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The Effect of Polypropylene Fibre on the Behaviour of Soil Mass with Reference to the Strength Parameters

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***Abstract*— The stability of the soil is one of the important factor during the construction of a structure. For better performance of structures built on such soils, the performance characteristics of such soils need to be improved. The poor engineering performance of such soils has forced Engineers to attempt to improve the engineering properties of poor quality soils.This paper presents how polypropylene fibers influence on shear strength parameters of the soil. In the initial stage, the effect of polypropylene fiber on maximum dry density and optimum moisture content with different fiber inclusion were studied. Test specimens were prepared with various percentages such as 0%, 0.05%, 0.15%, 0.25%, and 0.35% with the same dry density. In the second stage unconfined compression test were carried out to determine the shear strength parameters of the soil. From this study it was observed that polypropylene fibers could be an effective method to improve the physical and mechanical properties of the subsoil with minimum percentage of reinforcement.**

Keywords—Clay, Polypropylenefiber, Unconfined compression strength, Shear strength.

I. INTRODUCTION

Soil stabilization may be broadly defined as the alteration or preservation of one or more soil properties to improve the engineering characteristics and performance of a soil ,thus improving the load bearing capacity of a subgrade to support pavements and foundation .In recent years, soil stabilization is considered of great importance in many of the civil projects [4].

The application of polypropylene fibers can be taken as a solution for several geotechnical engineering problems due to their availability, low cost and durability. The curved short fibers are randomly distributed in the soil, these reinforced soil shows more ductility compared to the unreinforced soil. It is due to the fibres are capable of taking tensile load in soil matrix, with increasing fibre content. The number of fibres per unit volume is increased and the acquired reinforcement benefit of fibres to the tensile strength was therefore more pronounced [8]. Various application of the polypropylene fiber are in the construction of embankment, sub grade, sub-base, and slope stability problems.

The main aim of this study is to evaluate the effect of polypropylene fibers on shear strength parameters of the soil. The experimental study was carried out on compacted soil specimens with 0%,0.05%,0.15%.0.25% and 0.35% polypropylene fiber additives, and the results of compaction, unconfined compression test were discussed.

II. MATERIALS

A. Soil

The clayey soil used in this study has been collected from 'Malappuram district' which is taken at a depth of 50 cm. The physical properties of the soil are as shown in table 1.

Table no.1. properties of clayey soil

soil characteristics	values
Colour	Light brown
Natural water content (%)	50.33%
Specific gravity of soil	2.41
Particle size distribution (a) Gravel (%) (b) Sand (%) (c)Silt (%) (d) Clay (%)	 4 31 52 13
Liquid limit (%)	48.5
Plastic limit (%)	29.07
Plasticity index	19.43
Shrinkage limit (%)	26.39
Classification of soil	ML
Optimum moisture content (%)	27.2
Maximum Dry Density (g/cc)	1.51
Unconfined compressive strength (kN/m^2)	15.1

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The collected soil sample was shown in fig.1

Fig.1. Collected clay

From the Standard proctor test, the MDD value obtained as 1.51g/cc and OMC value 27.2%. The compaction curve was obtained as shown in fig.3.

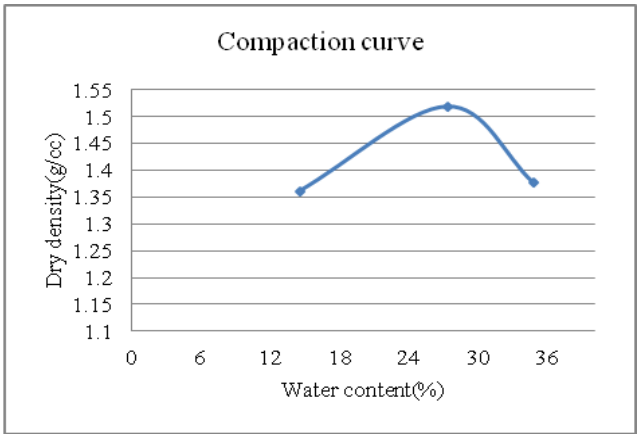

Fig .3. Compaction curve of soil.

B. Polypropylene fibre

The most commonly used synthetic material, polypropylene fiber is used in this study .This material has been chosen due to its low cost and hydrophobic and chemically inert nature which does not absorb or react with soil moisture or leachate. The high melting point of 160degree Celsius, low thermal and electrical conductivities, and high ignition point of 590 degree Celsius are other properties. The polypropylene fibers used in this study has physical properties such as specific gravity of 0.91 and an average diameter and length of 0.06mm and 20mm respectively.

Fig .4. Polypropylene fiber

Table no.2. Properties of polypropylene fiber

PPF Properties	Values
Fiber type	Single fiber
Unit weight	0.91 g/cm^3
Average diameter	0.03 mm
Average length	12mm
Breaking tensile strength	350Mpa
Modulus of elasticity	3500Mpa
Fusion point	160 degree
Burning point	590 degree
Acid and alkali resistance	Very good
Dispersibility	Excellent

III. SAMPLE PREPARATION

The air dried clayey soil samples were compacted using standard proctor test. The tests were conducted as per IS: 2720(Part-8)-1983).The unconfined compressive strength of soil sample was found out by unconfined compression test (UCC). The specimens were moulded at the maximum dry density, according to the value obtained from the standard Proctor test. Then it was extruded from the mould and tested. The amount of fiber that should be added to the soil has been calculated at various percentage of PPF according to the dry weight of the soil. The samples were mixed manually with proper care to get homogenous mix. The tests were conducted as per IS: 2720(Part-10)-1991).

IV. EXPERIMENTAL INVESTIGATIONS

A. Compaction Tests

For the determination of optimum moisture content and maximum dry density, the standard proctor test was conducted. The test used here to determine the optimum moisture content of different combinations of soil samples. A curve was obtained between the dry density and the water content.

B. Unconfined compression tests

The Unconfined compressive strength tests were carried out to determine the unconfined compressive strength of the soil sample which in turn is used to calculate unconsolidated, undrained shear strength of unconfined soil. The test specimen were prepared by compacting samples at the maximum dry unit weight and optimum moisture content determined by conducting standard proctor test. The unconfined compressive strength (q_u) is the compressive

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stress at which the unconfined cylindrical soil sample fails under simple compressive test. The experimental set up constitutes of the compression device and dial gauges for load and deformation.

The compressive load is applied to the specimen by turning the handle so as to produce an axial strain of 1.25 mm per minute. The shearing is continued till the specimen fails or till 20% of the axial strain occurs, whichever is earlier. The compressive force is determined from the proving ring reading, and the axial strain is found from the dial gauge reading.

V. RESULTS AND DISCUSSIONS

The results obtained from the standard proctor tests, unconfined compression tests have been analyzed to study the effect of polypropylene fibers on the behaviour of soils. During the investigation, it was observed that the strength of fiber reinforced clay at optimum moisture content increased with increasing amount of fibre and the moisture density relationship showes that increase in the fiber content up to 0.05% by dry weight of soil has significant effect on the magnitude of maximum dry density and optimum moisture content. The maximum dry density and optimum moisture content at different fiber contents are shown in fig.5.

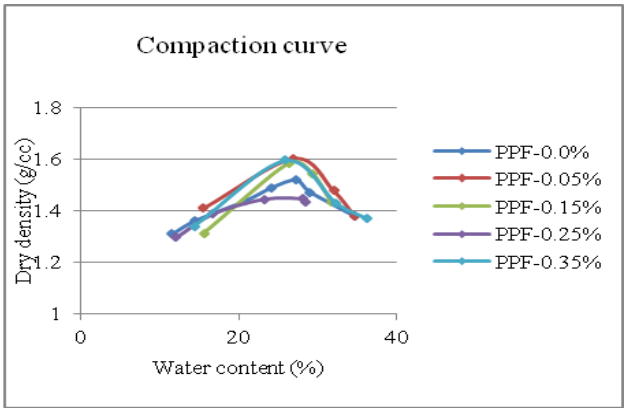

Fig .5. Compaction curve

From unconfined compressive test, it was observed that the unconfined compressive strength value of untreated soil is 15.1 KN/m^2 and the strength value is increased to 83.71KN/m^2 with increase in addition of polypropylene fiber up to 0.05% and then decreases. There is an increase of strength of about 454.37% at 0.05 % of fiber content.

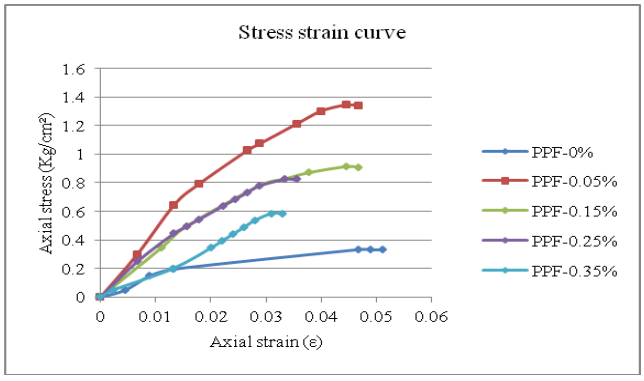

Fig .6. Axial stress Vs Axial strain curve with various PPF %

The variation of maximum values of unconfined compressive strength with respect to PPF% is shown in Table no .3. and fig .7.

Table no .3. Variation of unconfined compressive strength with various PPF%

PPF(%)	0	0.05	0.15	0.25	0.35
UCC	15.1	89.71	54.36	40.89	29.46

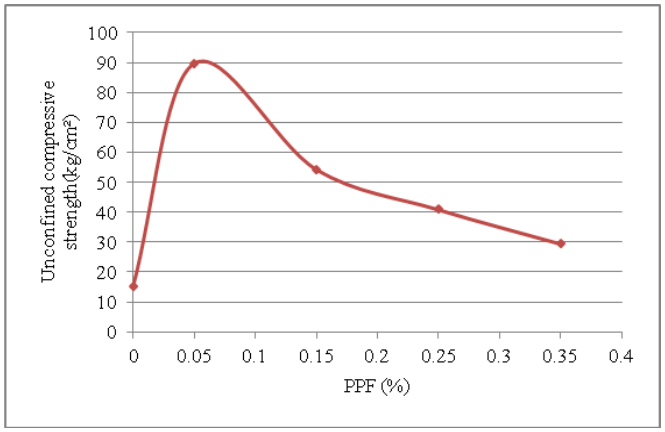

Fig .7. Variation of unconfined compressive strength with % of PPF.

VI. CONCLUSION

The fiber reinforced soil shows significant effect on the engineering characteristics and performance of a soil. The following are the main conclusion of this study on the shear strength parameter of the soil by adding polypropylene fiber.

The relationship between optimum moisture content and maximum dry density of soil significantly affected by the addition of polypropylene fiber. During the study, MDD increases with decreasing OMC.

From unconfined compressive test, it was observed that the unconfined compressive strength value of untreated soil was found to be 15.1 KN/m^2 and the strength value increased with increase in addition of polypropylene fiber up to 0.05% and then decreases. There is an increase of strength of about 454.37%.That may be due to increase in interfacial shear strength at 0.05 %.For higher amount of polypropylene fibre it shows reverse trend.

The strength is increased in low percentage of PPF addition, it ensures more economical in construction. So finally it was concluded that the polypropylene fiber can potentially stabilize the clayey soil.

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