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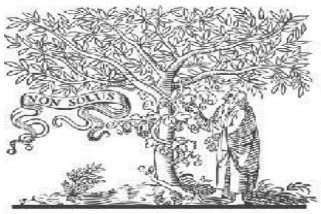

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# INFLUENCE OF FIBERS ON THE ENGINEERING BEHAVIOR OF MARINE CLAY

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**Abstract:** Fibers are proven to have typical influence on soilproperties. Individual utilization of the specific ingredients is a well practice in this category. An attempt is made to evaluate the individual and blended effects of different mineral admixtures on the geotechnical characteristics of expansive soils. Marine Clay is one such problematic soil which is annoying Geotechnical engineers. To overcome the problems posed by marine clays, various remedial measures like soil replacement, pre wetting, moisture control, lime stabilization have been practiced with various degrees of success. However, these techniques suffer from certain limitations with respect to their adaptability, like longer time periods required for pre wetting the highly plastic clays, difficulty in constructing the ideal moisture barriers, pulverization and mixing problems in case of lime stabilization and high cost for hauling suitable refill material for soil replacement etc. Many researchers all over the world are working, to evolve more effective and practical treatment methods, to solve the problems caused to pavements laid on marine clays. Investigations on soil stabilization revealed with some other availability materials like fly ash, quarry dust, lime, waste rubber, waste plastics etc., may be effectively used. Keeping in view the research findings, in the present work, experimentation was carried out to investigate the efficiency of fibres, in stabilizing the marine clay, thereby, improving the strength characteristics of the marine clay with optimum content of different fibres i.e. polypropylene fibres, nylon fibres and coir fibres . The materials considered had shown promising influence on the properties of marine clay.

**Key words**: *Clay, Nylon fibre, polypropylene fibre, coir fibre*

## 1. INTRODUCTION

The soil found in the ocean bed is classified as marine soil. It can even be located onshore as well. The properties of marine soil depend significantly on its initial conditions. The properties of saturated marine soil differ significantly from moist soil and dry soil. Marine clay is microcrystalline in nature and clay minerals like chlorite, kaolinite and illinite and non-clay minerals like quartz and feldspar are present in the soil. The soils have higher proportion of organic matters that acts as a cementing agent. India being peninsular country has large area coming under coastal region and also it has been the habitat for considerable percentage of population. The marine clays are generally found in the states of West Bengal, Orissa, Andhra Pradesh, Tamilnadu, Kerala, Karnataka, Maharashtra and some parts of Gujarat. Marine or soft clays existing in these regions are weak and compressible in nature. Marine clay is uncommon type of clay and normally exists in soft consistency. Marine clay deposit of east coast of India was used for the testing with the aim to investigate its engineering properties. Clay is an impermeable soil, meaning it holds water, as opposed to permeable soil that allows water to rapidly drain, like a gravel or sand. It is also an expansive soil, such as the marine clay which predominates in almost all countries of the world, which when shrinking or expanding, can damage foundations and structures. The shrink and swell movements are due to changes in soil moisture. Providing uniform soil moisture next to and under your foundation is the only best thing to reduce or minimize the damaging effects of expansive soil. These soils are highly saturated, soft, sensitive and normally consolidated. These usually have low density and low shear strength and are expansive in nature. The development of any country depends on

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the transportation facilities and the construction projects. For the projects to be successful, the soil used for the foundation beds must be strong which requires better soil properties. Expansive soils have the tendency to swell when they come in contact with moisture and to shrink if moisture is removed from them. These volume changes in swelling soils are the cause of many problems in structures that come into their contact or constructed out of them. The expansive soils in India have liquid limit values ranging from 50 to 100 %, plasticity index ranging from 20 to 65 % and shrinkage limit from 9 to 14 %.

## 2. Literature Review

Sing et al., (2008) reported an improvement in the engineering properties of peat soils stabilizing with cement and ground granulated blast furnace slag and proved a remarkable increase in the pH and unconfined compressive strength, significant reduction in linear shrinkage, compressibility and permeability of the stabilized peat soils.

Basak and Purkayastha (2009),reported that the Engineering characteristics of marine clay collected form Visakhapatnam, India and the physical, chemical and mineralogical properties were presented and the strength, stiffness of the soil water matrix were established.

TanitChalermyanont et al., (2009) represented that the properties of marine clay indicates that it has significant advantages over the lateritic soil as land fill liner material.

Sridharan et al., (1991), Presented the physical properties of marine clay and the properties marine clay may likely to change due to presence of organic matter. Narasimha Rao et al., (1996), stated that the permeability (k) values shown an enormous improvement by using lime column technique and the permeability value improved by 23 times.

Paul Mathew et al., (1996), presented the use of lime column technique to improve the permeability of marine clay. The results show an enormous improvement in the permeability values and they were improved by23 times when compared to the original values. This acted as a good promise for improving the coastal deposits.

Singh and Mittal (2014) investigated the clayey soil with varying the percentages of coir fiber as 0.25%, 0.50%, 0.75% and 1% by weight. A series of unconfined compression test (UCS) and California bearing ratio (CBR) test were conducted in his study. From the study, it was found that there is considerable improvement in compressive strength of the soil reinforced with the coir fiber. Soil with no reinforcement had an unconfined strength of 2.75 kg/cm2 which then on adding of fiber increased to a value of 6.33 kg/cm2 for coir content of 1% by weight of soil, this increase in value could be because of increase in the shear parameters, it was found difficult to prepare the identical sample beyond 1% of fiber content so, only up to 1% of coir fiber was used in his study. From the CBR tests also it can be stated that the value for both the unsoaked as well as the soaked test has considerably increased on increasing the fiber content in the soil sample, it was noted that the soaked value of CBR has improved to a value of 9.22% from that of 4.75% when 1% coir fiber was included in the soil and also for the unsoaked condition the value has increased from 8.22% to 13.55%. It could be concluded from his study that coir fiber can be utilized successfully in sub base for flexible pavement and also for the rigid pavement

## 3. Materials

**Marine Clay:** The soil used in this study is marine clay, obtained from Kakinada Sea Ports Limited, collected at a depth of 1.5m from ground level.

**Polypropylene fibers**: Polypropylene fibre is used in this study and it is a synthetic material. Fibers used for this study has a length of 12mm were purchased from the market. Polypropylene fibers are hydrophobic, non-corrosive and resistant to alkalis, chemicals and chloride Polypropylene fibers having lengths 6, 12 and 24 mm, and aspect ratio of 150,300 and 600 respectively were purchased from the market for use in this work.

Figure: 1 Polypropylene fibres

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**Nylon fibres:** The nylon fiber which is used in the present study has brought from 'CENTURY ENKA, SURAT'. Nylon Fibers are distributed randomly with different aspect ratios (L/D ratio) (i.e. 50, 100 & 150) and with different percentages (i.e. 0.2%, 0.4% & 0.6%) The Nylon Fibers used in the present research has following properties.

Figure: 2 Nylon fibers

**Coir Fibers:** These fibers are biodegradable and environmentally friendly. It has the greatest tearing strength among all natural fibers and retains this property in wet conditions. Therefore, coconut fiber is selected as the reinforcement material for this study. Coir is biodegradable and it takes approximately 20 years to decompose above ground.

Figure:3 Coir Fiber

## 3. Results

3.1 Maximum Dry Density values of marine clays with Polypropylene Fibers, Nylon Fibers and Coir Fibers

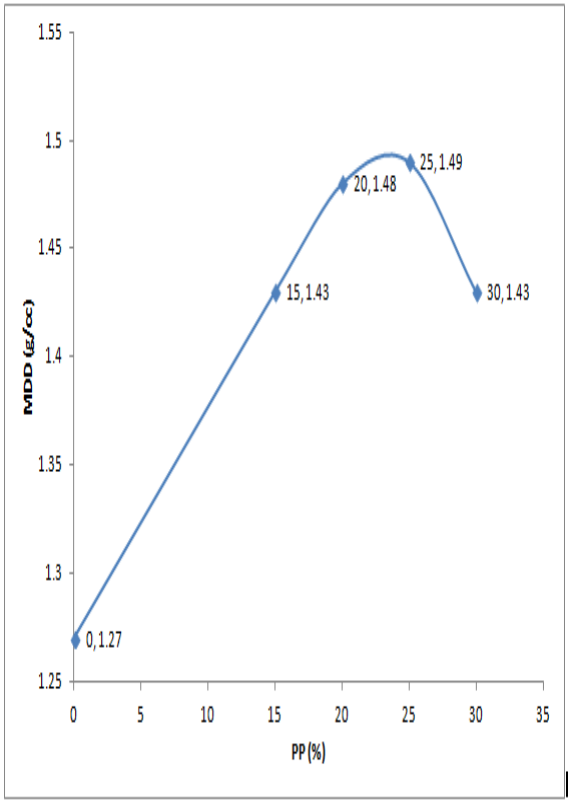


Figure:4 Maximum Dry Density values of marine clay with Polypropylene Fibers

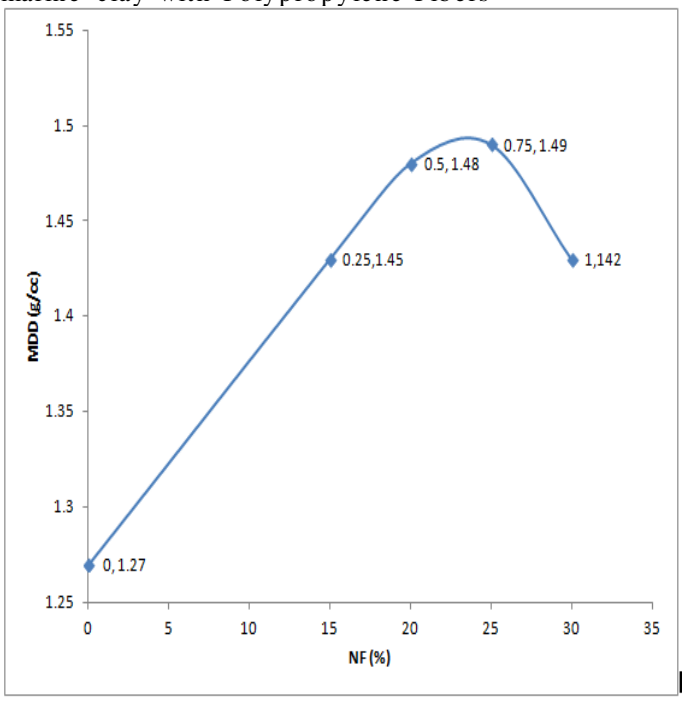


Figure: 5 Maximum Dry Density values of marine clays with Nylon Fibers

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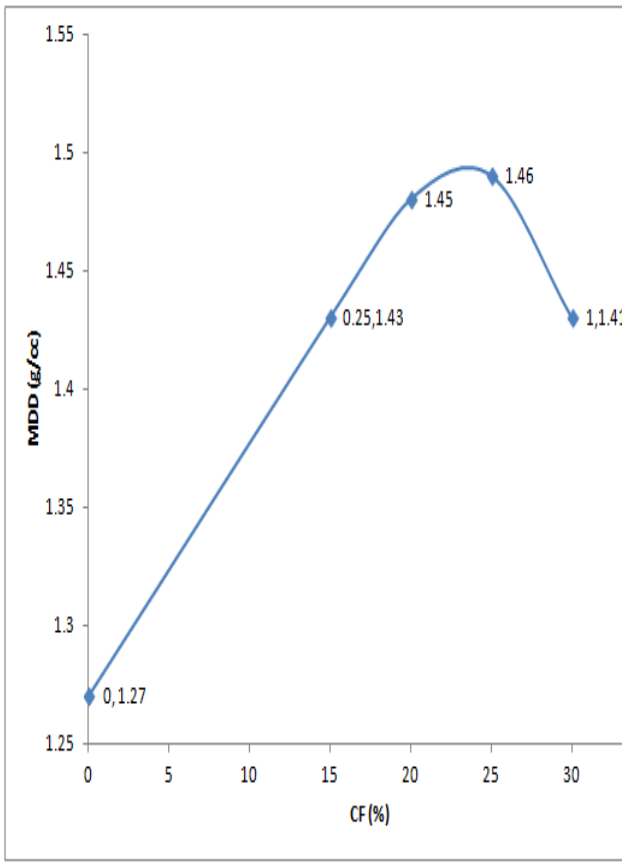


Figure: 6 Maximum Dry Density values of marine clay with Coir Fibers

3.2 variation of soaked CBR values with Polypropylene Fibers, Nylon Fibers and Coir Fibers

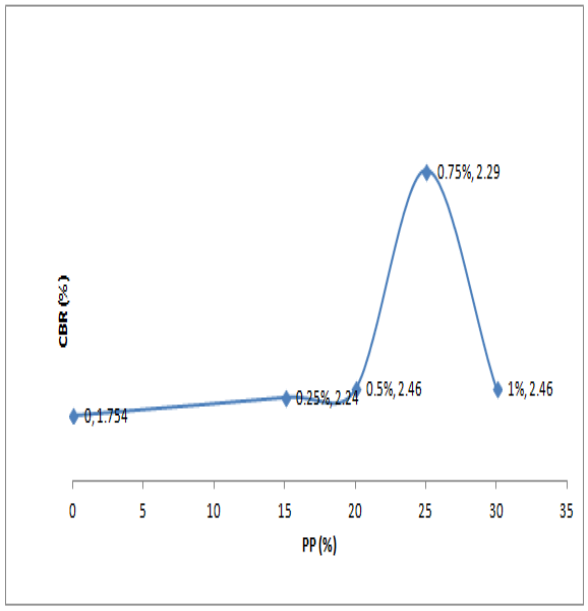


Figure: 7 CBR Test Results of Untreated Marine Clay with PP Fibers

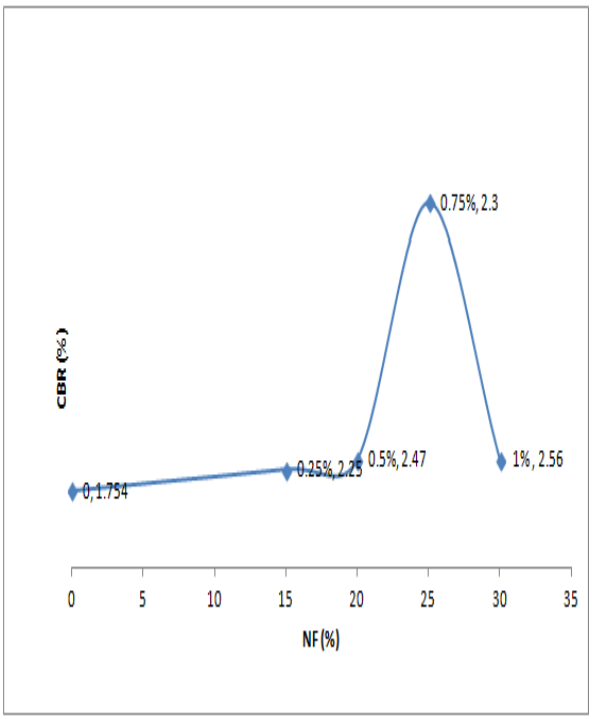


Figure: 8 CBR Test Results of Untreated Marine Clay with Nylon Fibers

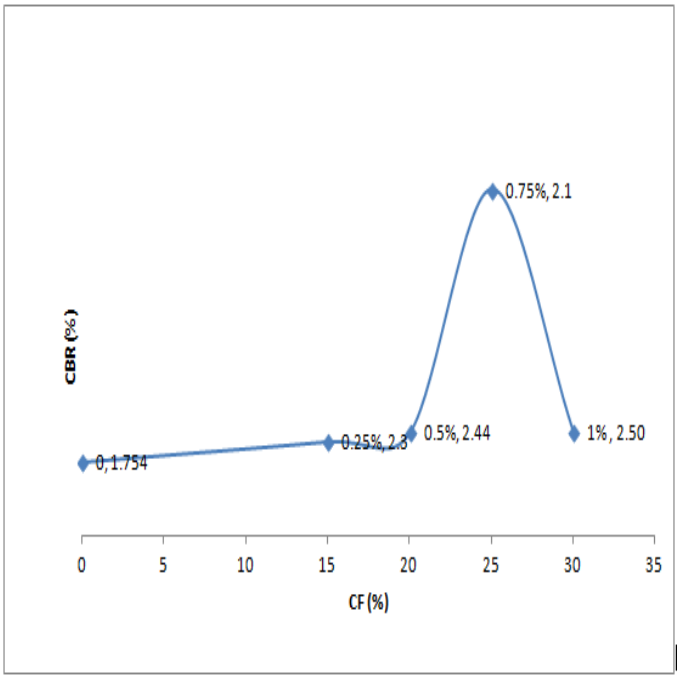


Figure: 9 CBR Test Results of Untreated Marine Clay with Coir Fibers

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**Properties of untreated and treated marine clay with 0.75% Fibers (PPF,NF,CF)**

| S.No | Property | Symbol | Marine Clay | MC + 0.75% PPF | MC + 0.75 % NF | MC + 0.75 % CF |
|---|---|---|---|---|---|---|
| 1 | Liquid Limit (%) | $W_L$ | 74 | 62 | 59 | 61 |
| 2 | Plastic Limit (%) | $W_P$ | 27 | 29 | 30 | 33 |
| 3 | Plasticity Index (%) | $I_P$ | 47 | 33 | 29 | 28 |
| 4 | Shrinkage Limit (%) | $W_s$ | 12 | 16 | 18 | 17 |
| 5 | Soil Classification | -- | CH | CH | CH | CH |
| 6 | Specific Gravity | G | 2.38 | 2.53 | 2.55 | 2.49 |
| 7 | Differential Free Swell (%) | DFS | 70 | 19 | 21 | 28 |
| 8 | Optimum Moisture Content (%) | O.M.C | 36 | 29.93 | 30.15 | 27.53 |
| 9 | Maximum Dry Density (gm/cc) | M.D.D | 1.27 | 1.486 | 1.487 | 1.457 |
| 10 | Cohesion ($t/m^2$) at OMC | C | 12.20 | 7.8 | 7.4 | 7.9 |
| 11 | Angle of Internal Friction($^0$) | Ø | 2.5 | 8.2 | 8.4 | 7.9 |
| 12 | CBR value (%) | Soaked | 0.754 | 2.29 | 2.30 | 2.10 |

## 4. Conclusions

5. It is observed that three fibers i.e polypropylene fibre, nylon fibre and steel fibers optimum content is 0.75%
6. It is noticed that the liquid limit of the marine clay has been decreased by 16.21% on addition of 0.75% Polypropylene fibers.
7. It is observed that the plastic limit of the marine clay has been improved by 7.40% on addition of 0.75% Polypropylene fiber.
8. It is observed that the plasticity index of the marine clay has been decreased by 29.78% on addition of 0.75% Polypropylene fiber.
9. It is found that the O.M.C of the marine clay has been decreased by 18.52% on addition of 0.75% Polypropylene fiber.
10. It is found that the M.D.D of the marine clay has been improved by 17.00% on addition of 0.75% Polypropylene fiber.
11. It is observed that the C.B.R. value of the marine clay has been increased by 282.0% on addition of 0.75% Polypropylene fiber.
12. It is observed that the DFS value of the marine clay has been decreased by 72.80% on addition of 0.75% Polypropylene fiber.
13. It is noticed that the liquid limit of the marine clay has been decreased by 20.27% on addition of 0.75% Nylon fibers.

14. It is observed that the plastic limit of the marine clay has been improved by 10% on addition of 0.75% Nylon fiber.

15. It is observed that the plasticity index of the marine clay has been decreased by 38.30% on addition of 0.75% Nylon fiber.

16. It is found that the O.M.C of the marine clay has been decreased by 16.25% on addition of 0.75% Nylon fiber

17. It is found that the M.D.D of the marine clay has been improved by 14.59% on addition of 0.75% Nylon fiber.
18. It is observed that the C.B.R. value of the marine clay has been increased by 282.0% on addition of 0.75% Nylon fiber.
19. It is observed that the DFS value of the marine clay has been decreased by 70% on addition of 0.75% Nylon fiber.
20. It is noticed that the liquid limit of the marine clay has been decreased by 17.56% on addition of 0.75% coir fiber.
21. It is observed that the plastic limit of the marine clay has been improved by 22.22% on addition of 0.75% Coir fiber.

22. It is observed that the plasticity index of the marine clay has been decreased by 40.42% on addition of 0.75% Coir fiber.

23. It is found that the O.M.C of the marine clay has been decreased by 23.53 % on addition of 0.75% Coir fiber
24. It is found that the M.D.D of the marine clay has been improved by 14.72% on addition of 0.75% Coir fiber.
25. It is observed that the C.B.R. value of the marine clay has been increased by 178.5% on addition of 0.75% Coir fiber.
26. It is observed that the DFS value of the marine clay has been decreased by 60% on addition of 0.75% Coir fiber.

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