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Modulus of Elasticity of Reinforced Silty Sand

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Abstract

Reinforced soil has been among the most effective soil modification materials. Its use has been expanded dramatically into civil engineering, geotechnical engineering and pavement engineering. Reinforcing subgarde in pavement systems has always been an issue. This study focuses on effect of fibre inclusion on the modulus of elasticity of subgrade material. Plastic fibre was used for this investigation. Fibre contents and aspect ratio have been changed during these tests. The fibre percentage varied from 0 % (for unreinforced samples) to 0.3%. Silty sand was used as sub grade material. Unconfined compression tests were carried out to investigate behaviour of the composite under different loading condition. The results showed that the modulus of elasticity of fibre reinforced composite has increased by fibre inclusion. The fibre length and fibre content found to play important rule on the modulus of elasticity of fibre.

Key words: Fiber, Silty sand, Modulus,UCS

1. Introduction

In conventional application of reinforcement in soil, the inclusion of tire, bars, grids etc are usually in a preferred orientation. The advances of these materials have usually been considered by an increase in their applications. The randomly discrete fibers are easily added and mixed randomly with soil part, the same way as cement, lime or other additives. Some researches have been done on cement additive (Consoli et.al. 2009; Cai et.al 2006; Lorenzo and Bergado, 2004) and can be used as a pattern of additive usage in soil. Fibre reinforced composite shows more ductility and small losses of peak strength i.e. in compared to unreinforced material. Therefore, fiber-reinforced soil composite is a practical solution in civil engineering projects. The main application of composite soil can be in embankment, subgrade, subbase, and slope stability problems. However, the data concerning the impact due to the addition of random discrete fibers on the characteristics of compacted native or virgin soils are limited, (Maher and Ho, 1993). This shortage is more considerable in pavement engineering therefore research on fibre inclusion in pavement systems needs to be more performed.

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2. 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. Usage of additional material with soil is mainly because of tensile strength of the soil.

Soil Type

The soil type in this study was Western Australian Sand. The Particle Size Distribution (PSD) of used sand is presented in figure 1. This type of sand is widely used in industrial project and research activities in Western Australia. Ten percentage of silt also was used to reconstruct mixture.

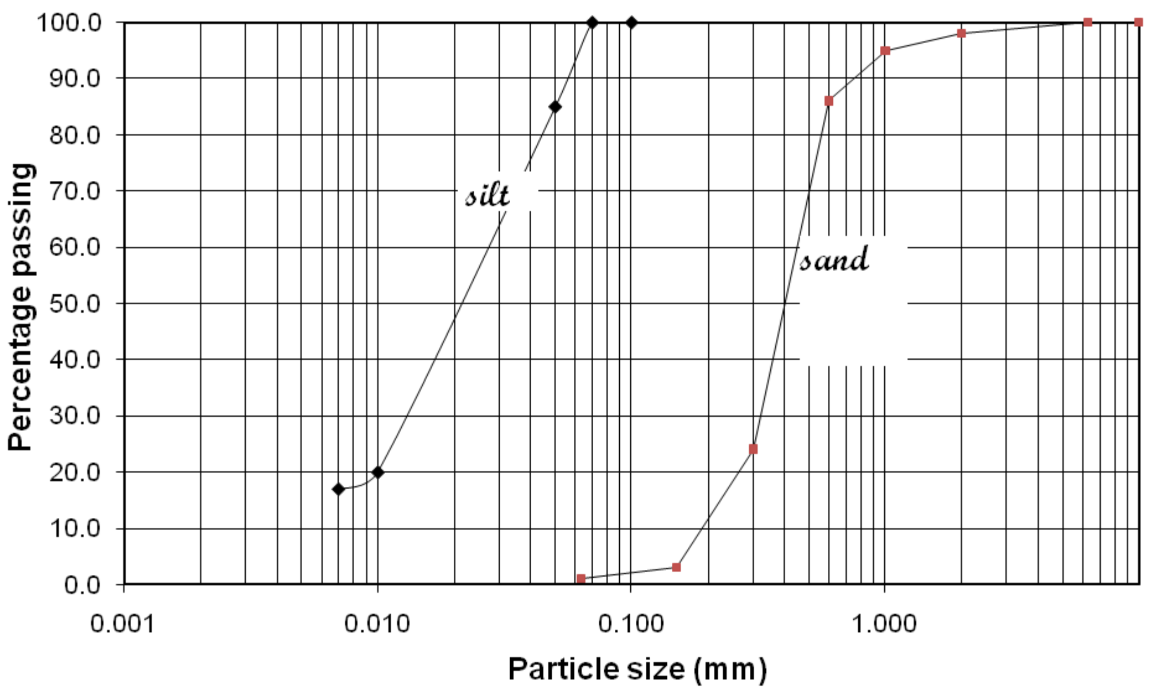

Fig. 1 Particle Size Distribution for Sand and Silt

Fiber Type

The plastic 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 Plastic fiber

3. Test Program

A series of unconfined compression tests have been conducted to verify effect of fibre content on elasticity modulus.

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Unconfined Compression Test Principle

Aim of Unconfined Compression test is to obtain unconfined compressive strength of soil. This can be applied to fine grade and cohesive soil and will represent very fast response in practical condition as the test time is very quick in respect to confined one. This test is widely used for slope stability and embankment dam applications.

Main Equipments

- Unconfined compression testing machine (Triaxial Machine) as shown in figure 3
- Specimen preparation equipment
- Sample extruder
- Fibre
- Balance

Figure 3 shows triaxial base which was used to conduct the tests.

Fig. 3 Triaxial machine

Sample Preparation

The samples were prepared by mixing silty sand and three percentage of fibre. Specimen preparation method was the standard compaction method, which was used in an ongoing experimental research on fiber-reinforced soil 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. 0.1%, 0.2% and 0.3%) and different fibre length (aspect ratio) which were 10mm, 20mm, 25mm.

4. Test Methodology and Procedure

The test procedure can be listed as:

- 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 modulus elasticity investigation

5. Results and discussions

The unconfined compression tests were conducted in order to determine the modulus of elasticity (E-value). The E values were calculated based on the initial tangent of the stress-strain curve. The tests were conducted on cylindrical specimen of 60 mm diameter and 170 mm height.

Table 1 provides values of elastic modulus of soil with and without fiber reinforcement. The maximum E-value of sility sand was 10260 kPa obtained at the aspect ratio of 25mm and fiber content 0.3% percent. It was observed that modulus of elasticity was increased with increasing in fibre length and fibre content.

Fibre length(mm)	Fiber content %	E value
-----	0.00	6000
10	0.1	7010
	0.2	8266
	0.3	8500
20	0.1	7418
	0.2	8630
	0.3	9370
25	0.1	8293
	0.2	9240
	0.3	10260

Table 1 E-Values (kPa) for Reinforced and Unreinforced Soils

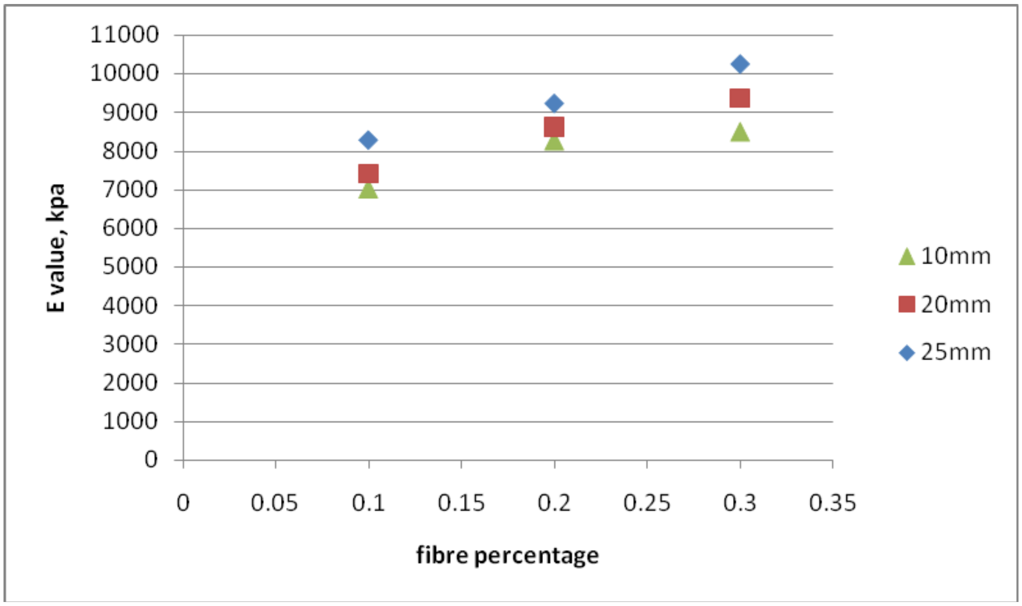

Fig. 4 Effect of fibre percentage and length on modulus of elasticity

6. Conclusion

A series of Unconfined Compression tests were performed and conclusions can be listed as:

- Increasing in fibre percentage increased modulus of elasticity
- Increasing in fibre aspect ratio increased modulus of elasticity
- During the test, it was observed that ductility behavior of reinforced silty sand increased because of fibre inclusion.
- Short and randomly fibre inclusion showed to be reliable solution to enhance strength of the composites.

Acknowledgements

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