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Study on the Effects of Marine Clay Stabilized with Banana Fibre

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Abstract: ***Marine clay is formed by the sedimentation of clayey soils in marine environments. They exhibit unusual physical properties like high liquid limit, low bearing capacity, higher settlement, high seepage loss but being predominantly distributed all over the world, it is a necessary factor to improve its characteristics and make it suitable for construction. The main objective of this study is to investigate the use of waste material such as banana fiber in geotechnical applications. Various tests such as unconfined compression (UCC), California Bearing Ratio (CBR), Atterberg limits, Compaction were carried out and the results are analysed.***

Keywords: banana fibre, marine clay, unconfined compression, California Bearing Ratio, Atterberg limit

1. Introduction

Nowadays the cost of construction materials is increasing at a tremendous rate. Hence the need to find out economic alternatives for construction materials is essential especially for road pavements. Marine clay is a type of clay found in coastal regions around the world. They exhibit unusual physical properties like high liquid limit, low bearing capacity, higher settlement, high seepage loss. Swelling characteristics of marine clay is also very high. For any construction works soil surrounding it plays an important role. Most of the soils especially in marine areas are not at all suitable for any construction works. Improvement in the soil properties can make it suitable for use especially for road pavements, since pavement constructed with marine clay will show very low durability and the cost of maintenance will also be very high.

Most of the areas in Kerala have marine clay deposits. They are very weak soil deposits, with very high organic matter, hence unsuitable for any construction works. Improvement in the properties of these soils may make it suitable for various purposes especially for road pavements. Stabilized soils can be successfully used for the construction of roads.

1.1 Literature Review

Coir fibre addition to soil in different proportion and length improves the geotechnical properties of soils making it suitable for road pavements [1]. The tensile and flexural strength of natural fibre reinforced polymer material is greater than that of glass fibre reinforced materials and proved their applications in automative, transportation, construction and packaging industries [2]. Coir fibre added to marine clay improves the shear strength nearly four times than that in raw clay sample. The shear strength increase is seen upto 0.8% of coir fibreaddition and increase in length upto 20mm beyond which the shear strength decreases [3]. The tensile and compressive strength of blocks with addition of coconut, and oil palm fibres improved with the increase in fibre aspect ratio, whereas in the case of bagasse fibres strength decreased with the increase in fibre aspect ratio[4]. The geotechnical properties and load carrying capacity of marine clay improved with addition of GBFS [5]. The saw dust ash addition to laterite soils improved the soil properties such as atterberg limits, unconfined compressive strength, California bearing ratio. The California bearing ratio obtained after addition of saw dust ash makes it suitable for subgrade and sub-base road pavements[6]. Jute fibres added to lime treated black cotton soils in 1%, 2%, 5% decreased the expansive behavior of soil thereby improving the geotechnical properties of soil [7]. The effective and total porosities tested by tracer test showed only minor variations that is less than 10%[8]. Addition of lime and saw dust improved the geotechnical properties of marine clay with optimum values of 15% and 4% for saw dust and lime [9]. The addition of coir fibre with different proportion and length improves the bearing capacity of clayey soils[10].

1.2 Methodology

As the first step literatures were reviewed and objectives were selected considering the scope of the study. In the second part of the project the samples were collected and different mix proportions were selected such that the percentage of banana fibre varies from 0%, 0.25%, 0.75%, 1% and 2%.In the third part of the project different laboratory tests were conducted on the selected mixes. In the fourth part results obtained from the tests were interpreted and theoptimum value of banana fibre was selected.

2. Materials and Methods

2.1 Marine Clay

Marine clay was collected from Thopumpady, Ernakulam, Kerala. It was collected from a depth of 2-3m. The clay obtained contained lot of organic matter, was greenish black in colour and undesirable smell. The marine clay used for the test was air dried before the tests.

2.2 Banana fibre

It is a natural fibre obtained from banana plant. This fibre is obtained mainly from pseudostem and peduncle which acts as a strong fibre after dried properly. It is a bast fibre with

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appropriate stiffness and good mechanical properties. Fibre was obtained from Trivandrum.

2.3 Methods

Preliminary studies were conducted to analyse the geotechnical properties of marine clay such as liquid limit and plastic limit, compaction test to determine the optimum moisture content and dry density from which the optimum moisture content value is used to determine the unconfined compressive strength and California bearing ratio of marine clay. Free swell index was also conducted to determine the expansiveness of marine clay. The properties obtained for marine clay is shown in table 1. From the table it can be seen that expansiveness of clay is very high as the free swell index is a high value and the specific gravity is too low due to the presence of organic matter. Compaction tests, unconfined compressive strength and California bearing ratio were also conducted for stabilized soils and results were analysed.

Table 1: Properties of marine clay

Property	*Value*
Natural water content	87.5%
Specific gravity	2.083
Free swell index	50%
Liquid limit	90%
Plastic limit	36%
Plasticity Index`	54%
Clay	67%
Silt	30%
OMC	29%
Dry density	1.45g/cc
Unconfined Compressive Strength	17kN/m^2
Cohesion	8.5kN/m^2
California bearing ratio	2.79

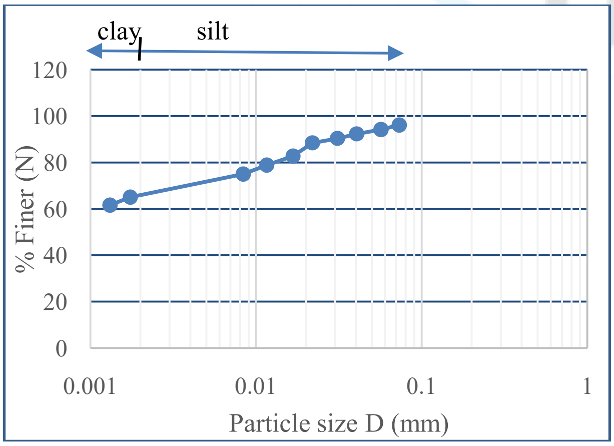

Figure 1: Grain size distribution curve of marine clay

3. Result and Discussion

3.1 Optimum Moisture Content and Maximum Dry Density

Standard proctor test was carried out to determine the optimum moisture content and maximum dry density. The test was conducted for clay without addition of fibre and later with addition of banana fibre at various proportions.

Table 2: Optimum moisture content and maximum dry density

% Fibre added	*OMC (%)*	*Dry Density(g/cc)*
0%	29	1.45
0.25%	32	1.42
0.5%	35	1.4
0.75%	43	1.36
1%	45	1.33
2%	47	1.3

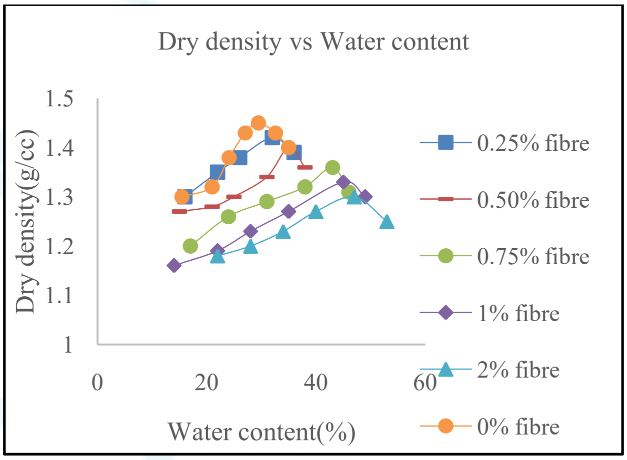

Figure 2: OMC versus MDD graph

OMC obtained for raw sample is 90%. It is seen that by the addition of banana fibre to marine clay the OMC value has increased and the dry density value has been decreased. The increase in OMC value is due to the absorption of water in fibres.

3.2 Unconfined Compressive Strength

The test was conducted to determine the shear strength of the soil sample at failure with the optimum moisture content obtained. The values obtained are represented in table 3 and the stress strain curve is shown in figure 3.

Table 3: Unconfined compressive strength

% Fibre added	*Unconfined Compressive Strength kN/m^2*	*Cohesion kN/m^2*
0%	17	8.5
0.25%	35.41	17.7
0.5%	44.34	22.17
0.75%	65.83	32.91
1%	50.62	25.31
2%	37.97	18.98

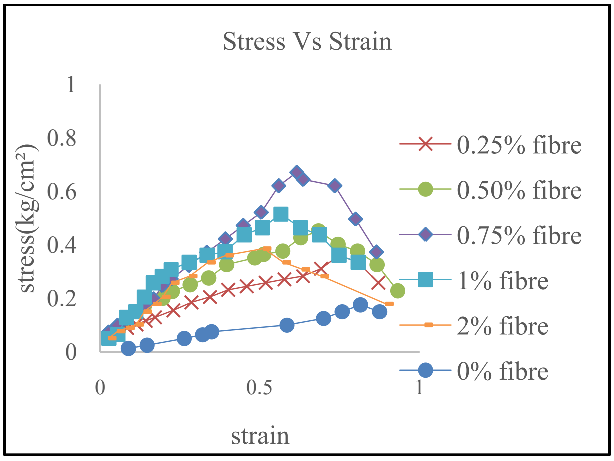

Figure 3: Stress- Strain graph

It is seen that strength increase with addition of banana fibre with a maximum value of 65.83kN/m^2 after which the value decreases. The increasing value is mainly due to the frictional interaction between soil and fibre and decrease in value further is due to reduced area of contact.

3.3 California Bearing Ratio

California bearing ratio was conducted to find the suitability of soils for road pavements. The table and the graph below shows the CBR values and the corresponding variation of marine clay stabilized with banana fibre with different proportions.

Table 4: California bearing ratio

% Fibre added	*CBR Value*
0.25%	8.2
0.5%	8.93
0.75%	13.2
1%	10.6
2%	9.48

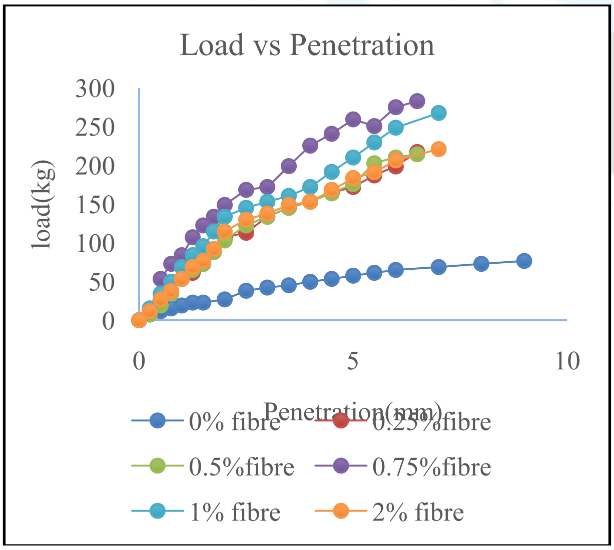

Figure 4: Load – Penetration graph

It can be seen that CBR value increases with addition of banana to soil fibre upto 13.2 which makes it suitable for subgrade road pavements.

4. Conclusion

The addition of banana fibre improved the properties of marine clay. The optimum value for marine clay stabilized with banana fibre was obtained at 0.75%.It was seen that OMC value increased with the addition of banana fibre and dry density decreases. The shear strength increased from 8.5kN/$m^2$to 32.91kN/m^2 with the addition of 0.75% of banana fibre and CBR value increased from 2.79 to 13.2 which makes it suitable for subgrade soil for road pavements.

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