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Compaction Characteristics of Reinforced Soil

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Abstract
Composite soils have been widely used in geotechnical engineering applications, especially in slopes, embankment dam and landfills. This paper aims to study effect of fiber inclusion on compaction characteristic of composite soil (i.e. silty sand composite). A series of laboratory tests carried out to evaluate fiber effect on optimum water content and maximum dry unit weight of composite soils. Silty sand was selected as soil part of the composite and plastic fiber was used as reinforcement. The fiber parameters differed from one test to another, as fiber length varied from 10 mm to 25mm and fiber content were selected as 0.1% and 0.3%. For each test, compaction curved derived and the results were compared. The results proved that inclusion of fiber affected compaction behaviour of samples so that increasing in fiber content and length caused increasing in Optimum Moisture Content (OMC) and slightly decreased maximum dry unit weight.

Key words: Fiber, Silty sand, Compaction

1. Introduction

Fletcher and Humphries (1991) investigated influence of fiber inclusion on compaction of silty clay soil. Unlike the case of sandy gravel reported by Hoare (1977), the test results indicated that increasing the fiber content causes a modest decrease in the maximum dry unit weight. The optimum water content was found to increase by increasing fiber content. Other researchers (Nataraj and McManis, 1997; Al Wahab and El-Kedrah, 1995; Puppala et al., 2006; Miller and Rifai, 2004; Ozkul et al., 2007; Kumar Tabor, 2003) also reported similar results. In contrast, some researchers such as Ozkul et al, 2007 reported not significant changes on compaction parameter by fiber inclusion. Therefore, the problem of effect of fiber inclusion on compaction parameter needs to be investigated precisely. Authors believe that different research results are due to different material which each researcher has used. This paper aims to investigate influences that are induced by fiber inclusion on compaction characteristics.

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.

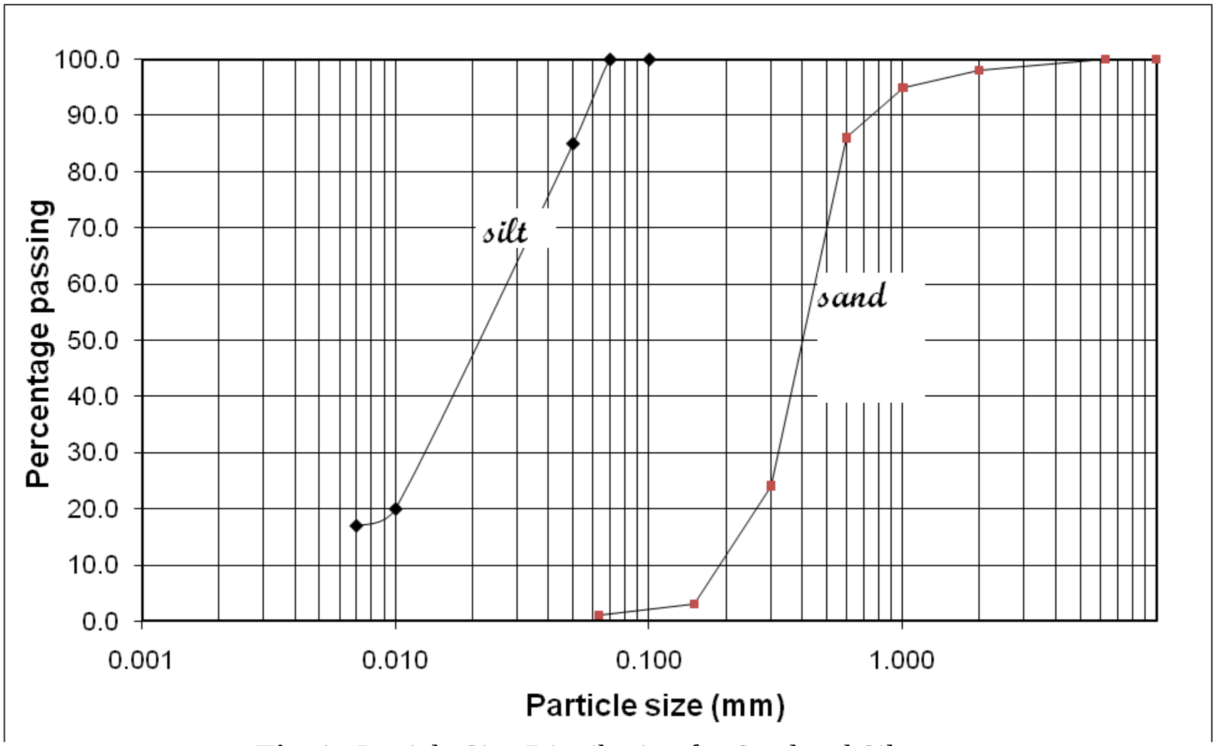

Fig. 1 Particle Size Distribution for Sand and Silt

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 compaction test have been performed on reinforced silty sand composite.

Compaction test

Soil compaction is a mean to increase the density of soil. In geotechnical projects, soil density is an important parameter. Any difficulty related to compaction may cause settlement of the soil and as a consequence unnecessary maintenance costs or structure failure. Therefore, all types of construction sites and construction projects take special care in mechanical compaction method.

Main Equipments

To run the test, tools are needed as:

- Proctor mould with a detachable collar assembly and base plate.
- Manual rammer weighing 2.5 kg and equipped with height of drop to a free fall of 30 cm (for standard method)
- Sample Extruder.
- A sensitive balance.
- Straight edge.
- Moisture cans.
- Drying Oven

Figure 3 shows rammer which was used to compact the soil. Figure 4 shows the used mould and base.

Fig. 3 Standard compaction rammer

Fig. 4 Mould and Base

4. Test Methodology and Procedure

The test procedure can be listed as:

1. About 4.5 kg of air-dried soil was put in the mixing pan so that it could pass No. 4 sieve.

2. The moisture content was increased by about 5%.

3. The weight of empty mould without the base plate and the collar was recorded as W1 (gr).

4. The collar and base plate was fixed and the first soil part was compacted with 25 blows in proctor mould

5. Some scratches were put with a spatula forming a grid to ensure uniformity in distribution of compaction energy to the subsequent layer. The second and third layer was placed and 25 blows were applied 25 blows.

6. The final layer was placed so that the compacted soil is just above the rim of the compaction mould when the collar is still attached.

7. The collar carefully was detached without disturbing the compacted soil inside the mould and edge was used to trim the excess soil leveling to the mould.

8. The weight of the mould with the moist soil W2, (gr) was determined.

9. Sample was extruded the sample and evaluated for water content in some cans

10. The rest of the compacted soil was broken with hand to pass US Sieve No.4. and moisture content was increased by 2%.

11. Steps 1 to 10 repeated again for different moisture contents.

12. The dry density plotted versus moisture contents

5. Test Design

The tests were designed systematically sothat the effect of each fiber parameters (i.e. length and content) can be obtained. For reinforced samples, special care was taken for achieving uniformity of mixture while compaction procedure. First series of the test was related to effect of fiber conetnt. In these test fiber contetnt changed while fiber length was constant. The fiber percentages were 0.1%, 0.2% and 0.3% with constant fiber length of 10mm.
The second round was related to effect of fiber length. Therefore, different fiber length (i.e. 10 20 mm and 25mm) with constant fiber content of 0.1% were evaluated. Finally all results compared with unreinforced samples.

6. Results and discussions

Figure 5 and 6 present the results of compaction test on reinforced silty sand composite.
Figure 5 shows the effect of fiber content on maximum dry density and Optimum Moisture Content (OMC). As can be seen increasing in fiber content caused decreasing in maximum dry density and increasing in OMC.
Figure 6 indicates the effect of fiber length (aspect ratio) on compaction curve. The results proved that increasing in fiber aspect ratio caused decreasing in maximum dry density and increasing OMC.

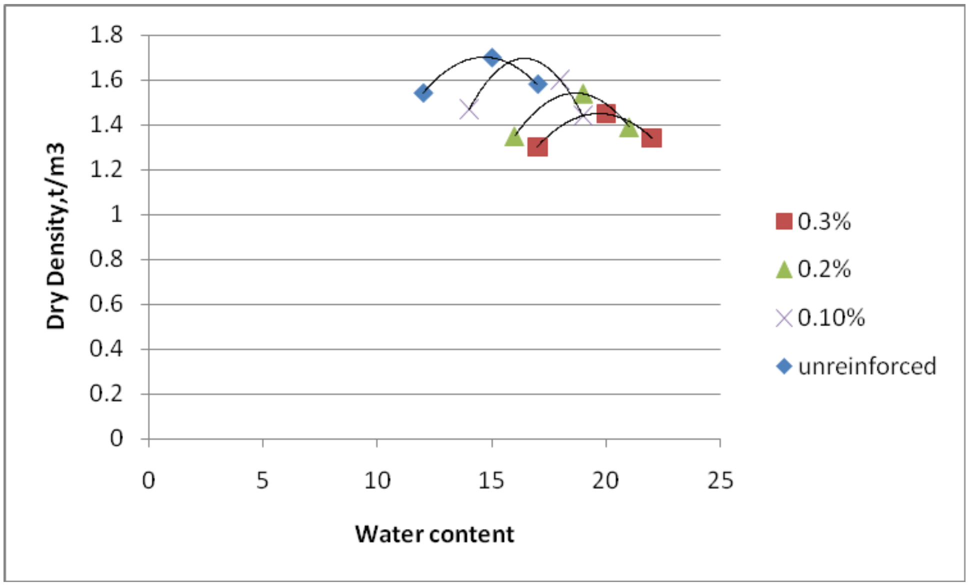

Fig. 5 Compaction Curve with different fiber content(at 10mmfiber length)

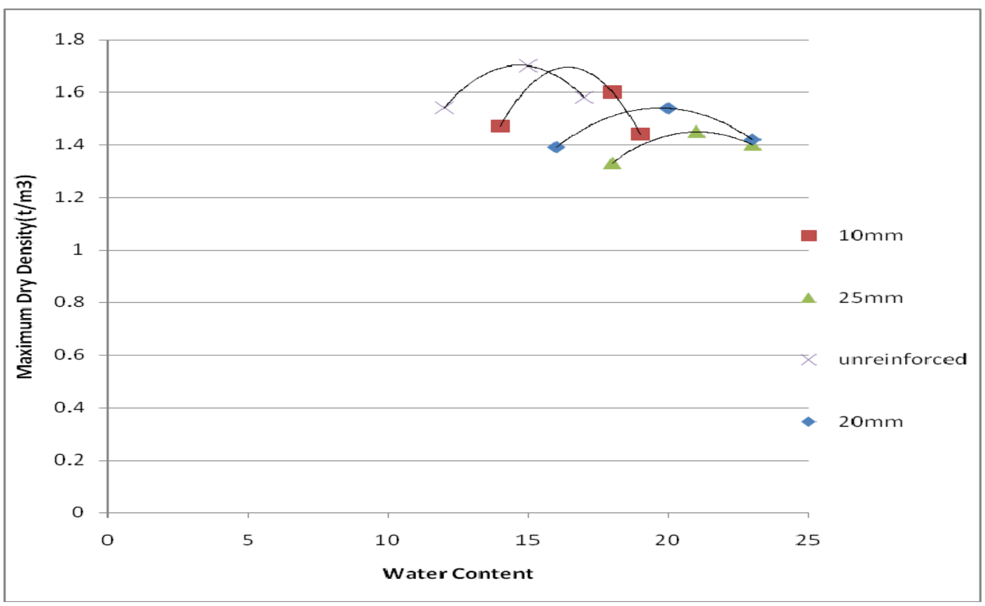

Fig. 6 Compaction Curve with different fiber length(at 0.1% fiber content)

7. Conclusion

A series of compaction test were performed to evaluate the effect of fiber inclusion on OMC and maximum dry density of composite silty sand. The following results were derived:

- Increasing in fiber percentage increased OMC of silty sand samples and decreased maximum dry density.

- The results proved that with increasing in fiber length, the OMC of composite silty sand was increased and decreased maximum dry density.

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