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# A Study on the Effect of Polypropylene Fiber on Jarofix-Stabilised Cochin Marine Clay

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**ABSTRACT:**Over the past two decades, the Port City of Cochin in India has been witnessing large scale construction activities due to the rapid industrialization. Most of the greater Cochin area consists of soft marine clays. Due to the presence of the weak marine clay deposits, expensive deep foundations are provided for the structures. The studies on the nature and engineering behaviour of soft clays and methods to improve their geotechnical properties have been of great relevance. So, soil stabilization was done by utilizing the binding properties of various materials. Research shows that the addition of industrial effluents resulted in the enhanced properties of soil. Clayey soil can be improved with reinforcement of randomly distributed fibers of natural and synthetic types. This project deals with the study on the effect of polypropylene fiber on jarofix-stabilised Cochin marine clay. The jarofix is added to marine clay ranging from 0%-40% with an increment of 10%. To the optimum of jarofix-soil mix, polypropylene fiber is added in different percentages (0.15%, 0.25%, 0.35%) and were subjected to compaction tests and California bearing ratio tests. This paper presents the results of geotechnical characteristics of jarofix, jarofix-marine clay and jarofix-synthetic fiber mixes for the utilization of jarofix material for the construction of subgrade layers of road pavement.

**KEYWORDS:**Jarofix, Polypropylene fiber, Standard Proctor test, California Bearing Ratio.

## I. INTRODUCTION

Rural road connectivity is one of the key components for rural development, as it promotes economic and social services. There are number of important points to be considered while involving suitable and economical designs for the roads in India. Although a pavement's wearing course in a highway/road is prominent, the success or failure of a pavement is more often dependent upon the subgrade, the material upon which the pavement structure is built. Construction of pavements on the soil that do not have sufficient strength to support loads imposed upon them during construction or during pavement service life presents a difficult problem. Clay soil shows severe problems in pavement design due to uncertainties in their performance. Even after compaction, they can be unstable beneath the pavement and can be prone to shrinkage and swelling due to changes in moisture content. It is highly expensive to remove large volumes of unsatisfactory soil present at sites and replace them with more suitable material, if it is to be transported for large distances. Therefore, studies have been done for finding methods of modifying the properties of soil and improving their engineering behaviour. This is where soil stabilization has become a cost-effective alternative. Soil stabilization does this by increasing the strength of the soil. It compounds the chemicals together to create a stronger and more cohesive soil that will not erode as easily.

## II. MATERIALS

**Soil :**The soil for the study was collected from Toc-H School Junction, near Kadavanthra, Kochi, Kerala, India. The soil samples were collected in polythene bags. The collected soil was black in colour with high natural water content.

**Jarofix :**The Jarofix used for this study was collected from Binanipuram Zinc.Ltd at Ernakulam, Kerala, India.

**Polypropylene fiber :**The Polypropylene fiber used for this study was collected from Mumbai. Fibers were trimmed into small pieces of average length of 6mm.

Fig. 1. Materials (a) Cochin Marine Clay (b) Jarofix (c) Polypropylene fiber



(a)



(b)



(c)

### III.METHODOLOGY

Collected samples were transported to laboratory and then basic property tests were done. The methodology followed for the study was as follows:

#### Determination of Soil Properties

- Initial moisture content (IS: 2720 (Part II) – 1973)
- Specific gravity (IS: 2720 (Part 3 / Sec 1) – 1980)
- Particle size distribution (IS 2720 (part 4) – 1985)
- Consistency limits (IS: 2720 (Part 5) – 1985, (Part 6) – 1972)
- Compaction characteristics like optimum moisture content and maximum dry density (IS: 2720 (Part 8) – 1983)
- Unconfined Compressive Strength (IS 2720 (Part 10) 1991)
- CBR value of soil by California Bearing Ratio test (Unsoaked & Soaked) (IS 2720 (Part 16) – 1987)
- Organic content (IS: 2720 (Part 22) – 1972)

#### Determination of Properties of Jarofix

- Specific gravity
- Particle size analysis
- Consistency limits
- Compaction characteristics - optimum moisture content & maximum dry density
- Unconfined Compressive Strength

#### Determination of Properties of Soil with Jarofix

The soil was mixed with different percentage of jarofix (0%, 10%, 20%, 30% and 40% of dry weight of soil). Several tests were conducted in the treated soil to get the optimum percentage of soil-jarofix mix and the tests include:

- Compaction test
- California bearing ratio test (Unsoaked & Soaked)

#### Determination of Properties of Soil with Jarofix-Polypropylene fiber mix

The soil was mixed with different percentage of polypropylene fibers (0.15%, 0.25% and 0.35% of dry weight of soil) by keeping the jarofix mix constant (optimum percentage of jarofix in soil-jarofix mix). The following tests were conducted to evaluate the strength variation of Cochin marine clay treated with jarofix and polypropylene fibers

- Compaction test
- California bearing ratio test (Unsoaked & Soaked)

### IV.EXPERIMENTAL RESULTS

#### 4.1 Properties of Cochin Marine Clay

Table 1. Properties of soil sample

Soil property		Values
Natural water content (%)		73
Specific gravity		2.63
Grain size distribution	Percentage of gravel (%)	0
	Percentage of sand (%)	19.4
	Percentage of silt (%)	26.6
	Percentage of clay (%)	54
Coarse/Fine grained type		Fine grained
Consistency characteristics	Liquid limit, LL (%)	70
	Plastic limit, PL (%)	31
	Shrinkage limit, SL (%)	20
Soil classification		Clay of High Plasticity(CH)
Compaction characteristics	Optimum moisture content (%)	25
	Maximum dry density ( $\text{kN/m}^3$ )	15
Unconfined Compressive Strength ( $\text{kN/m}^2$ )		64
CBR value (Unsoaked) (%)		0.88
CBR value (Soaked) (%)		0.74
Organic matter (%)		10



4.2 Properties of Jarofix

Table 2. Properties of Jarofix

Properties of Jarofix		Values
Specific gravity		2
Grain size distribution	Percentage of gravel (%)	0.4
	Percentage of sand (%)	1.7
	Percentage of silt & clay (%)	97.9
Consistency characteristics	Liquid limit, LL (%)	68
	Plastic limit, PL (%)	46
	Shrinkage limit, SL (%)	28
Compaction characteristics	Optimum moisture content (%)	47
	Maximum dry density (kN/m <sup>3</sup> )	13.8
Unconfined Compressive Strength (kN/m <sup>2</sup> )		234

4.3 Tests with Soil and Jarofix

The jarofix was added to soil in different percentages such as 0%, 10%, 20%, 30% and 40% of the weight of soil mass.

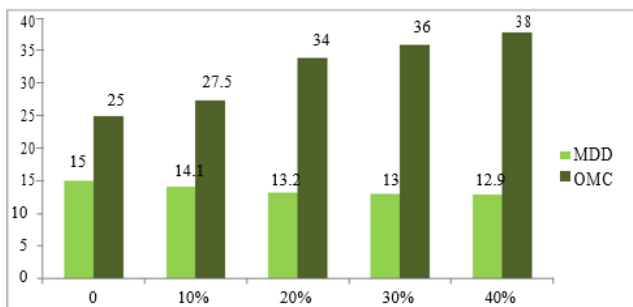
4.3.1 Effect of jarofix on Compaction Characteristics

The Optimum Moisture Content increased and Maximum Dry Density decreased on addition of jarofix. The increase in OMC was due to the lower specific surface area and less attraction of water molecules by the addition of jarofix and the decrease in MDD was due to the fact that jarofix had lesser specific gravity than soil.

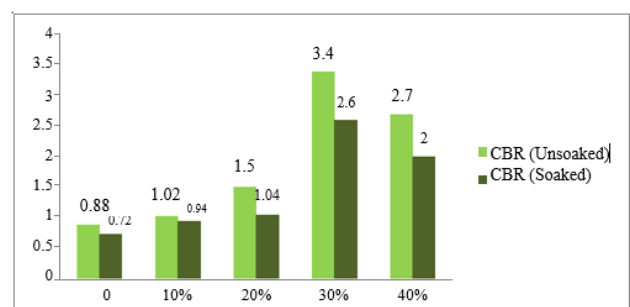
4.3.2 Effect of Jarofix on California Bearing Ratio

Each soil sample was tested for its unsoaked California Bearing Ratio and soaked California Bearing Ratio strength after being soaked in water for 4 days. As jarofix was added to soil, an increase in CBR value was observed. Maximum CBR value was obtained at 30% of jarofix content. At 40% addition of jarofix, the CBR again decreased. When jarofix was added to soil, it had made the sample more porous, reduced cohesion and jarofix has rough, sharp and angular particles causes gain in strength due to better interlocking. The decrease in CBR value after a while due to the decrease in bonding between particles on addition of coarser particle.

Fig.2 tests with soil and jarofix (a) Variation in Compaction Characteristics with different percentages of jarofix (b) Variation in CBR values with different percentages of jarofix.



(a)



(b)

4.4 Tests with combination of Jarofix & Polypropylene Fiber

Compaction tests and California bearing ratio tests were conducted with different combinations of jarofix and polypropylene fibre. Here the concentration of polypropylene fibre was kept varying while concentration of jarofix was kept constant as 30%. The compaction test was conducted by adding different percentages of polypropylene fibre (0.15%, 0.25% and 0.35%) and 30% jarofix.

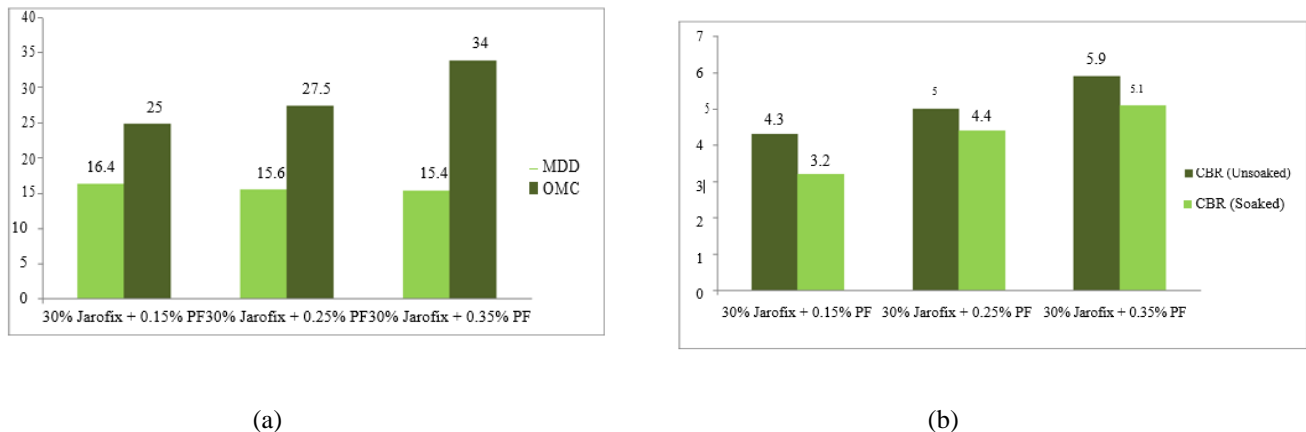
4.4.1 Variation in compaction characteristics

Here the OMC increased and MDD decreased on addition of 30% jarofix and different percentages of polypropylene fiber. The increase in OMC was due to the high-water holding capacity of fibers and the decrease in MDD was due to the low specific gravity of fiber.

#### 4.4.2 Variation in California Bearing Ratio

When polypropylene fiber was added to the mix, it showed an increase in CBR value. Maximum CBR value was obtained at 0.35% polypropylene fiber content. Improvement in strength was due to the frictional resistance between soil and fiber. With the addition of polypropylene fiber to jarofix-soil mix, CBR value got increased by 570% for unsoaked condition and 480% for soaked condition.

Fig.3 tests with combination of Jarofix & Polypropylene Fiber (a) Variation in Compaction Characteristics with different percentages of jarofix&Polypropylene Fiber (b) Variation in CBR values with different percentages of jarofix & Polypropylene Fiber.



## V. CONCLUSION

In the present investigation, the identification tests were conducted on Cochin marine clay and the results of wet sieve analysis indicate that, more than 50% of the soil passed 75 micron IS sieve and hence the soil can be concluded as fine grained in nature. The consistency limits of sample indicate that they can be classified as clay of high plasticity (CH) as per the plasticity chart. The CBR value of soil shows that the soil is weak. In its natural state, the soil cannot be used for pavement application.

Tests on treated soil lead us to the following conclusions.

Tests with soil and jarofix

- It was found that the liquid limit decreases irrespective of the percentage addition of jarofix
- CBR value of uncontaminated marine clay was 0.88% for unsoaked condition and 0.74% for soaked condition, was then increased by 290% and 300% respectively.
- It was found that the CBR value goes on increasing as percentage of jarofix increases upto 30%, and then decreases on further addition. So 30% was taken as the optimum percentage

Tests by the combination of jarofix and synthetic fibers

- With the addition of polypropylene fiber, CBR value again got increased by 570% for unsoaked condition and 480% for soaked condition.

As polypropylene fiber is cheaper than other fibers, it can be concluded that combination of jarofix and polypropylene fiber was more effective as it also gives more strength value. It can be concluded that the utilization of jarofix material is suitable for the construction of subgrade layers of pavement.

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