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Influence of Polypropylene Fibre on Shear Strength Parameters of Sandy Soil

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***Abstract*— The paper tries to give brief introduction to the readers regarding strengthening of sand using polypropylene fibre, Also to study the shear strength parameters of the collected soil samples by means of direct shear test. This study mainly deals with strength behaviour of fibre reinforced soil samples we. The polypropylene fibre content in collected soil sample varied as 0%, 0.25%, 0.5%, 0.75%, 1%, 1.25%, 1.5%and 1.75% respectively. Based on this study, the polypropylene fibres were found suitable for improving soil properties.**

Keywords—Polypropylene fibers; Direct Shear test; Shear strength.

I. INTRODUCTION

In different civil engineering projects, soil stabilization is considered of great importance. The most effective method without removing whole soil is to strengthen the soil properties by using proper available methods and materials. Therefore ,soil stabilization is considered as the most suitable method to improving the shear parameters of sand. The present work aims at the effectiveness of polypropylene fibre in stabilizing the soil, and hence, it becomes suitable for construction. Improving properties of sandy soil means to make remarkable changes in C –Φ values. Due to low cost and relatively wide applicability compared to standard stabilizers like as lime, cement, gypsum etc, polypropylene fiber based stabilizers appear to have many advantages. In this study, with the help of randomly distributed polypropylene fiber (which is obtained from waste materials) an attempt has been made to improve the soil properties.

II. MATERIALS

A. Soil

A soil used in this study was taken from thrissur at a depth of about 50cm from the ground level. The soil was characterized using laboratory characterization test as per Indian standards. The physical properties of the collected soils are given in table 1.

Table no.1Properties of sandy soil

SL No	SOIL CHARACTERISTICS	VALUES
1	specific gravity of soil	2.72
2	Relative density of sand(Kg/cm^3)	1.4
3	Sieve analysis (a)Uniformity coefficient, Cu	1.6
	(b)Coefficient of curvature ,Cc	1.02
4	Angle of friction ϕ (degree)	19.83

Fig 1.Collected sandy soil

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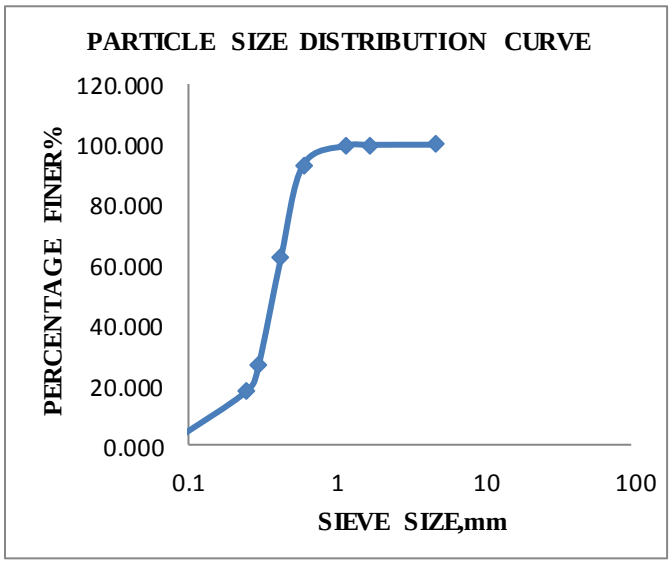

Fig 2.Particle size distribution curve

B. Polypropylene fiber

Polypropylene fiber is the most commonly used synthetic material which is used in this study .This material has been chosen due to it's low cost. Also it is hydrophobic and chemically inert in nature that is it does not absorb or react with soil moisture or leachate. The polypropylene fibers used in this study has physical properties such as specific gravity of 0.91 and an average diameter and length of 0.03 mm and 12 mm respectively. The length chosen for this study was 12 mm. The properties of polypropylene fibers are given in table 2.

Table no 2 Properties of polypropylene

Behavior Parameters	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

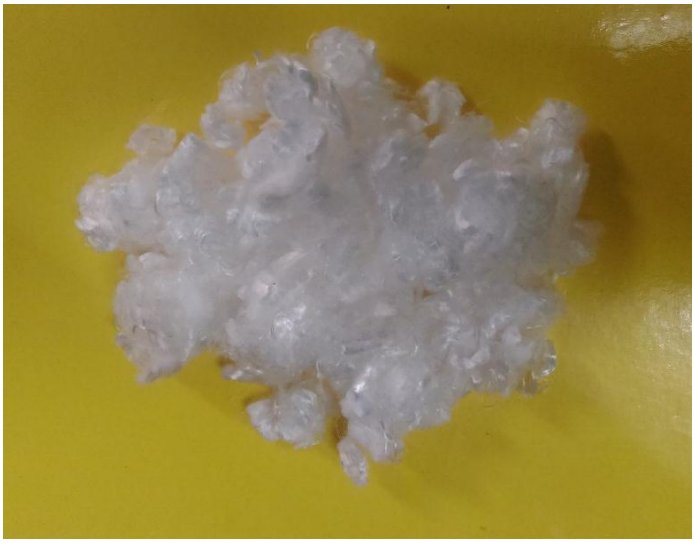

Fig 3. Polypropylene fiber

III. SAMPLE PREPARATION

Sandy soil was collected from Thrissur and it was extracted from 50cm depth from ground level. All the specimen tested were prepared by mixing relevant quantities of dry soil and PPF according to the mixture proportion and moulding specification. Polypropylene fiber is randomly mixed with sand. The added percentage of fibers were 0.25%,0.5%,0.75%,1%,1.25%,1.5%,1.75% respectively.

IV. EXPERIMENTAL WORKS

A. Direct shear test

The test was conducted as per the compendium of Indian standards of soil part 1[IS: 2720(Part13)-1986]. The soil sample taken for the study was thoroughly mixed proportion of air dried soil. Dried soil and PPF were thoroughly mixed in required proportion. Percentage of PPF added was chosen as 0.25%, 0.5%, 0.75%, 1%, 1.25%, 1.5%, and 1.75% respectively.

The Direct shear test is conducted to find out C– Φ values .That is cohesion and angle of internal friction is the soil shear parameters. To obtain one value of C-Φ ,a constant normal load is applied. At a constant rate horizontal load is increased and then applied till it attains the failure point. The shear strength S for that particular normal load is obtained by dividing this load -with the area.. The equation used is

$$S= C+ \sigma*\tan(\Phi)$$

The direct shear test were carried out by applying normal stress (σ) of 0.1Kg/m^3 ,0 .2 Kg/m^3 ,0 .3 Kg/m^3, 0.4 Kg/m^3 respectively.

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Direct shear strength gives more accuracy in determining the shear parameters of a soil sample.

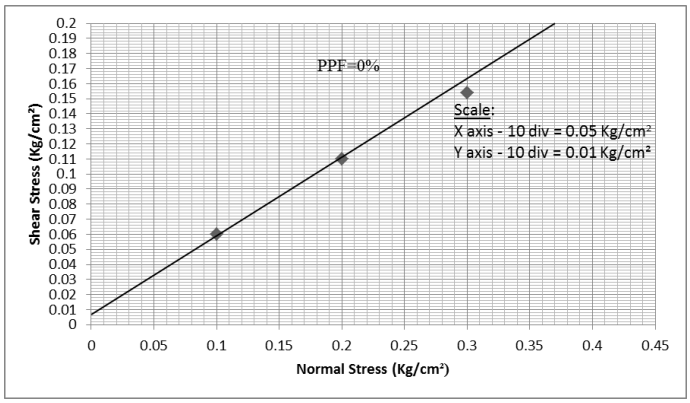
Fig 4. Shear test apparatus

V. RESULTS AND DISCUSSION

A. Direct shear test

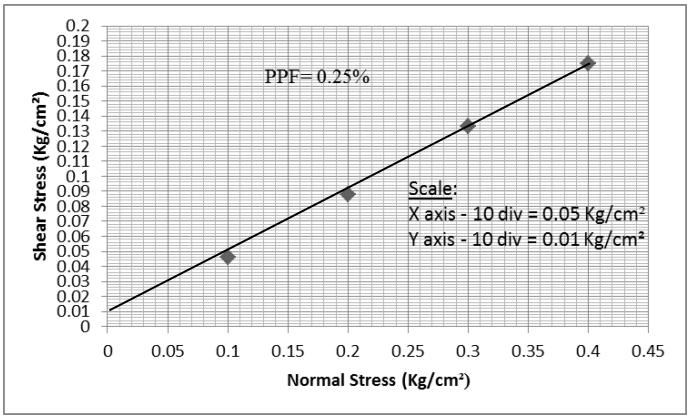
The results obtained from the direct shear tests have been analyzed to study the effect of polypropylene fibers on the strength characteristics of soils. The shear strength is increased with addition of poly propylene fibers. The shear strength was increased at 0.75% polypropylene fibers addition and further it decreases. The effect of the polypropylene fibers on the shear strength of sandy soil as given below.

i. Collected soil + 0% PPF



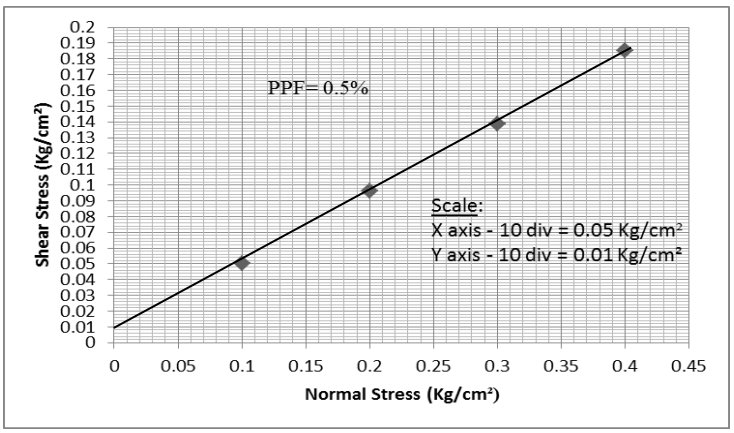
from graph for untreated sandy soil the Cohesion (C) value was obtained 0.005 Kg/m^3 and the angle of and the Angle of internal friction(Φ)was 19.83º

ii. Collected soil+ 0.25% PPF



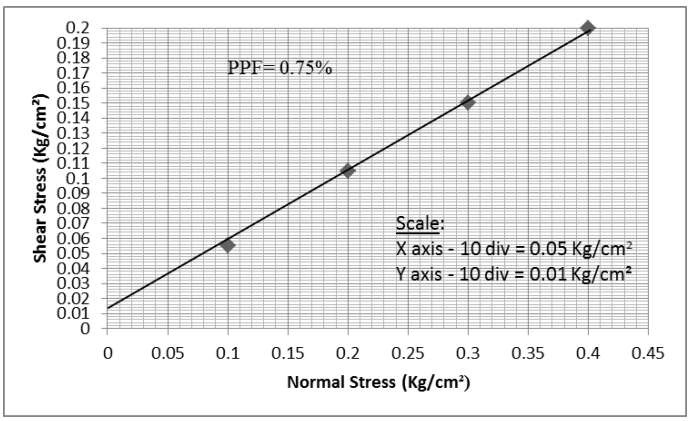
For PPF 0.25%, the Cohesion (C) value was obtained as 0 .01Kg/m^3 and the Angle of internal friction(Φ) was 23.96º.Slight increase in friction angle was observed but Cohesion intercept was less than that of untreated soil.

iii. Collected soil + 0.5% PPF



In third trial 0.5% PPF was mixed with the soil and for PPF 0.5% the Cohesion (C) value was obtained as 0 .01Kg/m^3 and the angle of internal friction (Φ) was 24.44º.

iv. Collected soil + 0.75% PPF



As the fibre content was increased,for PPF 0.75% the Cohesion (C) value was obtained as 0.012 Kg/m^3 and the angle of internal friction (Φ) was 26.91º.

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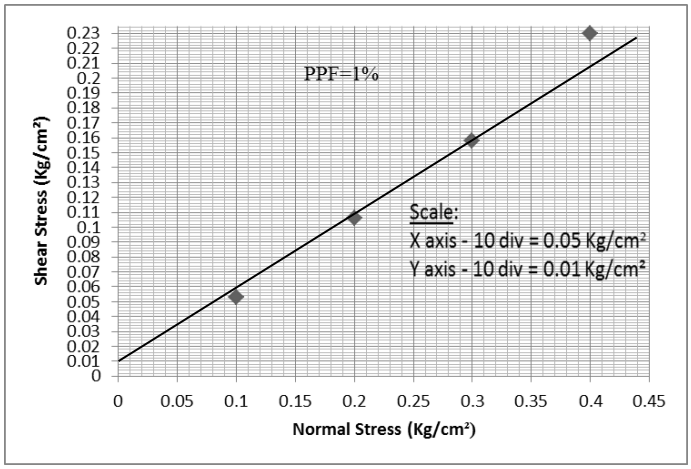
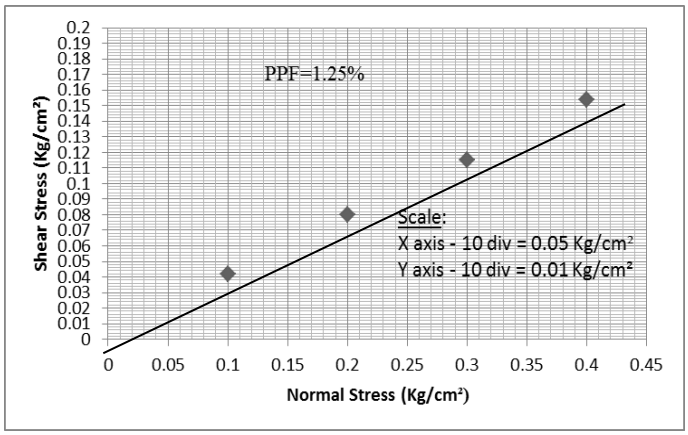
v. Collected soil +1% PPF



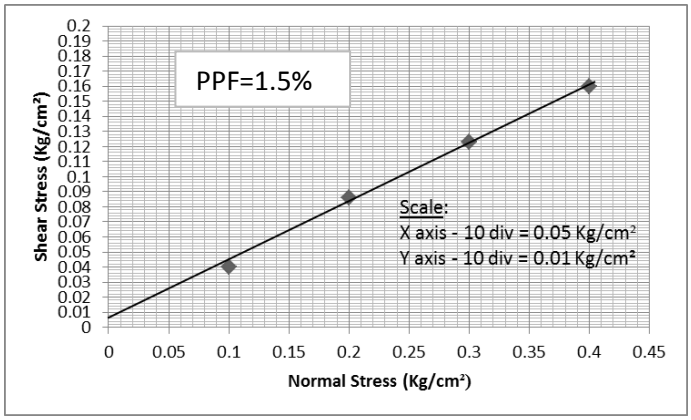
On adding PPF 1% the Cohesion (C) value was obtained as 0 .01Kg/m^3 and the angle of internal friction (Φ)was decreased and compared to the previous trial. Angle of shearing resistance was found to be 23.198º.

vi. Collected soil + 1.25% PPF



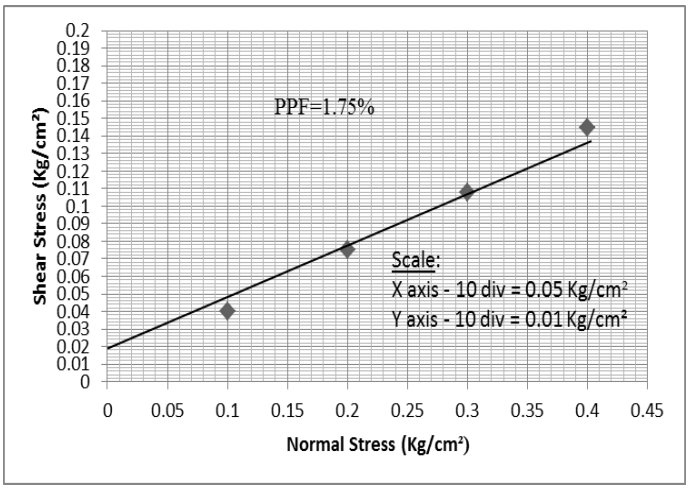
For PPF 1.25% , the Cohesion (C) value was 0.005 Kg/m^3 and the Angle of internal friction (Φ) was 21.8º.In this percentage both the C and Φ values found to be deceasing.

vii. Collected soil + 1.5% PPF



On addition of 1.5% PPF with the soil, the Cohesion (C) value was obtained as 0.005 Kg/m^3 and the Angle of internal friction (Φ) was 21.09^0.

viii. Collected soil + 1.75% PPF



On adding PPF 1.75% the Cohesion (C)value is obtained 0.019 Kg/m^3 and the Angle of internal friction (Φ) =18.4^0.

As the percentage of polypropylene increases, magnitude of shear parameters goes on decreasing. This may be due to the change of interfacial friction between the soil particles and fibers and their replacement.

From values obtained for C and Φ,shear strength of the soil was found out. Variation in shear strength of collected soil sample is as shown in table 3.From the results obtained ,0.75% PPF was found to be most effective for the soil sample.

Table:3 Variation in shear strength of soil

Percentage of PPF	Shear strength(Kg/cm^2)
0%	0.053
0.25%	0.067
0.5%	0.349
0.75%	1.897
1%	1.060
1.25%	0.72
1.5%	0.50
1.75%	0.154

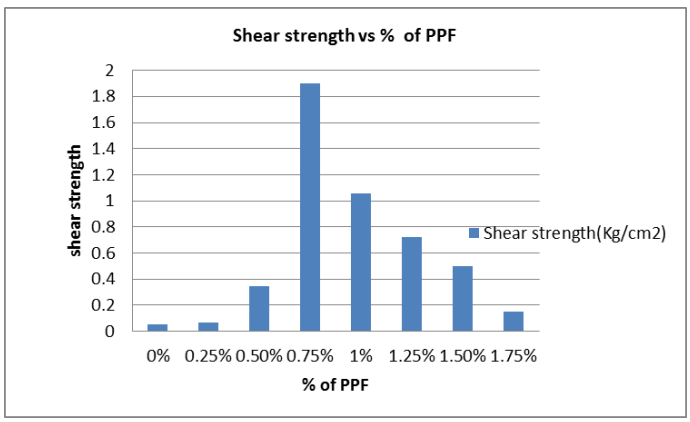


Fig 5. Shear strength vs % of PPF

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VI. CONCLUSION

The task of ground improvement is due to reducing cost of construction of project works. In terms of technical capabilities to face this challenge soil stabilization method is adopted. The following are the conclusion of this study on the shear strength parameters of the soil by adding PPF.

Addition of polypropylene fiber in sandy soil enhance the shear strength of the soil. From direct shear test it is observed that the Φ value of the untreated soil is 19.8° and the Φ value increases with increase in addition of polypropylene fiber upto0.75% and then decreases.

Based on the above experimental results it is noticed that the Φ value of soil has been increased by26.3% on addition of 0.75% polypropylene fiber. The strength is increased in low percentage of PPF addition. This may be due to the interfacial friction between soil and fibre. The mechanism of continuous fiber randomly distributed on the soil summarized as bending mechanism. Bending mechanism is that fiber in the distribution of the soil is composed of numerous curved transition .When the soil withstood external force, the fiber is in tension, the pressure and friction of particles are produced by the earlier concave fiber which play the role on soil.

But inclusion of higher amount of polypropylene fiber gives lesser strength to the sandy soil. The strength is increased in the low percentage of PPF addition, it ensure more economical construction.

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