Effect of Polypropylene Fibre on Compressibility and Swelling Behaviour of Soft Clay

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***Abstract*:- The soil is reinforced with polypropylene fibre is modified method to develop in recent years. It is a synthetic type fibre. Many studies have being reported in the literature on the performance evaluation of clayey soil. Although sample studies have being reported with randomly distributed fibres, relatively less amount of work is found in respect of polypropylene fibres with Cochin marine clay. The sample is prepared in the field condition. Then the soil is reinforced with varying fibre percentage and fibre length (F=0%,0.1%,0.2%,0.3%,fibre length =30mm,6mm,9mm,120mm).The experimental investigation being undertaken for the performance evaluation of polypropylene fibre- marine clay is reported ,evaluated the effect of polypropylene fibre on swell and compressibility of the clay. The objective of present investigation is to quantify the optimum quantity of randomly distributed fibre and the performance in terms of unconfined compressive strength, compressibility and swelling characteristics. The result obtained so far reveals that, there is a significant improvement in the above mentioned properties. Finally it is concluded that mitigation of clay using polypropylene fibre might be an effective method in reducing the swell pressure and compressibility of subsoil on which roads and light building are constructed.**

Keywords— Component; formatting; style; styling; insert (key words)

INTRODUCTION

Soil improvement is of major concern in the construction activities due to rapid growth of Urbanization and industrialization. The term soil improvement is used for the techniques which improve the index properties and other engineering characteristic of soils. The soils have high shrinkage and swelling characteristics. The shearing strength of the soils is extremely low. The soils are highly compressible and have very low bearing capacity. It is extremely difficult to work with such soils. These soils are residual deposits formed from basalt or trap rocks. The tendency of clayey soil to increase in volume due to infiltration of water is resisted by the structure resting on the soil and as a consequence, vertical swelling pressure is exerted on the structure. Swelling pressure develop if the soil is not allow to swell freely. The magnitude of swelling pressure depends on the degree of expansion permitted. If the swelling pressure exerted by soil is not controlled, it may cause uplift and distress in structure.

Construction of buildings and other civil engineering structures on weak or soft soil is highly risky because such soil is susceptible to differential settlements due to its poor shear strength and high compressibility. Improvement of certain desired properties like bearing capacity, shear Strength (c and Φ) and permeability characteristics of soil can be undertaken by a variety of ground improvement techniques such as the use of prefabricated vertical drains or soil stabilization. Incorporating reinforcement inclusions within soil is also an effective and reliable technique in order to improve the engineering properties of soil. In comparison with conventional geosynthetics (strips, geotextile, geogrid, etc.), there are some advantages in using randomly distributed fibre as reinforcement..

II.OBJECTIVE AND SCOPE

A .*Objectives*

- To study the effect of amount of geofibre on Atterberg limits and consolidation of marine clay, were carried out on soil samples adding different percentages of fibre content.
- To study strength and swelling compressibility behavior of randomly distributed Polypropylene fibre
- Determine the index properties of marine clay soil including Grdation, Atterberg limits, FSI, compaction and unconfined strength properties.
- Swelling and compressibility of both treated and untreated samples in terms of shrinkage measurements swell pressure, and compression indices.
- Swell-shrink behavior of clays

B. *Scope*

To study the properties of clay and the problems associated with it when used in EngineeringTo study the use of fibres in the soil, paying special attention to polypropylene fibres.Predict the effect that the addition of fibres will have in this study.

III. MATERIALS

C.Soil

The materials used in the experimental study are lacally available cochin marine clay,Disturbed marine clay were collected from Vaduthala valav,Cochin. The soil is collected at depth about 6m from the ground surface brought to laboratory in polythene bags. Samples of clay were collected by bore holes advanced by shell and auger method. The in-situ water content is 120.30%. Marine clay sample was well protected by using polythene bag to avoid the evaporation losses of natural moisture content. Natural soil was greenish grey, very hard, laminated silty clay with traces of fine sand and calcareous matters

Table 3.1 Properties of Moist Marine Clay

SL. No	Properties	quantities
1	Depth (m)	6
2	Specific gavity	2.50
3	Natural moisture content (%)	120.30
4	Sand (%)	8.8
5	Clay +Silt (%)	91.2
6	Soil classification	CH
7	Liquid limit (%)	166.10
8	Plastic limit (%)	72
9	Shrinkage limit (%)	15.73
10	Plasticity index	94.10
11	Free swell index (g/cc)	2.1
12	Unconfined compressive strength(kN/m²)	11.14
13	Coefficient of consolidation (cm²/sec)	1.91 x 10^{-4}
14	Compression index	4.519

D. Polypropylene fibre

The polypropylene fibre used in this study is the most commonly used synthetic material due to its low cost and hydrophobic and chemically inert nature which does not allow the absorbtion or reaction with soil moisture or leachate. The other properties are the high melting point of 170°C, low thermal and electrical conductivity, and high ignition point of 590°C.

Fig.3.1 Polypropylene fibre

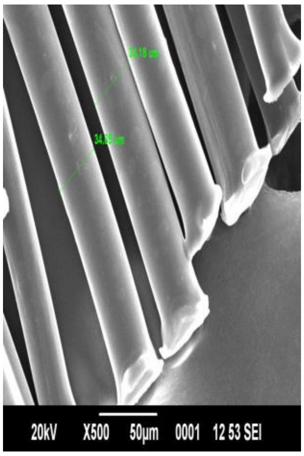

Fig: 3.2 SEM image of Polypropelene fibre

TABLE 3.2 PROPERTIES OF POLYPROPYLENE FIBRE

Properties	Values
Diameter (mm)	0.05
Melting point	170°C
Density (g/cc)	0.91
Elasticity	Very good
Moisture regain (MR%)	0%
Ability to protect friction	Excellent
Colour	White
Ability to protest heat	Moderate

IV.*RESULTS AND DISCUSSION*

E. Experimental Investigations on Fibre Reinforced Soil

A series of conventional laboratory tests such as Atterberg limits, standard compaction tests, unconfined compressive strength tests, consolidation test, swell pressure test have been carried out on soil and with different proportion of polypropylene fibre.

F..Effect of Fibre on Atterberg limits

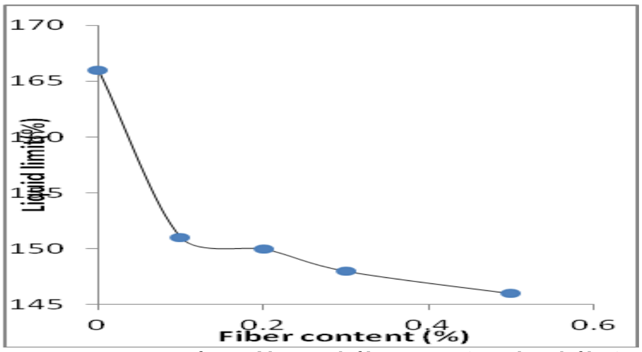

FIG. 4.1 *Variation of Liquid limit with fibre content(6mm length fibre)*

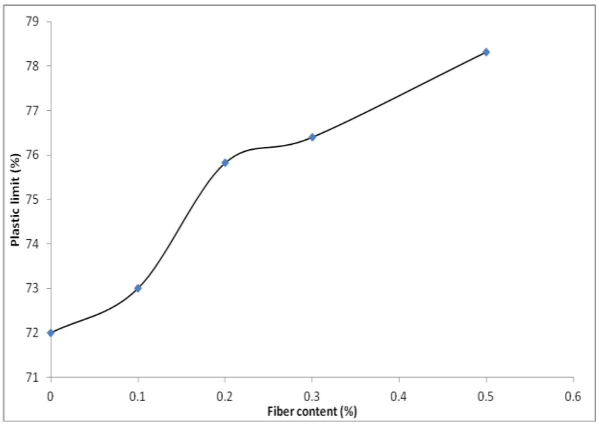

Fig 4.2 Variation of Plastic limit with fibre content

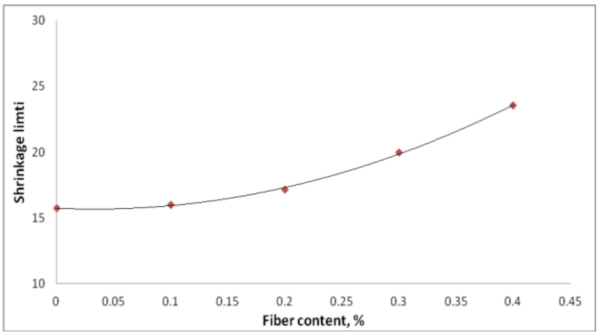

Fig 4.3 Variation of shrinkage limit with fibre content

Fig 4.1 shows as the clayey soil reinforced with polypropylene fibre the Liquid limit decreases with increasing of fibre content.Fig 4.2 show the variation of plastic limit with different fibre content. On being reinforeced with polyester fibres ,plastic limit increases as fibre content increases.Fig 4.3 shows the variation of shrinkage limit with different fibre content. On being reinforeced with polyester fibres, shrinkage limit increases as fibre content increases.The technique of fibre reinforced soil is very effective method and help to restrain the shrinkage behavior of marine clay

G.Effect of Fibre length on Atterberg limits

Table 4.2.Effect of Fibre length on Atterberg limits at 0.2% fibre content

Fibre length(mm)	Liquid limit(%)	Plastic limit(%)	Shrinkage limit(%)
3mm	130.2	64	15.87
6mm	150.2	75.82	13.17
9mm	151	70.5	14.57
12mm	160	85	14.98

From table 4.1 the results ,3mm length fibre length shows the low value of liquid limit and the maximum value of shrinkage limit.so the crack will reducing using 3mm length fibre and from
fig 4.4, Fibre reinforcement significantly reduced the extent and distribution of cracks due to desiccation as observed by the reduced number, depth and width of cracks. It can be sthat increasing fiber contents and lengths resulted in increasing the shrinkage limit of the samples. The resulted increase in the shrinkage limits became more pronounced by increasing fiber length from 3 to 6mm as compared to when it changed from 9 to 12mm. The shrinkage limit determined for the unreinforced sample was approximately 15%. This was increased to 25%for the sample reinforced with 0.2% fibers having 12mm length. This significant increase means that samples reinforced with random inclusion of fibers experienced less volumetric changes due to desiccation. Increase in the shrinkage limits means that longer fibers having greater surface contacts with the soil have shown greater resistance to volume change on desiccation. It can be said that random fiber inclusion improved the soil tensile strength very effectively, thus resisting shrinkage on cracking

0% FIBRE

0 .2%FIBRE

0.3% FIBRE

0.4% FIBRE

Effect of fibre length of coefficient of consolidation (Cv)

Coefficient of consolidation (Cv) can be obtained by squre root time method (tylor method) or by log –time method and the typical values are in Table 4.6

% FIBRE	Coefficient of consolidation Cv values (cm^2/sec)			
	50-100(kPa)	**100-200(kPa)**	**200-400(kPa)**	**400-800(kPa)**
0% fibre	$1.91*10^{-4}$	$8.16x\ 10^{-5}$	$0.776x10^{-}4$	$0.550x10^{-4}$
3mm length				
0.1%	1.77×10^{-4}	7.26×10^{-4}	8.97×10^{-5}	1.14×10^{-4}
0.2%	3.24×10^{-4}	2.03×10^{-4}	1.15×10^{-4}	7.53×10^{-4}
0.3%	4.39×10^{-4}	2.79×10^{-4}	1.70×10^{-4}	1.87×10^{-4}
6mm length				
0.1%	1.29×10^{-4}	6.26×10^{-4}	2.21×10^{-4}	1.23×10^{-4}
0.2%	2×10^{-4}	1.8×10^{-4}	7.85×10^{-5}	1.17×10^{-4}
0.3%	1.28×10^{-4}	9.65×10^{-5}	5.1×10^{-5}	8.44×10^{-5}
9mm length				
0.1%	7.07×10^{-4}	1.76×10^{-3}	2.33×10^{-4}	3.76×10^{-4}
0.2%	1.35×10^{-4}	1.87×10^{-4}	1.07×10^{-4}	1.34×10^{-4}
0.3%	2.98×10^{-3}	1.06×10^{-3}	9.19×10^{-4}	3.15×10^{-3}
12mm length				
0.1%	2.62×10^{-4}	1.89×10^{-4}	1.65×10^{-4}	1.25×10^{-4}
0.2%	2.54×10^{-4}	1.87×10^{-4}	1.81×10^{-4}	1.53×10^{-4}
0.3%	2.85×10^{-4}	3.21×10^{-4}	2.1×10^{-4}	2.59×10^{-4}

found to be at a pressure of 50-100kPa, 1.91 x 10^{-4} cm^2/sec and 4.519 respectively.

SUMMARY AND CONCLUSIONS

SUMMARY

Geotechnical properties of Cochin marine clays were determined and consolidation and swelling test were conducted using polypropylene fibre having different length and percentages. The interaction with the soil. The compressibility and swelling effects were analysed. In the present study an attempt is being made to study the behavior of randomly distributed polypropylene fibre reinforced soil. For that, a series of conventional laboratory tests were done with different proportion of fibre. An optimum fibre content and fibre length was obtained and at this optimum fibre soil was found to be suitable for construction. The engineering properties of soil were found to be improved with the addition of polypropylene fibres.

CONCLUSIONS

Based on the experimental investigations, test results and analysis, the following conclusions are made.

- Strength and stiffness of fibre reinforced soil is influenced by fibre length and percentages.
- As the percentage fibre increases the strength of reinforced soil increases
- Fibres can be used as effective reinforcement in actual field geotechnical applications.
- Inclusion of polypropylene fibres to the clay soil resulted in reducing the amount of swelling.

- Fibre reinforcement significantly reduced the extent and distribution of cracks due to desiccation as observed by the reduced number, depth and width of cracks.
- The experimental results show that there is a significant improvement in the strength of soil with inclusion of polypropylene fibre. This increase in strength of soil may be due to increase in friction between soil and fibre and the development of tensile stress in the fibre.
- The unconfined compressive strength of clay increases with increasing polypropylene fibre (up to 0.2%) and thereafter decreases.
- The maximum value of ucc strength found to be 16.54 kPa for a fibre length of 6mm and fibre content of 0.2%. so the optimum fibre content and fibre length observed are 0.2% and 6mm length respectively for the polypropylene fibre.
- Inclusion of fibre in the soil results in a reduction in swelling pressure which is found to be 0.101N/mm² for fibre length 3mm and fibre content of 0.3%.
- With the addition of fibre to the soil, the change in compressibility for different percentage of fibres is only marginal.
- Compression index of unreinforced soil is higher than that of the fibre reinforced soil, also Cc of reinforced soil shows only slight variation with fibre length and percentages.
- Co-efficient of consolidation for 3mm length fibre shows the higher value of Cv and 12mm length fibre shows the lower value of Cv in 100-200kPa
- Fibre content significantly affects the compressibility of marine clay.but there has not been a general trend regarding the effect of fibre on the compressibility. The addition of randomly distributed polypropylene fibres in substantially reduces the consolidation settlement of the clay soil.

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