CBR TEST ON REINFORCED CLAY

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ABSTRACT
Geosynthetic fibers are an established family of geomaterials used in a wide variety of civil engineering applications such as pavement systems. In pavement design, CBR ratio count as an important parameter. This study aims to investigate effect of fiber inclusion on CBR ratio. A series of laboratory investigation were carried out to evaluate effects of reinforcing the sub grade soil in pavement system with randomly distributed plastic fibers. In this study, two types of clay and one type of fiber were used. CBR test were conducted on unreinforced samples as well as reinforced ones at different fiber contents (i.e. 0.1%, 0.3%) and different fiber length (i.e. 10mm , 25 mm and 50mm).The results of CBR test showed that the CBR ratio for reinforced clay increased even more than two times in some cases as fiber content and fiber length increased. The results proved that application of short randomly distributed fiber is a good method to apply in practical projects.

RÉSUMÉ
Les fibers de Geosynthetic sont une famille établie de geomaterials utilisé dans une large variété d'applications de travaux publics comme les systèmes de pavement. Dans le design de pavement, le compte de rapport de CBR comme un paramètre important. Cette étude a l'intention d'enquêter sur l'effet d'inclusion de fiber sur le rapport CBR. Une série d'enquête de laboratoire a fait pour évaluer des effets de renforcer le sol de qualité sub dans le système de pavement avec les fibers au hasard distribuées de plastique. Dans cette étude, deux types de glaise et d'un type de fiber ont été utilisés. L'épreuve de CBR a été accomplie sur les échantillons non renforcés aussi bien que les renforcés à de différents contenus de fiber (c'est-à-dire 0.1 %, 0.3 %) et différente longueur de fiber (c'est-à-dire 10 millimètres et 25 millimètres). Les résultats d'épreuve de CBR ont montré que le rapport CBR pour la glaise renforcée a augmenté même plus de deux fois dans certains cas comme le contenu de fiber et la longueur de fiber a augmenté. Les résultats ont prouvé que l'application de fiber courte au hasard distribuée est une bonne méthode de faire une demande dans les projets pratiques.

1 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.

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

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.
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2.1 Soil Type

The soil type in this study was Western Australian clay. The properties of clay are presented in table 1.

Table1. Clay properties

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

2.2 Fiber Type

The natural fiber and plastic fiber has been used for this investigation. Figure2 and figure 3 shows the used fiber. The used fiber has good potential to absorb energy and good adhesion with soil particle.

Figure. 2 Plastic fiber

Figure. 3 Natural fiber

3 TEST PROGRAM

A series of CBR tests have been conducted on reinforced clay composite. Reinforced samples prepared by putting plastic and natural fiber inside clay.

3.1 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.

3.2 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.

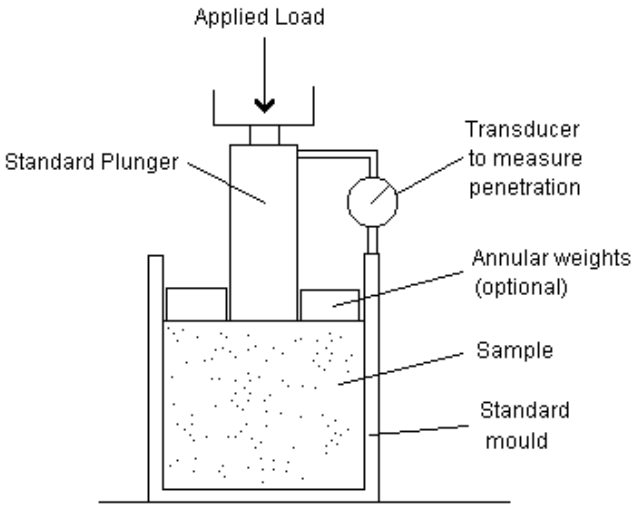

Figure. 3 Mechanism of CBR Test Machine(Gray,1983)

4 TEST METHODOLOGY AND PROCEDURE

The sample was sieved through 20mm 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 base plate 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 base plate. Then the normal load was applied and CBR values recorded. The fiber content and length were varied during the tests. Fiber contents were selected as 0.1%,0. 2% and 0.3%. On other hand, fiber lengths were varied from 10mm up to 50mm. For both fiber type (i.e. plastic and natural) same procedure applied.

5 RESULTS AND DISCUSSIONS

The CBR tests were performed in order to determine effect of fiber inclusion on CBR values of reinforced clayey soil. Figure 4 showed the CBR values obtained from the tests at different plastic fiber length and content. The maximum CBR value obtained for a length of 50mm and 0.3 percent fiber content.

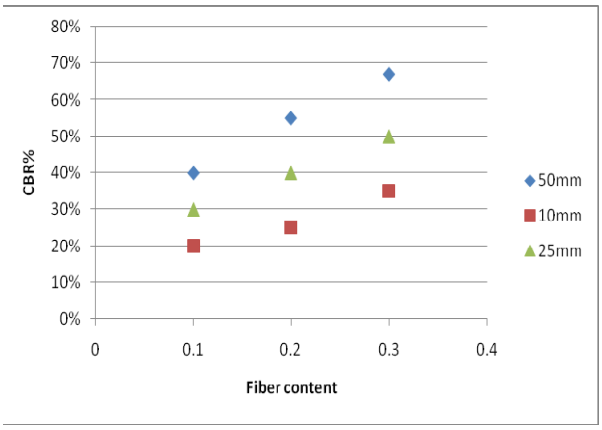

Figure. 4 results of CBR test for plastic fiber

Same procedure applied for natural fiber. Figure 5 shows the effect of fibre length and content on CBR values.

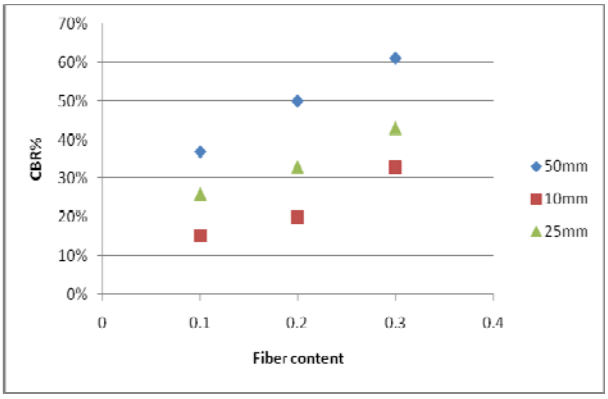

Figure. 5 results of CBR test for natural fiber

The maximum cbr value for natural fiber obtained in fiber content of 0.3% and length of 50mm. The CBR values in natural fiber were less than plastic fiber. However, the results for both types of fiber proved that fiber inclusion will be recomended for practical projects.

6 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. Two types of fiber used in this study (i.e. plastic and natural). Following results were derived:

- Increasing in fiber percentage increased CBR values in clayey samples for both natural and plastic fiber
- The results proved that with increasing in fiber length, the CBR values of composite clayey were increased for both kinds of fiber
- CBR values for case of natural fiber was less than those plastic fiber. That shows plastic would be better solution for subgrade material.
- 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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