STUDIES ON STRENGTH CHARACTERISTICS OF SOIL MIXED WITH BIO-WASTE

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ABSTRACT: Researches are always in quest for finding innovative methods for ground improvement using sustainable and environmental friendly solutions. Theproduction of large quantity of biowastes all over the world faces serious problems of handling and disposal. Coir pith is a biowaste from coir industry and sugarcane baggase is another biowaste obtained after extractingjuice from sugar cane. So the present study is an investigation into the effect of coir pith and sugarcane baggase on some geotechnical properties of red earth. The investigation includes study on variation of properties such as O.M.C, maximum dry density, C.B.R. values,unconfined compressive strength and permeability when these materials are included in soil. Several conclusions are arrived at, on the basis of the experiments conducted and it may be helpful for predicting the behavior of such soil matrix.

INTRODUCTION

Ground improvement is a rapidly developing field because good sites for construction are becoming limited day by day. As land requirements increase but the total land available for use remains the same or is lost due to erosion, the importance of ground improvement techniques has greatly increased. The main objective of the ground improvement is to improve the characteristics of the soil at the site[1]. Now the researchers have focused more on the use of potentially cost effective and locally available materials from industrial and agricultural waste so as to improve the properties of deficient soils and also to minimize the cost of construction. Production of large quantity of agricultural wastes all over the world faces serious problems of handling and disposal. The disposal of agricultural wastes creates environmental pollution, finally affecting ecosystems. Hence safe disposal of agricultural wastes becomes a challenging task. Many researchers are working around the world, experimenting different biowastes, to improve the soil properties[2].

One of the abundantly available biowaste is sugarcane bagasse. Major problem that the sugar manufacturing industries face today is the disposal of sugarcane bagasse waste. The by-product or residue of milling sugarcane is bagasse (the fiber of the cane) in which the residual juice and the moisture from the extraction process remain. The locally generated bagasse and those from sugar factories present a problem of handling due to the huge bulk of the material. When left in the open air, it decays, hence necessitating the safe disposal of the pollutant [3]. Also, when the pollutant is inhaled in large doses it can cause a respiratory disease known as bagassiosis. Since bagasse is a by-product of the sugar industry, the quantity of production in each country is in proportion with the quantity of sugarcane produced.

Coir pith is one another biowastes. Production of coconut in India is a leading one compared to many countries in the world. All parts of coconut are used for various purposes. The by-product or residue of extracting coir fibers from coconut husk is coir pith. During the process of production of one ton of coir approximately two tons of coir pith is produced [4,5]. Also, coir pith is produced locally by individuals by removal of husk from coconut for domestic purposes.It is usually stored along the sides of production units creates environmental pollution problems.Almost all of the coir pith produced locally is disposed of openly and these coir pith heaps act as bacteria growing medium and results in poor hygiene of the surrounding areas. Also, main portion of coir pith is used as fuel in domestic stoves which creates pollution and is not an effective way to dispose of it. In some places it is directly dumped into water bodies likerivers,lakes etc.. It creates problems like it affects the life within water bodies due to pith

decay, thus necessitating the safe disposal. Transportation of coir pith to dumping sites is also expensive.

Many studies have conducted around the world to understand the changes in the various properties of the soil due to the addition of different materials to the soil. This paper deals with the results of investigations on the effect of sugarcane bagasse and coirpith on some geotechnical properties of soil, such as compaction characteristics, CBR, U.C.C., permeability etc., with the different percentage of sugarcane bagasse and coir pith.

MATERIALS USED

Soil Sample

Representative soil sample used for this experimental study was Laterite soil, which are most commonly observed soil types in Kerala. Laterite soil sample was obtained from the site of Aluva, Ernakulam district, Kerala by machine excavation after clearing of 1m top soil and its properties are given in Table 1.

Table 1 Properties of soil used

Sl. No:	Properties	Values
1	Natural Moisture Content	7%
2	Specific Gravity	2.52
3	Atterberg's Limits	
	Liquid Limit	56%
	Plastic Limit	31.5%
	Plasticity Index	24.5%
	Flow index	25.1
	Toughness index	97.49%
4	Maximum Dry Density	18.46 kN/m3
5	Optimum Moisture Content	14.28%
6	CBR value at 5mm	13.22%
7	Vane Shear	0.238N/cm^2
8	Cohesion	0.051N/mm^2
9	Angle of Internal Friction	27^0

Sugarcane Bagasse

Sugar cane is a genus of 6 to 37 spices of tall perennial grasses, nature to warm temperate to tropical regions of the world.Bagasse is the fibrous matter that remains after sugarcane stalks are crushed to extract their juice. Sugarcane bagasse consists of cellulose, 43.6%, hemi-cellulose, 33.8%, lignin,18.1%, ash, 2.3% and wax, 0.8%, on a dry weight basis [6].The sugarcane bagasse samples used for these studies were air dried for two weeks and were collected from sugarcane juice shop.It was cut into pieces of lengths 15-25 mm for adding into the soil as shown in the Figure 1.

Fig.1 Cut Sugarcane Bagasse of length 15-25 mm

Coir Pith

Coir pith is made from coconut husks, which are byproducts of the industries that use coconuts. Chemical Composition of coir fiber which is contained in coir pith is Lignin 45.84%, Cellulose 43.44%, Water Soluble 5.25%, Pectin and Related Compounds 3.30%, Ash 2.22%, Hemi Cellulose 0.25%[7].Coir pith used for this study was procured from a local coir manufacturing unit near Alapuzha and is as shown in the Figure 2.

Fig.2 Coir Pith used

EXPERIMENTAL STUDIES

For studying the changes in the properties of the soil, various experiments such as Proctor Compaction tests, CBR test, Unconfined Compressive Strength test and permeability tests were conducted on parent soil samples and soil mixed with both sugarcane bagasse and coir pith in different percentages. The experiments were conducted as per Indian Standard Specifications.

The sugarcane bagasse samples were first cut using industrial knives in to length ranging from 15mm-25mm was added to the soil sample in 2, 4, 6 and 8 percentages by weight of the soil sample and the coir pith were added to the soil sample in 1,2,3,4,5 and 6 percentages by weight of the soil sample for every test.

RESULTS AND DISCUSSION

Proctor Compaction Test

Modified Compaction test was conducted with different percentages of sugar cane bagasse and coir pith.The tests were conducted as per IS-2720-Part8-(1980).[8]

Variation in O.M.C.

Figure 3 shows the variation of optimum moisture content with different percentage of sugarcane bagasse and coir pith. It is found that the optimum moisture content increases till the addition of 4% sugarcane baggase and decreases afterwards. OMC increased from 13.22% for parent soil to 22.5 % for 4 % sugarcane baggase in soil and decreased thereafter till 14% for 8% sugarcane bagasse. In the case of coir pith mixed soil it is found from the graph that the optimum moisture content increases till 4 % coir pith and decreases afterwards. OMC was found to be 24.4 % for 4 % coir pith in soil.

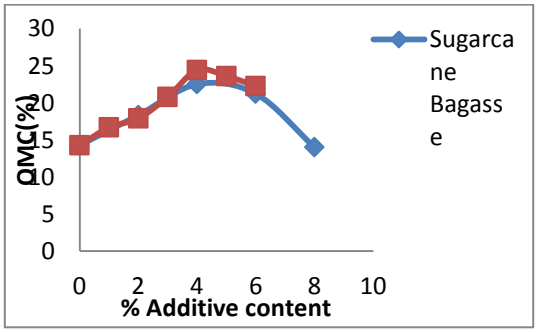

Fig. 3 Variation of OMC

Variation in Dry Density

It is found that dry density decreases with increase in the sugarcane bagasse content. Dry density was found to be 1.846 g/cc for parent soil and it decreased to 1.51 g/cc for 8% sugarcane bagasse. But in the case of coir pith mixed soil it is found (Figure4) that dry density increases just till 1 % coir pith and decreases afterwards.

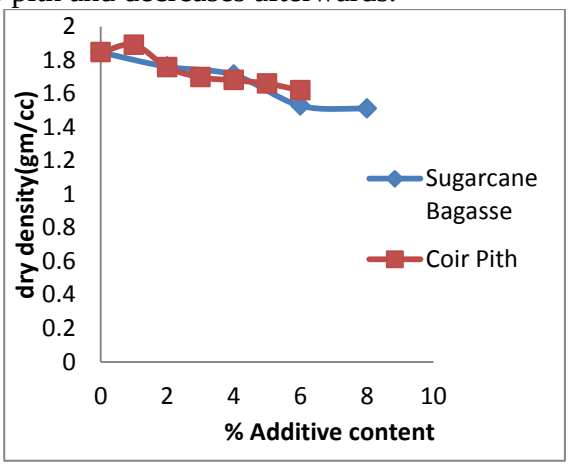

Fig. 4 Variation of Dry Density

Dry density was found to be 1.891 g/cc for 1 % coir pith content in the soil.And it decreases upto 1.62 g/cc for 6% coir pith. The decrease in dry density may be due to the fact that soil bagasse mixuture and soil coir pith mixture bocomes more soft because of small density of these materials.

California Bearing Ratio

CBR tests were conducted as per IS 2720-Part16(1979) on parent soil and different percentage of sugarcane bagasse and coir pith mixed with soil[9]. It is found that the CBR value corresponding to 5 mm penetration increases with increase in sugarcane bagasse and decreases after a particular percentage of sugarcane bagasse. CBR value increased from 13.22% for 0% sugarcane bagasse to 25.1%for 2 % sugarcane bagasse content in the soil and decreased thereafter to 16.84% for 8% sugarcane bagass. Similar type of variations are shown for CBR values,by the addition of different percentage of coir pith also. It is found that the CBR value (%) at 5 mm penetration increases as we add on coir pith and decreases after a particular % of coir pith.Maximum CBR value for 5mm was obtained

as 34.78% at 4% coir pith concentration.The variations are as shown in the Figure.5

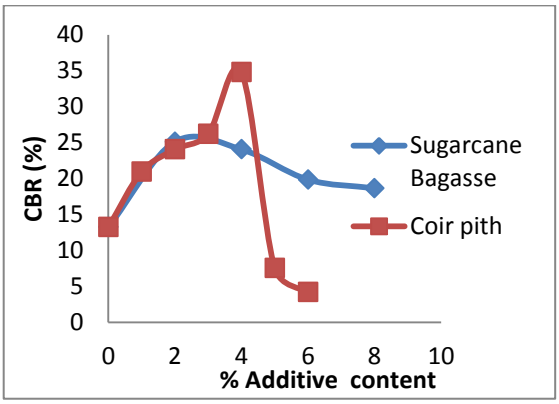

Fig. 5 Variation in CBR value

Unconfined Compressive Strength(UCC)

The unconfined compressive strength test was carried out as per IS-2720-Part 10(1973) and the unconfined compressive strength corresponding to different percentages were obtained from corresponding stress streain curve[10]. Figure 6 shows the variation of unconfined compressive strength with different percentage of sugarcane bagasse and coir pith. It is found that the UCC values increases as we add on sugarcane baggase and decreases after a particular percentage of sugarcane bagasse. Unconfined compressive increased from 1.752 kg/cm^2 for parent soil to 3.608kg/cm^2 for 8 % sugarcane bagasse content in the soiland thereafter decreased to 1.913 kg/cm^2 for 10% sugarcane bagasse. Also it is found that the unconfined compressive strenth increases as we add on coir pith and decreases after 4% coir pith. Unconfined compressive was found to be 3.35kg/cm^2 for 4 % coir pith content in the soil.

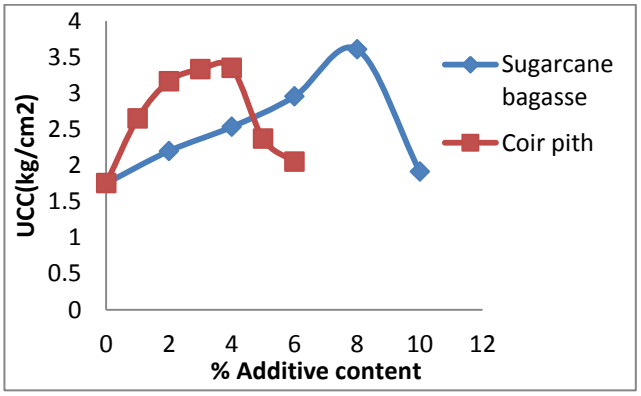

Fig. 6 Variation in UCC

Permeability

The falling head permeability test was carried out as per IS2720-Part17 (1986)with different percentages of materials and on parent soil[11]. It is found from the Figure7 that the permeability increses with increase in percentage of sugarcane bagasse in soil. Permeability was found to increase from 0.0157 cm/s for parent soil to 0.0358 cm/s for 8 % sugarcane bagasse content in the soil. On the other set of experiments the permeability decreases as the percentage of coir pith increases initially and thereafter increases after a particularpercentage of coir pith. Minimum value of permeability was found to be 0.0028cm/s for 3 % coir pith content in the soil.

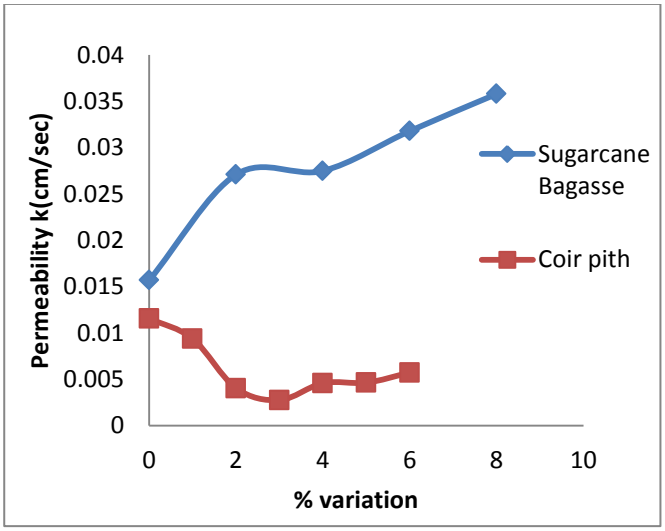

Fig. 7 Variation in Permeability

CONCLUSIONS

The variation of different soil properties such as dry density, optimum moisture content (OMC) which is obtained from Modified Proctor test, CBR value, unconfined compressive strength and permeability were studied with different percentage by weight of sugarcane bagasse and coir pith and the following variations were seen.

- The optimum moisture content (OMC) increased from 0% sugarcane bagasse to 4% sugarcane bagasse and then decreased thereafter. A similar variation is obtained when the percentage coir pith increased from 0 to 4% and then decreased thereafter.

- The dry density decreases as sugarcane baggase content increases. The dry densityshows a marginal increase initially and then decreases as coir pith content increases.

- The CBR value increases with increase in sugarcane bagasse content till 2% and decreases thereafter. Similarly the CBR value increases with increase in coir pith content till 4% and decreases thereafter.

- The unconfined compressive strength increases as the sugarcane bagasse content increases and decreases after about 8% and the same type variation has shown for coir pith mixed soil also after 4% .

- The permeability increases as the sugarcane bagasse content increases whereas the permeability decreases as the percentage of coir pith increases.

Hence the engineering behaviour of the soil varies when different percentages of sugarcane bagasse and coir pith added to the soil. Hope that the results obtained would be helpful for predicting the engineering behavior of such mixed soil to certain extent and more study is pending in this aspect before the actual field applications.

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