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# Study on the Effect of Rubber Latex Modified Coir on Clayey Soil

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***Abstract*— Expansive clay or expansive soil is a clay or soil that is prone to large volume changes (swelling and shrinking) that are directly related to changes in water content. The engineering properties of such soils are high compressibility, low bearing capacity and low shearing strength. In this study the expansive clay is treated with rubber latex modified coir in different percentages to study the effect on soil. Natural fibers are used to determine the bearing capacity and shear strength of treated soil. They are biodegradable and hence will not create environmental problems. To increase the durability of coir added to soil natural extract- rubber latex was used to preserve it. The clay content found in the soil was 65.65%, so it is considered as clayey soil and silt content was 34.35%. From the study, the coir treated with rubber latex gives increase in strength up to 2% inclusion to the soil.**

***Keywords—Expansive Clay; Rubber Latex; Coir; Shear Strength; MDD; OMC; CBR***

## I. Introduction

Soil is a vital part of the natural environment. Soil is always responding to changes in environmental factors, along with the influences of man and land use. Some changes in the soil will be of short duration and reversible, others will be a permanent feature of soil development. It is one of the most important engineering materials. Determination of soil conditions is the most important first phase of work for every type of civil engineering facility. The geotechnical properties of a soil such as its grain-size distribution, plasticity, compressibility, and shear strength can be assessed by proper laboratory testing. In addition, recently emphasis has been placed on the in situ determination of strength and deformation properties of soil, because this process avoids disturbing samples during field exploration. However, under certain circumstances, not all of the needed parameters can be or are determined, because of economic or other reasons. In such cases, the engineer must make certain assumptions regarding the properties of the soil.

This paper focuses on the effect of coir which is modified with rubber latex to reinforce the soil and also to retard the degradation of coir. Study on the property change by conducting various laboratory experiments are carried out.

## II. Objectives of Study

*A.* To find the property changes of untreated and treated clayey soil

*B.* To reinforce the soil with natural fiber treated with rubber latex.

*C.* To evaluate the performance of stabilized soil and suitability for pavements.

## III. Materials Used

### *A. Expansive clay*

The soil sample of expansive clay was collected from Ponga, Alappuzha District, Kerala at a depth of 9m from the ground surface. The clay was dark grey in colour and was fine grained soil.

### *B. Coir*

The natural fiber used for this study is Coir which was removed from coconut shell gathered from Alappuzha District, Kerala. The coir was randomly cut into pieces of approximately 2mm in length

### *C. Natural Extract*

Natural rubber latex is a colloid, the dispersed phase being predominantly rubber and the dispersion medium water. It was collected from a rubber latex manufacturing private unit in Alappuzha District, Kerala.

Figure 1 Rubber latex extracted from bark of tree

## IV. LABORATORY TESTING

The physical properties of the expansive clay and rubber latex are listed in Tables No 1 to 2

TABLE I. PROPERTIES OF EXPANSIVE CLAY

| Sl. No. | Property | Expansive clay(untreated) |
|---|---|---|
| 1 | Specific gravity (G) | 2.4 |
| 2 | Moisture content (w) | 123.8 % |
| 3 | Percentage of clay particles | 65.65% |
| 4 | Percentage of silt particles | 34.35% |
| 5 | Liquid limit (LL) | 91 % |
| 6 | Plastic limit (PL) | 40 % |
| 7 | Plasticity index (PI) | 51 |
| 8 | Shrinkage limit (SL) | 20.32% |

The clayey soil is treated with rubber modified coir at 0, 0.5, 2 and 3 percentages to find the engineering properties. The tests conducted are triaxial test, standard compaction test, and California bearing ratio test. Comparison of the parameters with the inclusion of coir is listed in table no. II.

TABLE II. PROPERTIES OF RUBBER LATEX

| Sl No | PROPERTY | RANGE |
|---|---|---|
| 1 | Specific Gravity | 0.96-0.98 |
| 2 | pH | 6.5-7.0 |
| 3 | Rubber | 30-40% |
| 4 | Proteins | 1-1.5% |
| 5 | Resins | 1.5-3% |
| 6 | Mineral matter | 0.7-0.9% |
| 7 | Carbohydrates | 0.8-1% |
| 8 | Water | 55-60% |
| 9 | Size | 0.02-3.0µm |
| 10 | Shape | Spherical |
| 11 | Ammonia | 0.7-1.0% |

TABLE III. PROPERTIES OF TREATED EXPANSIVE CLAY AT 0, 0.5,2.0,3% COIR

| SL. No. | PROPERTIES | MODIFIED COIR ADDED TO THE SOIL IN PERCENTAGES | | | |
|---|---|---|---|---|---|
| | | 0% | 0.5% | 2% | 3% |
| 1 | Cohesion ((kN/m$^2$) | 13.72 | 9.806 | 11.76 | 21.57 |
| 2 | Angle of internal friction (ϕ) | 0° | 1 | 3.5 | 3 |
| 3 | Modulus of Elasticity (kN/m$^2$) | 533.29 | 378.86 | 953.85 | 596.69 |
| 4 | Maximum dry density (g/cc) | 1.31 | 1.55 | 1.569 | 1.584 |
| 5 | Optimum Moisture Content (%) | 31.11 | 13.31 | 12.34 | 11.29 |
| 6 | California Bearing Ratio (%) | 1.48 | 1.89 | 2.97 | 2.56 |

## V. RESULTS AND DISCUSSION

Fig. 1. Particle size and percentage finer graph obtained from wet sieve and hydrometer analysis.

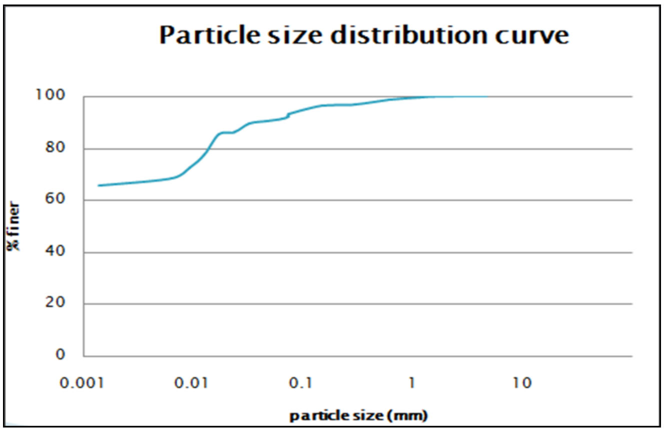
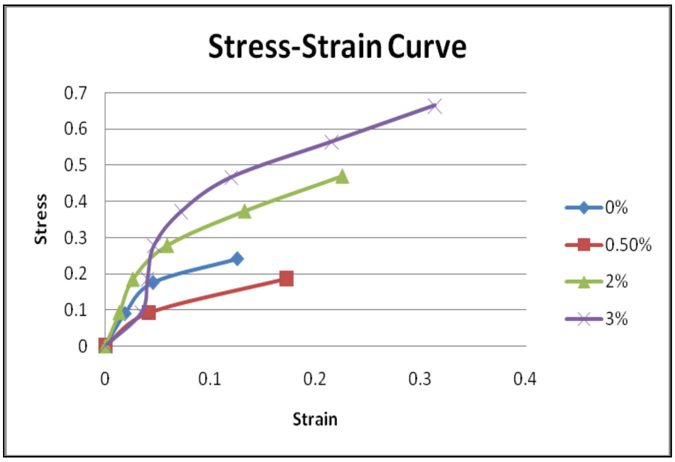
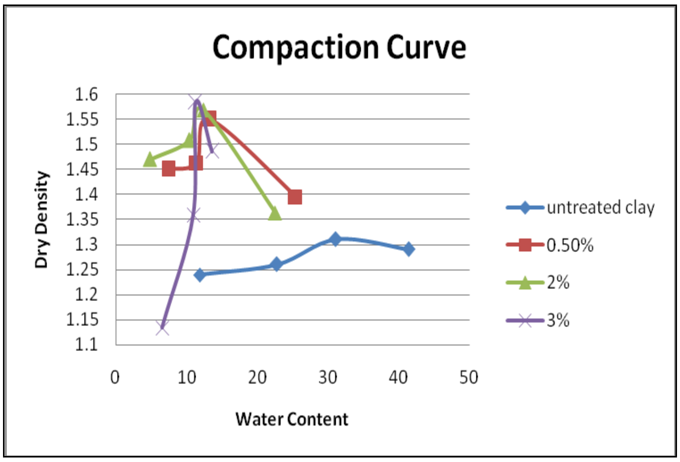



Fig. 2. Stress – strain curve of expansive clay from Triaxial test



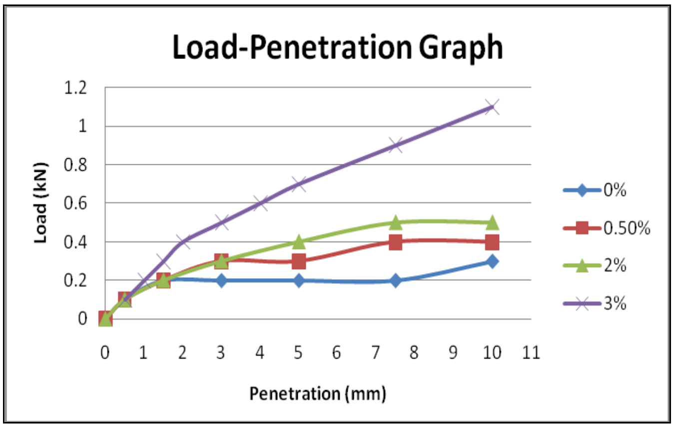
The modulus of elasticity calculated from the stress- strain graphs are 533.29, 378.86, 953.86 and 596.69kN/$m^2$ for 0, 0.5, 2 and 3% coir treated soil.

Figure 3. Compaction curve of expansive clay



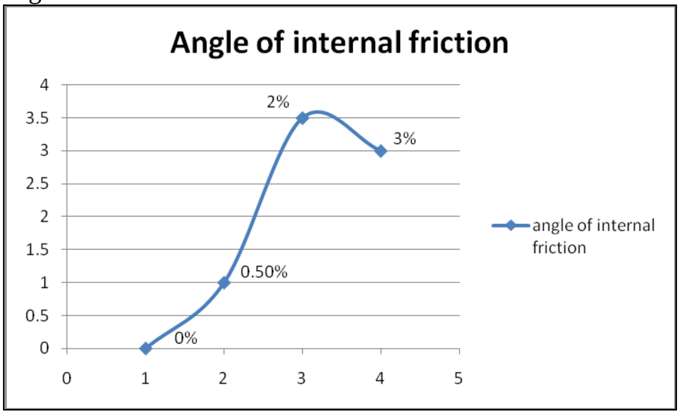

Compaction Curve obtained from Standard Penetration test with MDD of 1.31, 1.55, 1.569, 1.584g/cc and OMC of 31.11, 13.31, 12.34 and 11.29 % at 0, 0.5, 2 and 3% rubber latex modified coir on soil.

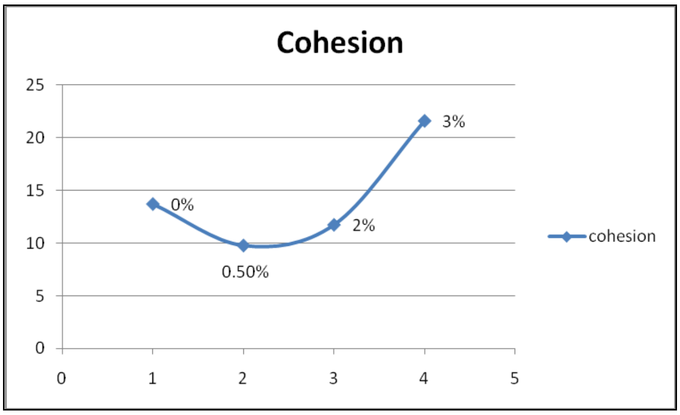
Fig. 3. Load- Penetration graph from California Bearing Ratio test

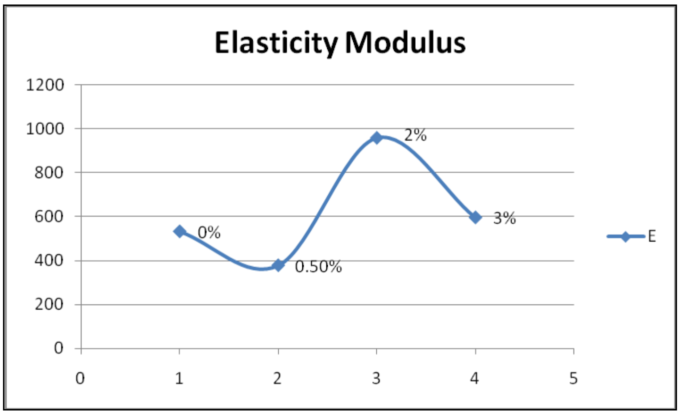


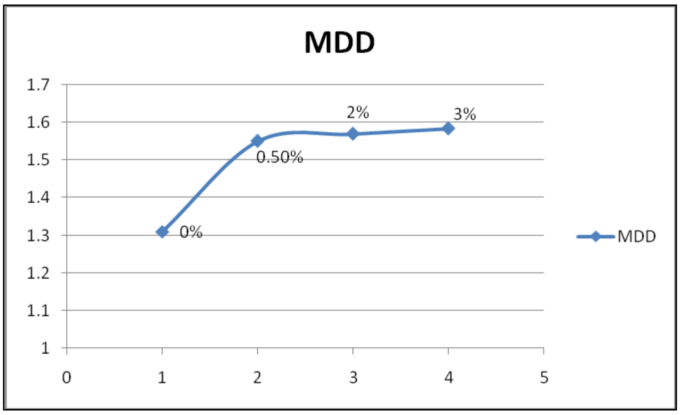

## CONCLUSION

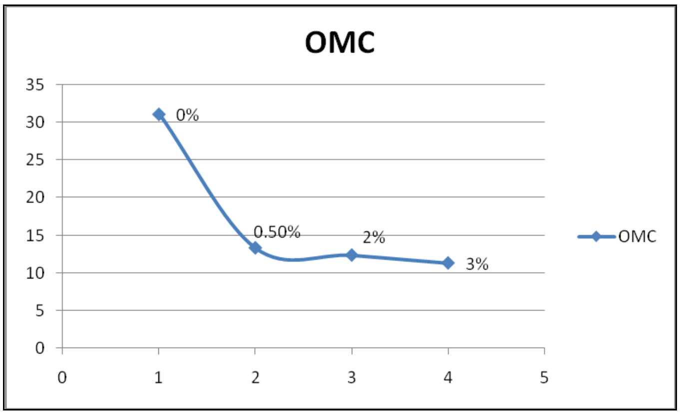
The clay content found in the soil was 65.65%, so it is considered as clayey soil and silt content was 34.35%.The LL, PL, PI and SL was found to be 91, 40, 51, and 20.32% for untreated soil. By the inclusion of rubber latex modified coir at 0, 0.5, and 2% in soil, the cohesion and maximum dry density was increased, while angle of internal friction attained an optimum value at 2% inclusion of coir. CBR values increased with increase in rubber latex modified coir up to 2% to the soil and decreased with the further inclusion of coir. The modulus of elasticity attained optimum at 2% with initial decrease at 0.5%. From the studies made with the laboratory results, the rubber latex modified clay increases the strength parameters and latex acts as a preservative for the coir which increases the durability and retards the degradation of coir reinforced in the soil.

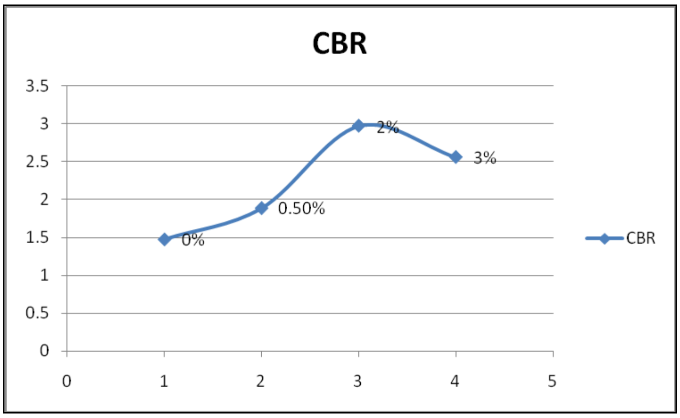


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