# An Experimental Study on Utilization of Polyethylene Waste Sachets with Lime for Improving Weak Marine Clays

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***Abstract-*** *Marine clay deposits are found both in the coast and in several offshore areas spread over many parts of the world. India being peninsular country has a large area coming under coastal region and also it has been the habitat for considerable percentage of population. The marine clays are found in the states of West Bengal, Orissa, Andhra Pradesh, Tamilnadu, Kerala, Karnataka, Maharashtra and some parts of Gujarat. These soils are highly saturated, soft, sensitive and normally consolidated. These usually have low density and low shear strength in nature. This project will investigate the possibility of utilizing polyethylene waste sachets to reinforce stabilized weak marine clays to pave way for its use in civil engineering projects such as in road bases, embankments etc.. A series of tests will be done on weak soil-lime-plastic with varying percentages of the chosen materials for stabilization. The testing programme will involve addition of different percentages of lime and shredded polyethylene waste sachets to marine clay and the results will be analyzed to assess the efficacy of the materials used.*

***Keywords:-*** Marine Clay, Lime, Polyethylene Waste Sachets, Stabilization, Shear Strength

## I. INTRODUCTION

India has large coastline. In view of the developments on coastal areas in the recent past, large number of ports and industries are being built. In addition, the availability of land for the development of commercial, industrial and transportation, infrastructure etc. are scarce particularly in urban areas. This necessitated the use of land, which has weak strata, wherein the geotechnical engineers are challenged by presence of different problematic soils with varied engineering characteristics. Many of these areas are covered with thick soft marine clay deposit, with very low shear strength and high compressibility.

Majority of the population in India depends on road-based transport. There are many deposits of fine clays on coastal corridor and those soils are suffering from high saturation, low density, low shear strength, sensitivity, and deformation problems and are normally consolidated. The marine clays, because of the specific physico-chemical make-up, are subjected to volume change with the changes in their ambient environment. The marine clays are not suitable as pavement sub grade & foundation soil beds and pose problems due to their inability of strength criteria. More and more construction projects are encountering soft clays and hence there is a need to better quantifying the properties of marine clays.

These soils are generally found in the states of West Bengal, Orissa, Andhra Pradesh, Tamilnadu, Kerala, Karnataka, Maharashtra and Gujarat in India. So there is need to improve transportation and also the construction facilities in these coastal regions for easy access. Marine clays exist in these regions are weak and highly compressible in nature.

A comprehensive review of literature indicates that considerable amount of work related to determination of engineering behavior of marine soils has been carried out worldwide since last 50 years. Amongst various contributions, the investigations on physical, chemical and mineralogical properties of marine clay conducted by Eden et al. (1957), Noorani (1984), Shridharan et al.(1989), Mathew et al. (1997) and Chew et al. (2004) are worthy of note. Significant research on strength and stiffness characteristics was performed by Koutsoftas et al.(1987) and Zhou et al. (2005). ; Zhuge et.al, (2007); Ameta,( 2007); Basack et. al,( 2009); Kamruzzaman et.al, (2009) and Fairfax Country, Virginia,( 2010). The loss caused due to the damaged structures proved the need for more reliable investigation of such soils and necessitates methods to eliminate, or reduce, the effect of settlements. To overcome these problems, there is no other alternative, except to improve the sub-soil or sub grade for expected loads with suitable treatment to the in-situ soil. In this work it is attempted to study the effect of Lime and shredded polyethylene waste *sachets* on the properties of marine clay.

### Objectives of the Study

The objectives of present experimental study are as follows.

- To identify the strategy of techniques to overcome the problems posed by marine clays with a view to adopt suitable methodology through critical review of literature.
- To study the impact of proposed additives and admixtures on the properties of marine clays through laboratory experimentations.
- To evaluate the performance of marine clay when stabilized with proposed additives and admixtures and their suitability for fill material and sub grade material.
- To investigate the suitability and adoptability of Waste plastics as discrete reinforcement.

## II. METHODOLOGY

### Marine clay

The marine clay used in this study and was typical soft clay. The marine clay was collected at a depth of 0.30m to 1.00m from ground level from ONGOLE, Andhra Pradesh State, India. The properties of soil are presented in the Table 1.

Table -1: Physical properties of Marine Clay

| S. No | Property | Value |
|---|---|---|
| 1. | **Grain size distribution**<br>Sand (%)<br>Silt (%) & clay(%) | <br>8.2<br>91.8 |
| 2. | **Atterberg limits** | |
| | Liquid limit (%) | 75.20 |
| | Plastic limit (%) | 29.80 |
| | Plasticity index (%) | 45.40 |
| 3. | **Compaction properties** | |
| | Optimum Moisture Content, (%) | 27.60 |
| | Maximum Dry Density, (g/cc) | 1.33 |
| 4. | **Specific Gravity (G)** | 2.65 |
| 5. | **IS Classification** | CH |
| 6. | **SOAKED C.B.R (%)** | 0.99 |
| 7. | **Differential free swell (%)** | 31.3 |
| 8. | **Shear Strength Parameters** | |
| | Cohesion (kN/m²) | 49 |
| | Angle of internal friction (⁰) | 0 |

### Lime

The commercial Birla lime taken from market for the purpose of stabilizing soil, which imparts cementing property to the soil mix. Commercial grade lime mainly consisting of 58.67% of Cao and 7.4% Silica was used in the study. The quantity of lime was varied from 0% to 8% by dry weight of soil.

### Polyethylene strips

Polyethylene sachets strips used in this project are obtained from household waste.

## III. RESULTS AND DISCUSSIONS

In the laboratory, various experiments were conducted by adding different percentages of Waste Polyethylene Strips (WPS) in the Weak marine Soil and also further stabilizing it with lime as a binder. Liquid Limit, Plastic Limit and Compaction, CBR and Triaxial shear tests were conducted with a view to determine the optimum combination of Waste Polyethylene Strips (WPS) as additive in weak marine soil and Lime as a binder. The influence of the above said materials on the Index, Compaction and Strength properties were discussed below.

### Effect of % Lime As Additive on the Properties of Weak Marine Soil

The individual influence of lime on the Index, Compaction and Strength properties of marine soil are clearly presented in below Chart. The percentage of lime was varied from 0%, to 8% with an increment of 2%.

Table -2: Results of the tests conducted on Marine Clay addition with different percentages of lime

| Clay+ Lime % | LL % | PL % | PI % | O M C | MDD (g/cc) | C KPa | Ø (°) | CBR US (%) | CBR Soake (%) |
|---|---|---|---|---|---|---|---|---|---|
| 100+0 | 75.2 | 29.8 | 45.4 | 27.6 | 1.33 | 49 | 0 | 1.96 | 0.99 |
| 100+2 | 68.4 | 27.6 | 40.8 | 27.2 | 1.37 | 57 | 1 | 2.30 | 1.35 |
| 100+4 | 60.5 | 29.3 | 31.2 | 26.7 | 1.40 | 69 | 1 | 3.06 | 2.72 |
| 100+6 | 51.9 | 31.0 | 20.9 | 26.3 | 1.48 | 86 | 2 | 4.83 | 4.79 |
| 100+8 | 40.6 | 23.3 | 17.3 | 25.8 | 1.52 | 101 | 2 | 5.94 | 5.96 |

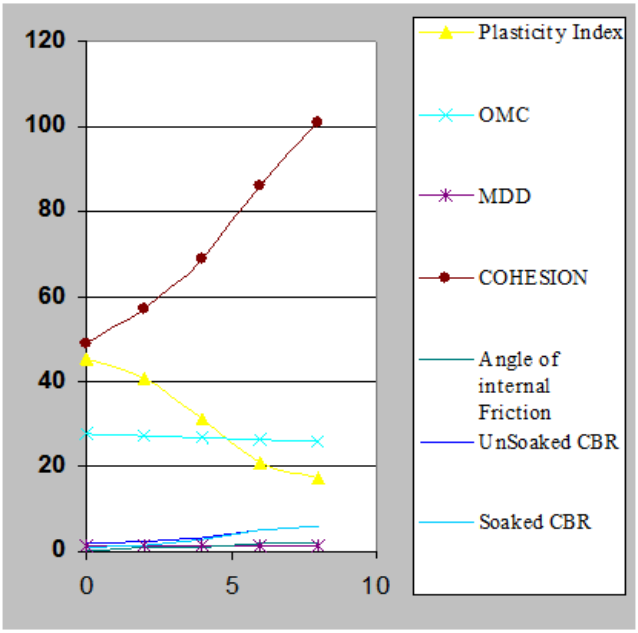


Chart -1: Chart showing the variation of Various properties with % Lime as additive of Marine clay.

From the above graphs, it was observed that the treatment as individually with 6% lime has improved the marine soil. It can be inferred from the graphs, that there is a gradual reduction in the Plasticity index with an increment in % addition of lime up to 8% with a reduction of about 160%. Also maximum dry density is improved by an amount of 14% and it was about 106% for cohesion and 5 times for soaked CBR respectively. Cohesion is increased from $0^0 – 2^0$ for the increment of lime in marine soil from 0-8%. It is also clear from the graphs that the improvement in the properties of the weak marine clay was almost close with the addition of 6% and 8% Lime content. Hence, keeping in view of the economic aspect, the optimum percentage of lime can be taken as 6%.

**Effect of Waste Polyethylene Strips on the Properties of Lime Stabilized Weak Marine Soil**

The influence of Waste Polyethylene Strips (WPS) on the Strength characteristics of weak marine Soil + lime mix is clearly presented in below Chart. The percentage of Waste Polyethylene Strips (WPS) was varied from 0%, to 1.5% with an increment of 0.5%. In the laboratory, tests were conducted by blending different percentages of WPS to Weak Marine Soil + lime mix with a view to determine its optimum blend.

Table -3: Results of the test conducted on optimum mix of MC + lime and addition of different % of WP

| 100+ 6% Lime+ %WP | C(KPa) | Ø (°) | CBR (Unsoaked) (%) | CBR (SOAKED) (%) |
|---|---|---|---|---|
| 0 | 86 | 2 | 4.83 | 4.79 |
| 0.5 | 91 | 4 | 5.28 | 4.96 |
| 1.0 | 98 | 7 | 5.83 | 5.41 |
| 1.5 | 94 | 5 | 5.29 | 4.87 |

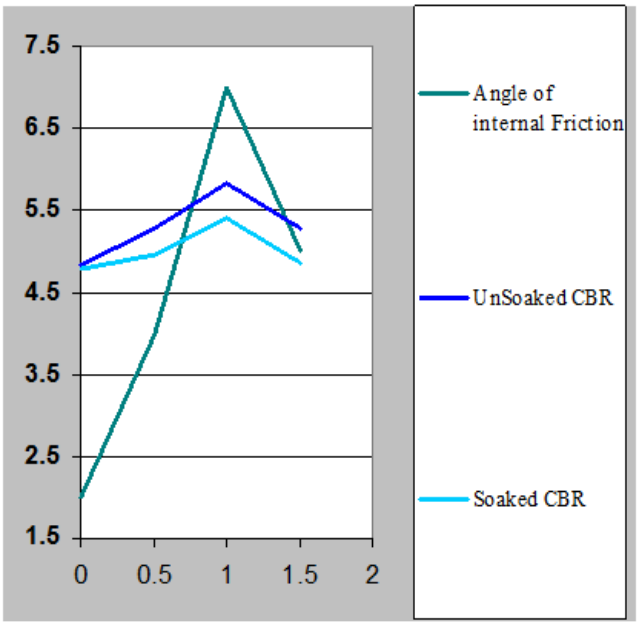


Chart -2: Chart showing the variation of Various properties with with % WP addition in Optimum mix of Marine clay & lime.

Finally from the above discussions, it is clear that there is improvement in the behaviour of Weak Marine soil stabilized with lime + WPS. It is evident that the addition of lime to the virgin Marine soil showed an improvement in plasticity, compaction and strength properties to some extent and on further blending it with waste plastic, the improvement was more pronounced. This made the problematic weak

marine soil which if not stabilized is a discarded material, a useful fill material with better properties. The lime addition in the weak marine soil has reduced the plastic nature of the clay and upon further blending with WPS, the frictional resistance has improved. It can be summarized that the materials Waste Polyethylene Strips (WPS) and lime had shown promising influence on the properties of marine soil, thereby giving a two-fold advantage in improving problematic marine soil and also solving a problem of waste disposal.

## IV. CONCLUSIONS

From the laboratory studies, it is observed that the Marine Soil chosen was a problematic soil having high compressibility and high plasticity characteristics.

- It was observed that the treatment as individually with 6% lime of has improved the weak marine clay.
- There is a gradual reduction in the Plasticity index with an increment in % addition of lime up to 8% with a reduction of about 160%. Also maximum dry density is improved by an amount of 14% and it was about 106% for cohesion and 5 times for soaked CBR respectively. Cohesion is increased from 00 – 20 for the increment of lime in marine soil from 0-8%.
- It is also clear that the improvement in the properties of the weak marine clay was almost close with the addition of 6% and 8% Lime content. Hence, keeping in view of the economic aspect, the optimum percentage of lime can be taken as 6%.
- There is an improvement in the Strength characteristics with an increase in the Waste Polyethylene Strips (WPS) content from 0% to 1.0% with an improvement of 100% for cohesion and about 4.5 times for Soaked CBR respectively. Also there is an improvement in Angle of internal friction by 7 times, when compared to that of the virgin marine clay.
- It is evident that the addition of lime to the virgin Marine Clay showed an improvement in properties to some extent and on further blending it with Waste plastic, the improvement was more pronounced.
- Finally it can be summarized that the materials Waste Polyethylene Strips (WPS) and lime had shown promising influence on the properties of Weak Marine Clay, thereby giving a two-fold advantage in improving Weak Marine Clay and also solving a problem of waste disposal.

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