CBR Test on 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 fiber inclusion on CBR values of composite soil (i.e. sand composite). A series of laboratory CBR tests carried out to evaluate fiber effect on CBR values 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 20 mm to 50 mm and fiber content were varied from 1% and 3%. For each test, CBR values were calculated and compared. The results proved that inclusion of fiber affected CBR values of sand composite so that increasing in fiber content and length caused increasing in CBR.

***Keywords*—**CBR, Reinforced, Fiber, Sand

I. Introduction

CBR test is the ratio of force per unit area required to penetrate a soil mass with standard circular piston at the rate of 1.25 mm/min. to that required for the corresponding penetration of a standard material. The California Bearing Ratio Test (CBR Test) is a penetration test developed by California State Highway Department (U.S.A.) for evaluating the bearing capacity of subgrade soil for design of flexible pavement. Tests are carried out on natural or compacted soils in water soaked or un-soaked conditions and the results so obtained are compared with the curves of standard test to have an idea of the soil strength of the subgrade 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.

[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

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 of CBR values of clayey sand induced by fiber inclusion. The CBR tests were conducted as per ASTM D1883 on the selected soils with and without reinforcement to investigate the influence of length and fiber content on CBR values. Moreover, the obtained CBR values were taken as indication of improvement in the soil strength due to fiber reinforcement. For different length and fiber contents, the dry weight required to fill the CBR mould was calculated based upon maximum dry densities of the soil and the volume of the mould. The water corresponding to Optimum Moisture Content (OMC) was put and mixed thoroughly. The water was added prior to fiber to prevent floating problems.

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.

Table1. Clay properties

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

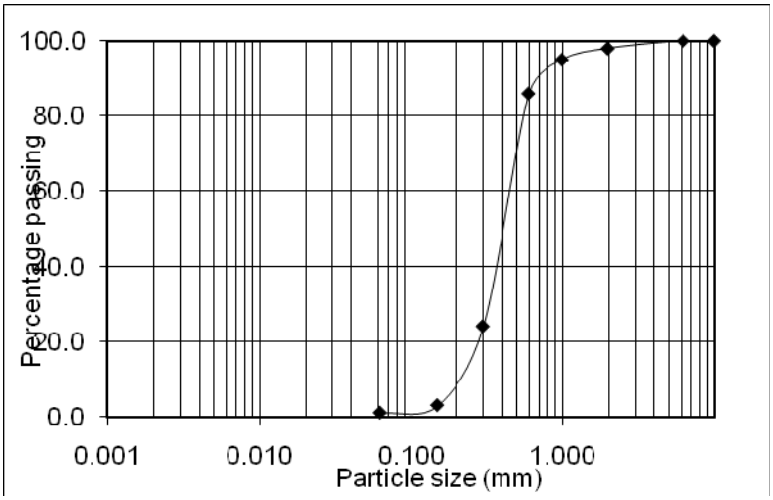

Fig. 1 Sand Particle Distribution

B. 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

III. TEST PROGRAM

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

A. CBR Test

The California Bearing Ratio (CBR) test was developed by the California Division of Highways as a method of classifying and evaluating soil- subgrade and base course materials for flexible pavements. CBR is a measure of resistance of a material to penetration of standard plunger under controlled density and moisture conditions. CBR test may be conducted in remoulded or undisturbed sample. Test consists of causing a cylindrical plunger of 50mm diameter to penetrate a pavement component material at 1.25mm/minute. The loads for 2.5mm and 5mm are recorded. This load is expressed as a percentage of standard load value at a respective deformation level to obtain CBR value.

B. Main Equipments

- Mould
- Steel Cutting collar
- Spacer Disc
- Surcharge weight
- Dial gauges
- IS Sieves
- Penetration Plunger
- Loading Machine
- Miscellaneous Apparatus

Figure 3 shows the mechanism of CBR test machine.

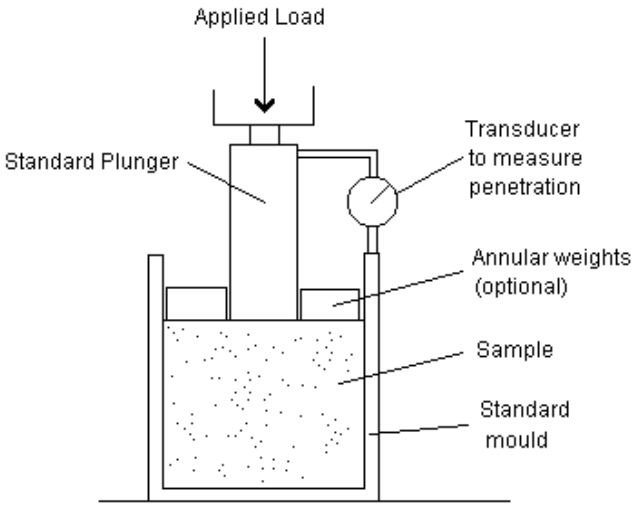

Fig. 3 Mechanism of CBR Test Machine(Gray,1983)

IV. Test Methodology and Procedure

The sample was sieved through 20mm IS sieve. 5kg of the sample of soil specimen was taken. Water was added to the soil in the quantity such that optimum moisture content or field moisture content was reached. Then soil and water were mixed thoroughly. Spacer disc was placed over the baseplate at the bottom of mould and a coarse filter paper was placed over the spacer disc. The prepared soil water mix was divided into five. The mould was cleaned and oil was applied. Then was filled one fifth of the mould with the prepared soil. That layer was compacted by giving 56 evenly distributed blows using a hammer of weight 4.89kg. The top layer of the compacted soil was scratched. Again second layer was filled and process was repeated. After 3rd layer, collar was also attached to the mould and process was continued. After fifth layer collar was removed and excess soil was struck off. The base plate was removed and the mould was inverted. Then it was clamped to baseplate. Then the normal load was applied and CBR values recorded. The fibre content and length were varied during the tests. Fibre contents were selected as 1%, 2% and 3%. On other hand, fibre lengths were varied from 20mm up to 50mm.

V. Results and Discussions

The CBR tests were performed in order to determine effect of fiber inclusion on CBR values of reinforced clayey sand. Figure 4 showed the CBR values obtained from the tests at different fiber length and content. The maximum CBR value obtained for an length of 50mm and 3 percent fiber content

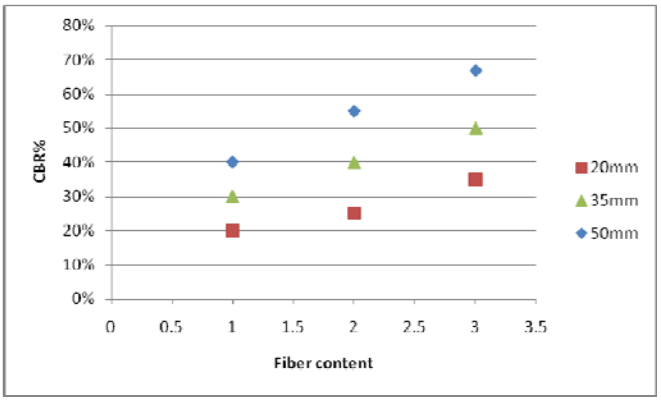

Fig. 4 Results of CBR test in different fiber content and lengths

VI. Conclusion

Two important parameters have been well investigated in this paper. The first parameter is fiber content and the second one is aspect ratio. The effect of these two parameters studied on CBR values. Following results were derived:

- Increasing in fiber percentage increased CBR values in clayey sand samples
- The results proved that with increasing in fiber length, the CBR values of composite clayey sand were 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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