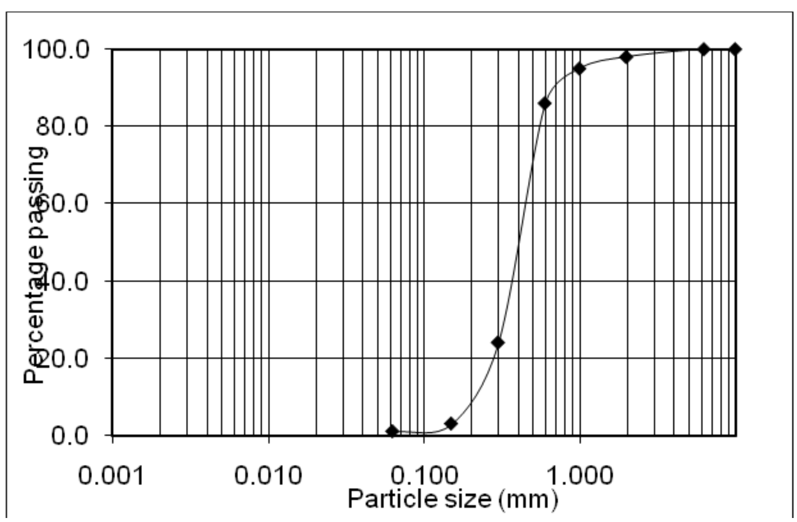

Fig. 1 Sand Particle Distribution

B. Fibre Type

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

Fig. 2   Plastic fibre

III. TEST PROGRAM

A series of unconfined compression have been conducted on reinforced sand composite.

A. Unconfined Compression Test

The unconfined compression test imposes uniaxial stress conditions on a sample of soil, and is therefore a special case of the trixial test with zero confining stress. The unconfined compression test has a significant cost advantage over triaxial test due to the simpler testing requirement. The limitation of this test can be named as: preparing stable sample for cohessionless material and undrained estimation due to quick test.

B. Main Equipments

- Unconfined compression testing machine (Triaxial Machine)
- Specimen preparation equipment
- Sample extruder
- fibre
- Balance

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

Fig. 3   Trixial Machine

IV. SAMPLE PREPARATION

The samples were prepared by mixing clay and three percentage of fibre. Specimen preparation method was the standard compaction method, which was used in an ongoing experimental research on fiber-reinforced clay at Curtin University. The soils were first oven-dried. The dry soils were then crushed using a hammer. A mixer was used to thoroughly mix the soils with water to obtain the desired water moisture content for compaction. The mixing of soil with fibers was performed mostly by hand rather than using the mixer because the mixer caused the fibers to tangle or break. The fiber-soil mixture was placed in a closed container for 24 hours after mixing was completed. A split mold and a specific hammer were used to compact the specimen. The specimens were prepared in different fibre content (i.e. 0.6%, 1.5%, 3.5 %,) and different fibre length (aspect ratio) which were 10mm, 25mm, 40mm.

V. TEST METHODOLOGY AND PROCEDURE

- The specimens were prepared in the laboratory with 90% compaction effort, special care was taken during this process
- The size of samples were checked to be suitable for the test purpose
- The samples were put for 24 hours in geotxtile and packed
- Special attention was applied for preventing any moisture loose
- The samples were put in trixial base without any confinement pressure
- According to ASTM 1.27 mm/min were applied through the tests
- The data was collected automatically

The stress-strain curve plot used for strength behavior investigation

VI. RESULTS AND DISCUSSIONS

The unconfined compression tests were conducted in order to determine effect of fibre inclusion on Unconfined Compressive Strength (UCS). Figure 4 showed the stress-strain curve obtained from the tests. The tests were conducted on cylindrical specimen of 60 mm diameter and 170 mm height. The presented results in figure 4 are at fibre length of 10mm.

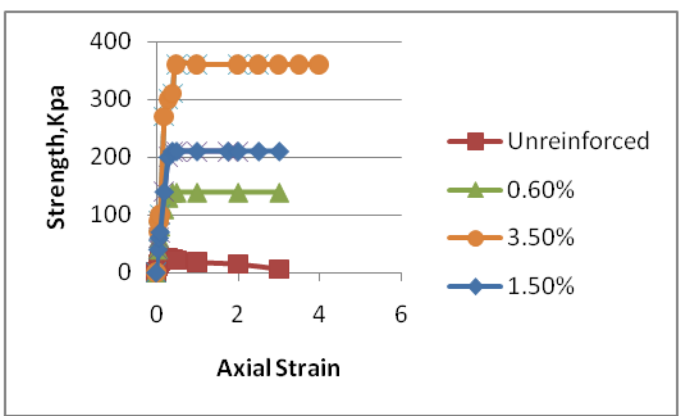

Fig. 4 Results of UCS test in different fibre content

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

Figure 5 shows the effect of fibre length on strength of composite clayey sand at constant fibre content of 0.6%.

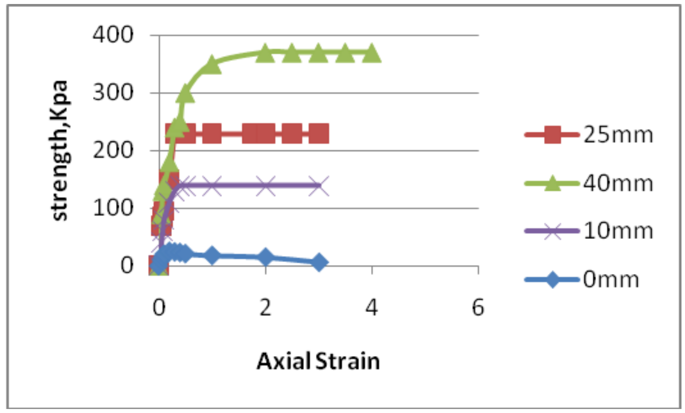

Fig. 5 Results of UCS test in different fibre length

VII. CONCLUSION

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

ACKNOWLEDGEMENTS

The technical support from the Curtin University Laboratory is gratefully acknowledged.

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