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A STUDY ON SOIL STABILIZATION USING POLYPROPYLENE, PLASTIC AND COCONUT FIBERS

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Abstract: Soil having poor bearing and shearing strength need stabilization to make it suitable for construction purpose. If the soil is weak and has not enough stability to resist heavy loading, the soil should be reinforced and stabilized. As the quality of the soil is increased, the ability of the soil to distribute the load over a greater area is generally increased. Soil stabilization refers to alteration of soil properties to improve the stability or bearing power of the soil by controlled compaction, proportioning or by adding admixtures. Soil stabilization can be done by different methods like mechanical, chemical stabilization or by using different types of admixtures. The samples are prepared at their respective maximum dry density and optimum moisture content. From the study, it is observed that the friction angle increases by 26% at fiber content of 0.5% and fiber length of 6mm. The fiber reinforced low plasticity clay exhibited crack fracture and surface shear fracture failure modes, implying that polyester fiber is good earth reinforcement material with potential applications in civil engineering.

***Index Terms* - Optimum Moisture Content , Maximum Dry Density, tri axial test, California Bearing Ratio.**

1. INTRODUCTION

Soil Stabilization is the biological, chemical or mechanical modification of soil engineering properties. In civil engineering, soil stabilization is a technique to refine and improve the engineering properties of soils. These properties include mechanical strength, permeability, compressibility, durability and plasticity. Physical or mechanical improvement is common but some schools of thought prefer to use the term ‘stabilization’ in reference to chemical improvements in the soil properties by adding chemical admixtures.

For any construction project, whether it’s a building, a road or an airfield, the base soil acts as the foundation. Additionally, soil is one of the crucial construction raw materials. As such, the soil should possess properties that create a strong foundation.

The practice of stabilizing or modifying soils dates back to the age of the Romans. Other nations such as the United States and China among many others adopted it in the latter half of the20thcentury.

1.1 *What is the purpose of soil stabilization?*

There are several reasons for it and these reasons include:

1. Substituting poor grade soils with aggregates possessing more favorableengineering properties.
2. Enhancement of the strength and therefore bearing capacity of the soil.
3. Dust control for a good working environment.
4. Waterproofing for conservation of natural or manmade structures.
5. To promote the use of waste geo materials in constructions.
6. Finally, enhancing the properties of soil on site.

Not all sites offer favorable construction conditions. At such sites, a contractor usually has six main reasons why soil stabilization is needed as described above. Reasons 1,2, 3 and 4 are more chemical and mechanical soil stabilization, whereas reason 5 is biological and mechanical stabilization. Today, with better research and more effective equipment and materials, soil stabilization for reason 6 involves choosing the best suitable technique which achieves the deliverables of the soil stabilization project according to prior cost-benefit analysis. Some definitions of soil stabilization also refer to the process as soil modification of steady or weak soil.

Fig. 1: Soil Stabilization

1.2 *What are the benefits of Soil Stabilization?*

- Offers erosion and sediment control and by controlling both we are attemptingto maintain the most productive layer of the soil, the topsoil in place.
- Places barriers that prevent the movement of air and water over the soil thatcarry away soil particles.
- Makes weak or sub-optimal soil stronger.

such as large lakes and marine basins.

2. LITERATURE REVIEW

Peddaiah, S., Burman, A. & Sreedeep, S Experimental Study on Effect of Waste Plastic Bottle Strips in Soil Improvement With rapid advancements in technology globally, the use of plastics such as polyethylene bags, bottles etc. is also increasing. The disposal of thrown away wastes pose a serious challenge since most of the plastic wastes are non-biodegradable and unfit for incineration as they emit harmful gases. Soil stabilization improves the engineering properties of weak soils by controlled compaction or adding stabilizers like cement, lime etc. but these additives also have become expensive in recent years. This paper presents a detailed study on the behavior and use of waste plastic in soil improvement.

Anas Ashraf, Arya Sunil, J. Dhanya, Mariamma Joseph, Meera Varghese, M. Veena, investigated Soil stabilization using raw plastic bottles. The analysis was done by conducting plate load tests on soil reinforced with layers of plastic bottles filled with sand and bottles cut to halves placed at middle and one third positions of tank. The comparison of test results showed that cut bottles placed at middle position were the most efficient in increasing strength of soil.

Gray and Ohashi in 1983 conducted a series of direct shear tests on dry sand reinforced with different synthetic, natural and metallic fiber to evaluate the effects of parameters such as fiber orientation, fiber content, fiber area ratios, and fiber stiffness on contribution to shear strength. Based on the test results they concluded that an increase in shear strength is directly proportional to the fiber area ratios and shear strength envelopes for fiber-reinforced sand clearly shows the existence of a threshold confining stress below which the fiber tries to slip or pull out.

3.MATERIAL AND THEIR PROPERTIES

3.1Materials:

Materials used in this project were

2.1.1. Soil.
2.1.2. PPE fiber.
2.1.3. Coconut fiber.
2.1.4. Plastic fiber.

3.1.1 *Soil*

Source of soils:

Two soil samples are collected from on going NHAI project from Development of six lane chittoor-thatchoor Highway of NH716B km 61+380 (veera kaverirajapuram) to 96+040(pondavakkam).

Various tests

3.1.1.1 Specific Gravity.
3.1.1.2 Liquid Limit.
3.1.1.3 Plastic Limit.
3.1.1.4 Pasticity Index.
3.1.1.5 Sieve Analysis.
3.1.1.6 Standard Proctor Test

3.1.1.3 *Specfic Gravity of Soil Sample:*

Objective:

To determine the specific gravity of a soil sample.

Scope:

This method covers the determination of specific gravity of soil of medium and course after sieving through sieve No. 7. The density of a substance is the mass per unit volume of that substance. The relative density is the density of a substance with reference to density water.

Formula for Specific Gravity

$$G = \frac{M_2 - M_1}{(M_2 - M_1) - (M_3 - M_4)}$$

Where M1 = mass of empty bottle,
M2 = mass of the empty bottle with dry soil
M3 = mass of the empty bottle and soil and water,
M4 = mass of empty bottle filled with water only.

G = Specific gravity of soils

Specific Gravity: Table. 1: Soilsample-1

Sample number	1	2	3
Mass of empty bottle (M1) in gms.	128.41	118.67	122.16
Mass of bottle + dry soil (M2) in gms.	178.41	168.67	172.16
Mass of bottle + dry soil + water (M3) in gms.	401.86	396.29	399.03
Mass of bottle + water (M4) in gms.	369.67	365.378	367.355
Specific gravity	2.81	2.62	2.73
Avg. Specific Gravity	**2.72**		

Table.2 : Soilsample-2:

Sample number	1	2	3
Mass of empty bottle (M1) in gms.	112.45	114.93	115.27
Mass of bottle + dry soil (M2) in gms.	162.45	164.93	165.27
Mass of bottle + dry soil + water (M3) in gms.	390.088	395.38	398.16
Mass of bottle + water (M4) in gms.	359.448	364.07	367.87
Specific gravity	2.58	2.68	2.54
Avg. specific Gravity	**2.60**		

RESULT:

1. Specific gravity of soil sample 1=2.72.
2. Specific gravity of soil sample 2=2.60.

3.1.1.4 Determination of Liquid Limit of Soil

Objective:

From liquid limit test, the compression index may be estimated, which is used in settlement analysis. If the natural moisture content of soil is higher than liquid limit, the soil can be considered as soft and if the moisture content is lesser than liquid limit, the soil is brittle and stiffer. The value of liquid limit is used in classification of the soil and it gives an idea about plasticity of the soil.

6. Calculation:

A flow curve' shall be plotted on a semi logarithmic graph representing water content on the arithmetical scale and the number of drops on the logarithmic scale.

Flow index,

$$I_f = (W1-W2)/ \log_{10}(N2/N1)$$

Where,

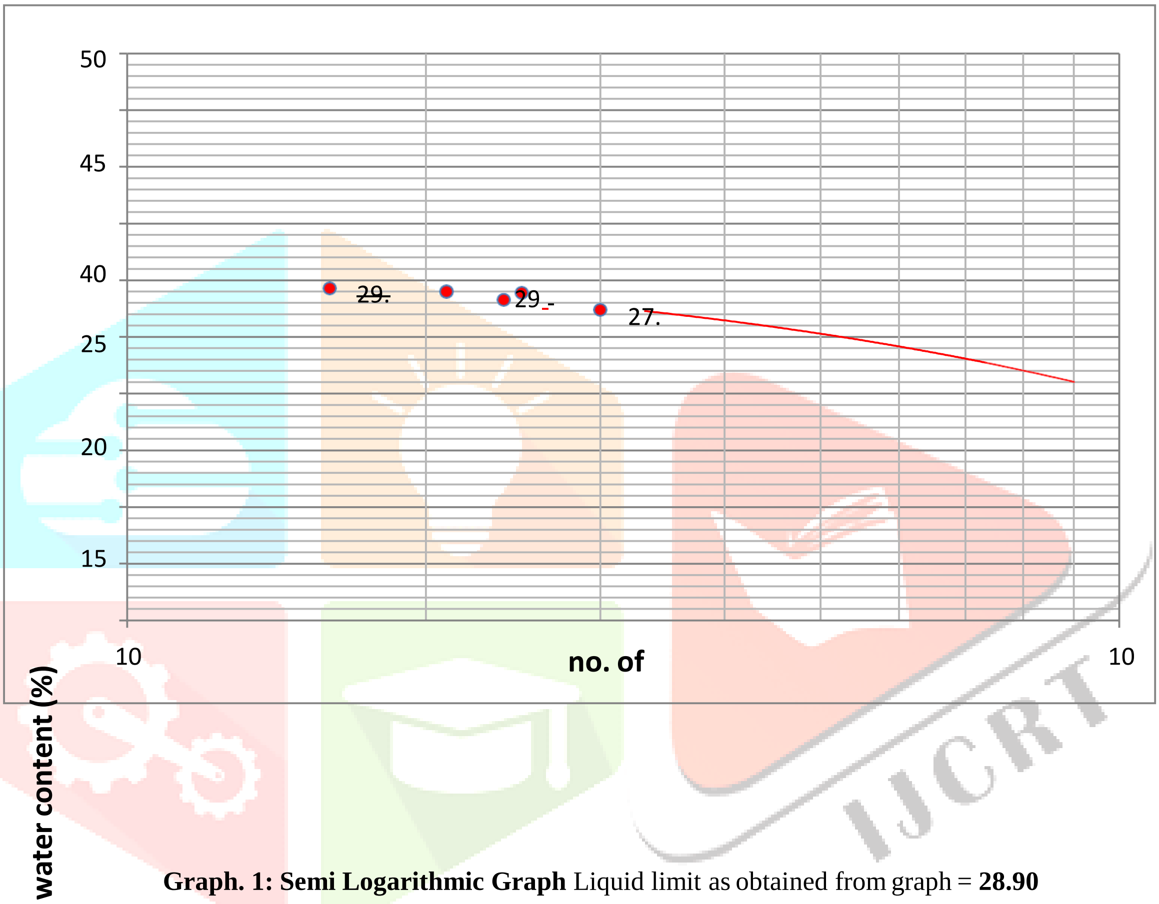
If = Flow Index

W1 = Moisture content in percentage corresponding to N1 drops andW2 =

Moisture content in percentage corresponding to N2 drops

Table.3: Soil sample- 1

Sample No.	1	2	3	4	5
Mass of empty can	13.00	12.38	13.58	12.56	13.4
Mass of can + wet soil in gms.	50.70	47.60	48.00	36.60	50.00
Mass of can + dry soil in gms.	42.60	39.70	40.40	31.20	41.70
Mass of soil solids	29.60	27.32	26.82	18.64	28.30
Mass of pore water	8.10	7.90	7.60	5.40	8.30
Water content (%)	27.40	28.90	28.30	29.00	29.30
No. of blows	30	25	24	21	16



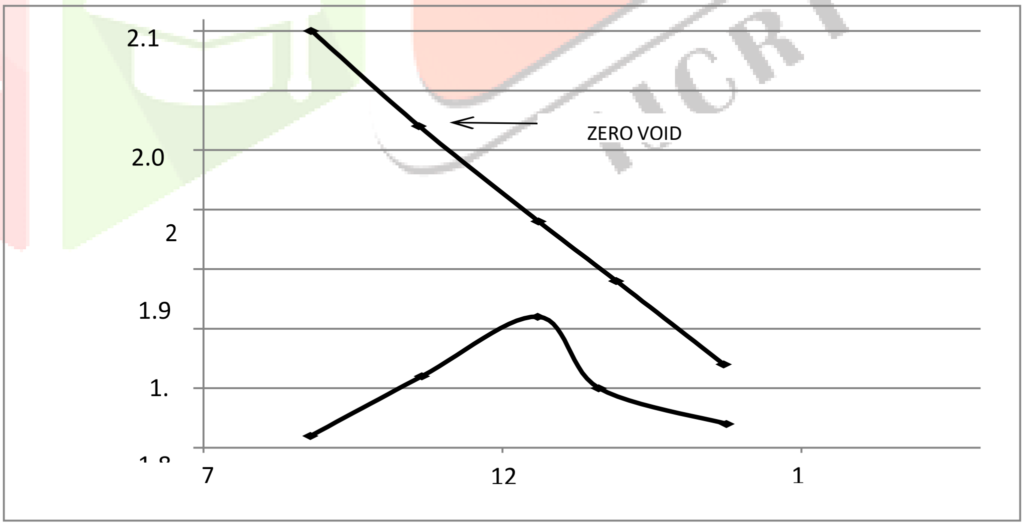
Graph. 1: Semi Logarithmic Graph Liquid limit as obtained from graph = **28.90**

Standard Proctor TestTheory:

In geotechnical engineering, soil compaction is the process in which a stress applied to a soil causes densification as air is removed from the pores between the soil grains. It is an instantaneous process and always takes place in partially saturated soil (three phase system). TheProctor compaction test is a laboratory method of experimentally determining the optimal moisture content at which a given soil type will become most dense and achieve its maximumdry density.

Table.9: Standard Proctor Compaction TestSoil Sample - 1

Test No.	1	2	3	4	5
Weight of empty mould(W_m) gms	2059	2059	2059	2059	2059
Internal diameter of mould (d) cm	10	10	10	10	10
Height of mould (h) cm	13	13	13	13	13
Volume of mould (V)=(π/4) d^2h cc	1000	1000	1000	1000	1000
Weight of Base plate (W_b) gms	2065	2065	2065	2065	2065
Weight of empty mould + base plate (W') gms	4124	4124	4124	4124	4124
Weight of mould + compacted soil + Base plate (W_1) gms	6089	6179	6271	6086	6080
Weight of Compacted Soil (W_1-W') gms	1965	2055	2147	2108	2102
Container no.	20.15	21.15	19.47	21.49	21.12
Weight of Container (X_1) gms	20.19	21.14	19.48	21.55	21.14
Weight of Container + Wet Soil (X_2) gms	84.81	124.16	89.93	154	113
Weight of Container + dry soil (X_3) gms	79.59	114.24	82.05	138.13	100.5
Weight of dry soil (X_3-X_1) gms	59.4	93.1	62.57	116.58	79.36
Weight of water (X_2-X_3) gms	5.22	9.92	7.88	15.87	12.5
Water content W%= X_2-X_3/X_3-1	8.79	10.65	12.59	13.61	15.75
Dry density Υ_d= V_t/1 + (W/100) gm/cc	1.81	1.86	1.91	1.85	1.82



Graph.5: From the Figure on the left side, it is Evident that,

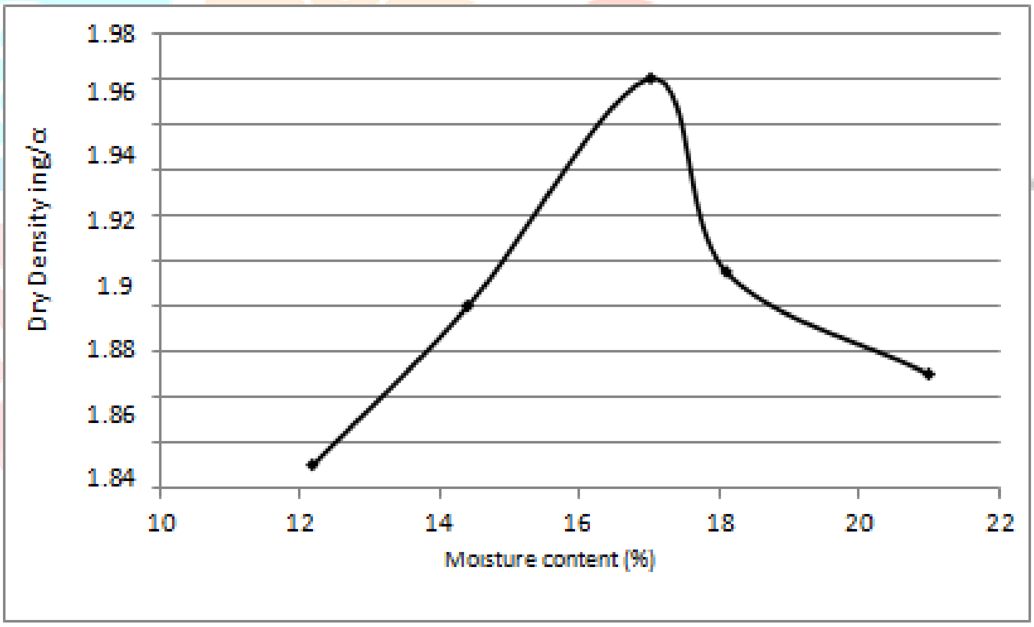
Optimum Moisture Content (OMC) = 12.6%

Maximum Dry Density (MDD) = 1.91 g/cc

Table.10: Standard Proctor TestSoil

Sample – 2

Test No.	1	2	3	4	5
Weight of empty mould(Wm) gms	2062	2062	2062	2062	2062
Internal diameter of mould (d) cm	10	10	10	10	10
Height of mould (h) cm	13	13	13	13	13
Volume of mould (V)=(π/4) d2h cc	1000	1000	1000	1000	1000
Weight of Base plate (Wb) gms	2071	2071	2071	2071	2071
Weight of empty mould + base plate (W') gms	4133	4133	4133	4133	4133
Weight of mould + compacted soil + Base plate (W1) gms	6174	6261	6427	6347	6348
Weight of Compacted Soil (W1-W') gms	2041	2128	2294	2214	2215
Container no.	19.47	21.15	21.12	20.15	21.49
Weight of Container (X1) gms	19.49	21.6	21.14	20.19	21.55
Weight of Container + Wet Soil (X2) gms	90.21	122.57	113.12	125.00	119.28
Weight of Container + dry soil (X3) gms	82.51	110.04	99.74	108.94	102.32
Weight of dry soil (X3-X1) gms	63.02	88.87	78.6	88.75	80.77
Weight of water (X2-X3) gms	7.7	12.53	13.38	16.06	16.96
Water content W%= X2-X3/X3-X1	12.18	14.4	17.02	18.1	21
Dry density ϒd= ϒt/(1 + (W/100)) gm/cc	1.79	1.86	1.96	1.875	1.83



Graph.6: Standard Proctor Test

From the figure on the left side, it is evident that,
Optimum Moisture Content (OMC) = 17.02% Maximum Dry Density (MDD) = 1.96 g/cc

3.1.2 *Polypropylene Fiber*

Polypropylene Fiber is the most widely used 100 % synthetic Fiber that is prepared from 85 % of propylene. This is used in this research because of its properties like low cost and chemically inert nature, which block the moisture content.

Fig.4: Polypropylene Fiber

Polypropylene Fiber Properties:

Polypropylene Fiber (PPF) is a kind of linear polymer synthetic Fiber obtained from propylene polymerization. It has some advantages such as light weight, high strength, high toughness, and corrosion resistance.

Polypropylene fibers have a softening point in the region of 140°C and a melting point at 165°C. At temperatures of -70°C or lower, PP fibers retain their excellent flexibility. At higher temperature (but below 120°C) PP fibers nearly remain their normal mechanical properties. PP fibers have the lowest thermal conductivity of all commercial fibers. In this respect, it is the warmest fiber of all.

Property	Polypropylene
Unit weight (gr/cm^3)	0.9-0.91
Reaction with water	Hydrophobic
Tensile strength (MPa)	300-400
Elongation at break (%)	100-600
Melting point (◦C)	175
Thermal conductivity (W/m/K)	0.12
Length (mm)	6

Fig.5: Properties of Polypropylene Fiber

3.1.3 *Coconut Fiber*

Coir, also called coconut Fiber, is a natural Fiber extracted from the outer husk of coconut and used in products such as floor mats, doormats, brushes, and mattresses. Coir is the fibrous material found between the hard, internal shell and the outer coat of a coconut.

Fig.6: Coconut Fiber

Coconut Fiber PropertiesFiber Length

Fiber length varies. Being a natural fiber, there are always going to be fibers of different lengths present (length distribution or fiber array). Cotton fiber length is measured and reported as the upper half mean length (average length of the longest 50% of fibers) to an accuracy of onehundredth of an inch.

Fiber Diameter

A larger fiber diameter creates a more open structure, but one with less efficiency. Fiberscan be round or angular in shape. An angular fiber typically provides a higher surface area than around fiber and raises efficiency.

Properties	Value
Fiber length (mm)	50-110
Fiber diameter (mm)	0.1-0.406
Average tensile strength(N/mm^2)	150
Specific gravity	1.12-1.15
Elongation (%)	10-25

Fig.7: Properties of Coconut Fiber

3.1.4 *Plastic Fiber*

Plastic optical fiber (POF) or polymer optical fiber is an optical fiber that is made outof polymer. Similar to glass optical fiber, POF transmits light (for illumination or data) through the core of the fiber. Its chief advantage over the glass product, other aspect being equal, is its ability to withstand under bending and stretching.

Fig.8: Plastic Fiber

PLASTIC FIBER PROPERTIES

Plastic Fiber is made by polymethyl methacrylate (PMMA), a synthetic resin produced from the polymerization of methyl methacrylate. A transparent and rigid plastic, PMMA is often used as a substitute for glass in products such as shatterproof windows, skylights, illuminated signs, and aircraft canopies.

Plastic Fiber is coated with Teflon for increasing Fiber flexibility and light transmission .Core refractive index determines how much the path of light is bent, or refracted, when enteringa material.

Most fibers can be bent up to 25mm (R25) without risk of damage.limiting bending radius for plastic Fiber is 8*diameter of Fiber.

Basic properties	Values
Core material	PMMA
Cladding material	PMMA/Teflon
Diameter (mm)	0.5
Core refraction index	1.49
Cladding refraction index	1.42
Numerical aperture	0.44
Acceptance angle (°)	52.2
Storage temperature (°C)	-20 to +70
Specific gravity (g/cm^3)	1.19
Wavelength (nm)	400–780
Limit of bending radius	8 × fibre diameter

Fig.9 : Properties of Plastic Fiber

4. EXPERIMENTAL INVESTIGATIONS

4.1 Preparation of Samples

The two soil samples are mixed with different fibers various percentages 0%, 0.05%, 0.15%, 0.25%, and direct shear test is conducted individually on two samples using threedifferent fibers to obtain the results of cohesion (C) and angel of friction (FI).

4.2 Types of Fibers Used in the Experimental Investigation

1. PP Fiber
2. Coconut Fiber
3. Plastic Fiber

Following steps are carried out while mixing the fiber to the soil-

- All the soil samples are compacted at their respective maximum dry density (MDD) and optimum moisture content (OMC), corresponding to the standard proctor compaction tests
- Content of fiber in the soils is herein decided by the following equation:

$$\rho_f = \frac{W_f}{W}$$

Where, ρf = Ratio of fiber content

Wf = Weight of the fiber

W = Weight of the air-dried soil

- The different values adopted in the present study for the percentage of fiber reinforcement are 0, 0.05, 0.15, and 0.25.
- In the preparation of samples, if fiber is not used then, the air-dried soil was mixed with an amount of water that depends on the OMC of the soil.
- If fiber reinforcement was used, the adopted content of fibers was firstmixed into the air-dried soil in small increments by hand, making sure that allthe fibers were mixed thoroughly, so that a fairly homogenous mixture is obtained, and then the required water was added.

The following Test was conducted on the soil samples mixed with the PP Fiber:

1. Direct Shear Test

4.3 Direct Shear Test Conducted on Two Soil Samples Reinforced with PPFiber:

Shear strength of a soil is its maximum resistance to shearing stresses. The shear strength is expressed asWhere C' = Effective cohesion $\overline{\sigma}$ = Effective stress Φ = Effective angle of shearing resistance Using direct shear test, one can find out the cohesion and angle of internal friction of soil which are useful in many engineering designs such as foundations, retaining walls, etc. This test can be performed in three different drainage conditions namelyunconsolidated-undrained, consolidated-undrained and consolidated- drained conditions. In general, cohesionless soils are tested for direct shear in consolidated drained condition.

$$s = c' + \overline{\sigma} \tan \phi'$$

Apparatus Required for Direct Shear Test

Fig.13: Direct Shear Test Apparatus

Test Procedure of Direct Shear Test

Fig 14: Shear Box,Porous Stones, Grid Plates, Loading pad

ANALYSIS:

(1) Calculate the density of the soil sample from the mass of soil and volume ofthe shear box.

(2) Convert the dial readings to the appropriate length and load units and enterthe values on the data sheet in the correct locations. Compute the sample area A, and the vertical (Normal) stress s_v.

$$\mathbf{S_V = N_V/A}$$

Where: N_V = normal vertical force, and s_V = normal vertical stress

(3) Calculate shear stress using $\mathbf{t = F_h/A}$

Where F_h = shear stress (Measured with shear load gauge)

(4) Plot the horizontal shear stress (T) versus horizontal (lateral)displacement H.

(5) Calculate the maximum shear stress for each test.

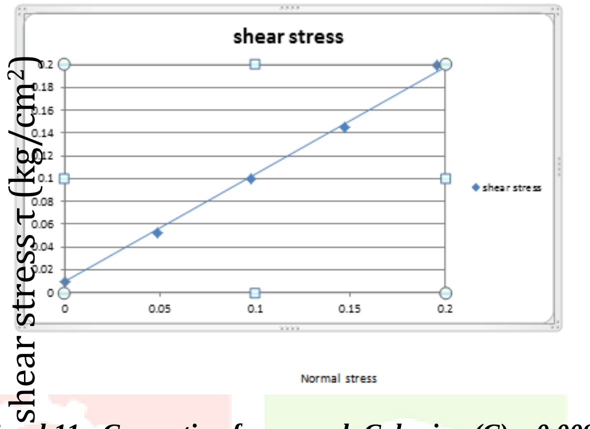
(6) Plot the value of maximum shear stress versus the corresponding vertical stress for each test and determine the angle of internal friction (Φ) from the slope of the approximated Mohr – Coulomb failure envelop.

4.3.1 DIRECT SHEAR TEST

The test is conducted on soil sample 1 & 2 with addition of PP fiber in percentages 0%, 0.05%,0.15%,0.25%

Table.11: Soil sample- 1

Volume of shear Box	90 cm3
Maximum dry density of soil	1.91 gm/cc
Optimum moisture content of soil	12.6 %
Weight of the soil to be filled in the shear box	1.91x90 = 171.9 gm
Weight of water to be added	(12.6/100)x171.9= 21.66 gm



Graph11.: Computing from graph,Cohesion (C) = 0.009N/mm^2 Angle of internal friction (φ) =46°

Shear strength for soilsample-1 for 0.25% fiber reinforcement:

S_{ss1} at 0.05% $S=C+\sigma \tan\varnothing$

$=0.009+0.2\tan46°$

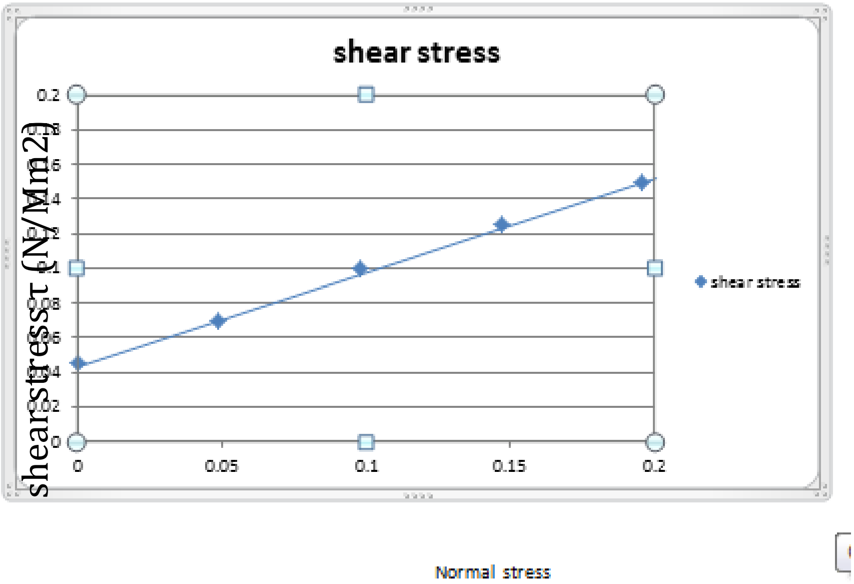
$S_{ss1\,at\,0.25\%}=0.21N/mm^2$

4.3.1.6 Direct shear test conducted on soil sample -2 with mixing of 0.05%PPE Fiber:

Table.16: Soil Sample - 2

Sample no.	*Normal load (ς)*	*Proving ring reading*	*Shear load (N)*	*Shear stress (N/mm^2)*
1	*0.49*	*53*	*202.86*	*0.07*
2	*0.098*	*75*	*286.74*	*0.1*
3	*0.147*	*96*	*367.20*	*0.125*
4	*0.196*	*117*	*447.66*	*0.13*

A graph is plotted by taking normal stress on X – axis and shear stress on Y – axis. Thevalue of (C) and (Φ) obtained form the graph



Graph.12: Computing from graph,

Cohesion (C) = 0.046 N/mm^2 ; Angle of internal friction (ϕ) =29°

Shear strength for soilsample-2 for 0.05% fiber reinforcement:

S=C+σ tanØ

S_{ss1} at 0.05% =0.0046+0.13tan29°

$S_{ss1 at 0.25\%=0.11N/mm^2}$

4.1.3.16 RESULTS OF DIRECT SHEAR TEST WHEN SOIL SAMPLES ARE MIXED WITH PLASTIC FIBER.

1.when soil sample -1 is mixed with plastic fiber of 0.05% percentage:

Cohesion (C) = 0.041N/mm^2

Angle of internal friction (ϕ)= 28°

$S_{ss1 at 0.05\%=0.11N/mm^2}$

2.when soil sample -1 is mixed with plastic fiber in 0.15% percentages:

Cohesion (C) = 0.034N/mm^2

Angle of internal friction (φ) = 34°

$S_{ss1 at 0.15\%=0.14N/mm^2}$

3. when soil sample -1 is mixed with plastic fiber in 0.25% percentage:

Cohesion (C) = 0.024 N/mm^2

Angle of internal friction (φ) = 36°

$S_{ss1 at 0.25\%=0.15N/mm^2}$

4.From Direct shear test conducted for Soil Sample-1 mixed with Plastic fiber the maximum value of angle of internal friction (ϕ)and minimum value of cohesion (C) obtains at when soil sample-1 is mixed with PPE fiber at 0.25% of fiber reinforcement .

the values are Cohesion(C)=0.024N/mm^2,Angle of internal friction(φ)=36°. $S_{ss1 at 0.25\%=0.15N/mm^2}$

4. when soil sample -2 is mixed with plastic fiber in 0.05% percentage

Cohesion (C) = 0.049 N/mm^2

Angle of internal friction (ϕ) = 29°

$S_{ss2 at 0.25\%=0.1N/mm^2}$

5. when soil sample -2 is mixed with plastic fiber in 0.15% percentage

Cohesion (C) = 0.028 N/mm^2.

Angle of internal friction (ϕ) = 34.

$S_{ss2at\ 0.25\%=0.11N/mm^2}$

6. when soil sample -2 is mixed with plastic fiber in 0.25% percentage

Cohesion (C) = 0.019N/mm^2

Angle of internal friction (ϕ) = 36°

Shear strength $S_{ss2at\ 0.25\%=0.14N/mm^2}$

RESULTS AND DISCUSSIONS

Test Results

Direct shear test done to investigate the effect of addition of fiber content with soil. The addition of different fiber content in percentages was taken at 0%,0.05%, 0.15%,0.25%. The test results of the experimental investigations performed on soil and fiber content are tabulated in the Table 5 to 7. The test results are also shown graphically in the Graphs 1 to 3.

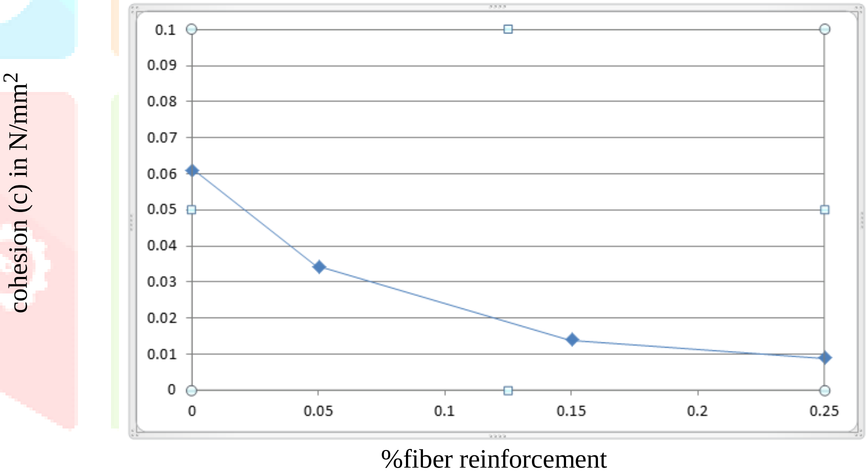
Discussions :

5.1 The relationship between shear strength parameters and fiber content for PP fiber.

5.1.1 cohesion and %fiber reinforcement:

Soil sample- 1:

A graph is plotted between cohesion and percentage of fiber reinforcement and its was found that their sharp decreases of 42% in cohesion from 0% to 0.05%increase in fiber reinforcement and decreases of 57% from 0.05% to0.15% increase in fiber reinforcement .Further increase in reinforcement 0.15 %to 0.25% cohesion decrease by 33%.



Soil sample-2:

A graph is plotted between cohesion and percentage of fiber reinforcement and its was found that their decrease of 14% in cohesion from 0% to 0.05% increase in fiber reinforcement and decrease of 46% from 0.05% to0.15% increase in fiber reinforcement.further increase in reinforcement 0.15 %to 0.25% cohesion decreases by 40%.

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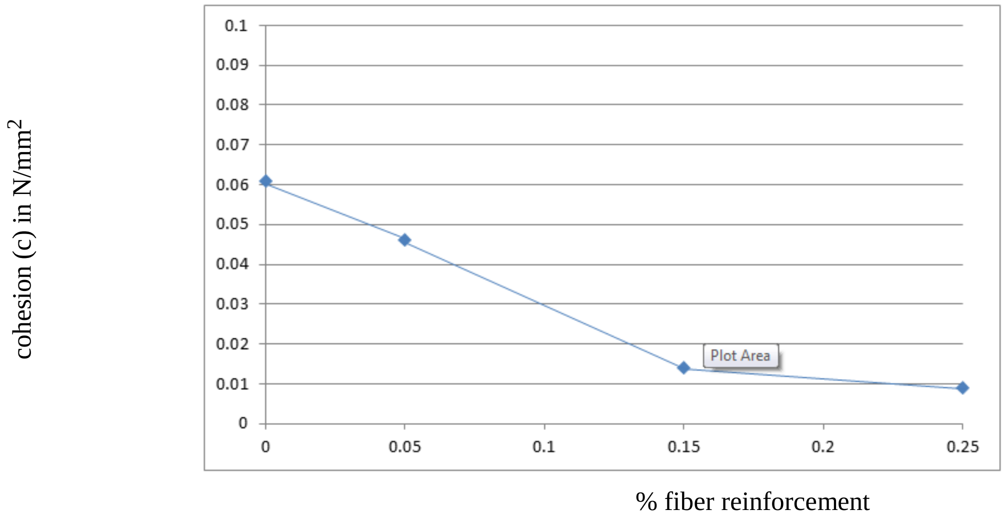
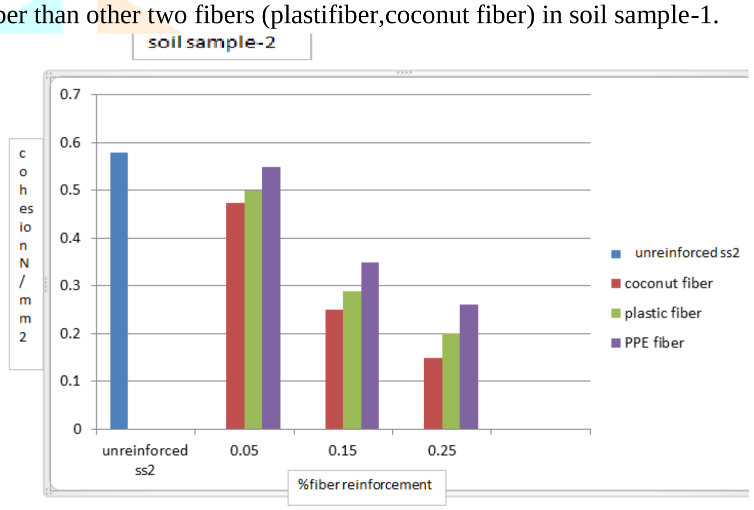


Cohesion :

For soil sample-2:

As the %percentage of fiber reinforcement increases from 0.05% to 0.25% the cohesion decreases hence in soil sample -2 the cohesion decreased from 0.0463N/mm2 to 0.014N/mm2 from the results in PPE fiber. The decrease in cohesion is more in PPE fiber than other two fibers (plastifiber,coconut fiber) in soil sample-1.



- The decrease in cohesion in soil sample -2 for Plastic fiber from 0.049N/mm2 to 0.019N/mm2.
- The decrease in cohesion in soil sampl-2 for coconut fiber from0.049N/mm2 to 0.025N/mm2.

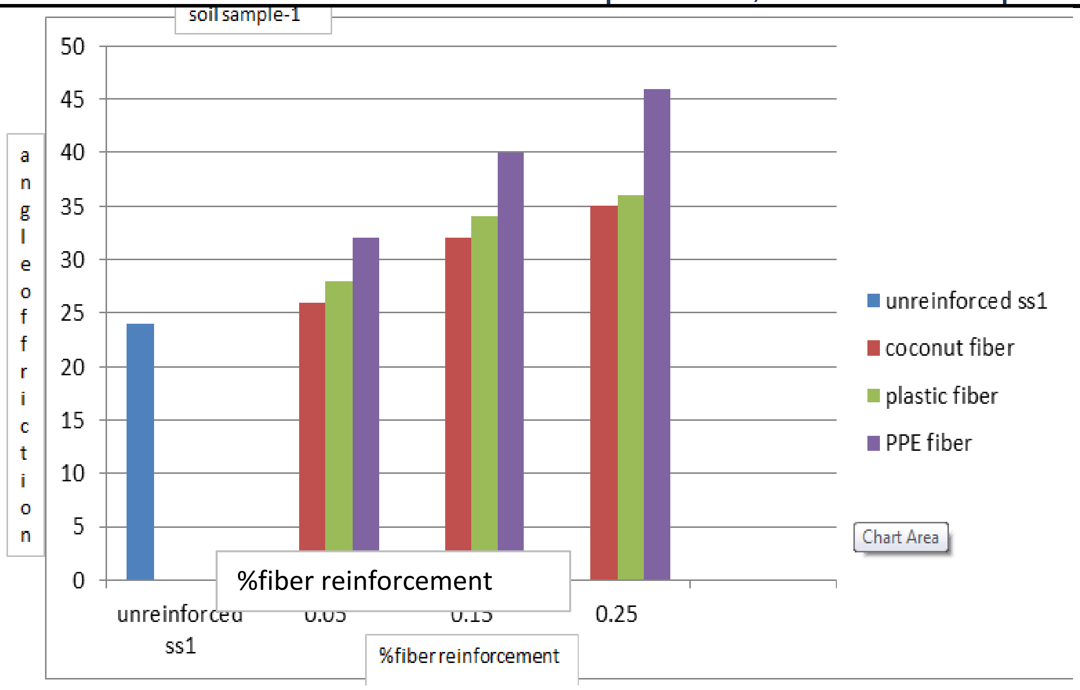
Angle of intenal friction Ø:

A Bar graph is plotted by taking %fiber reinforcement on x axis and angle of internal friction on y axis for both the soil samples .

Angle of internal friction :

For soil sample-1:

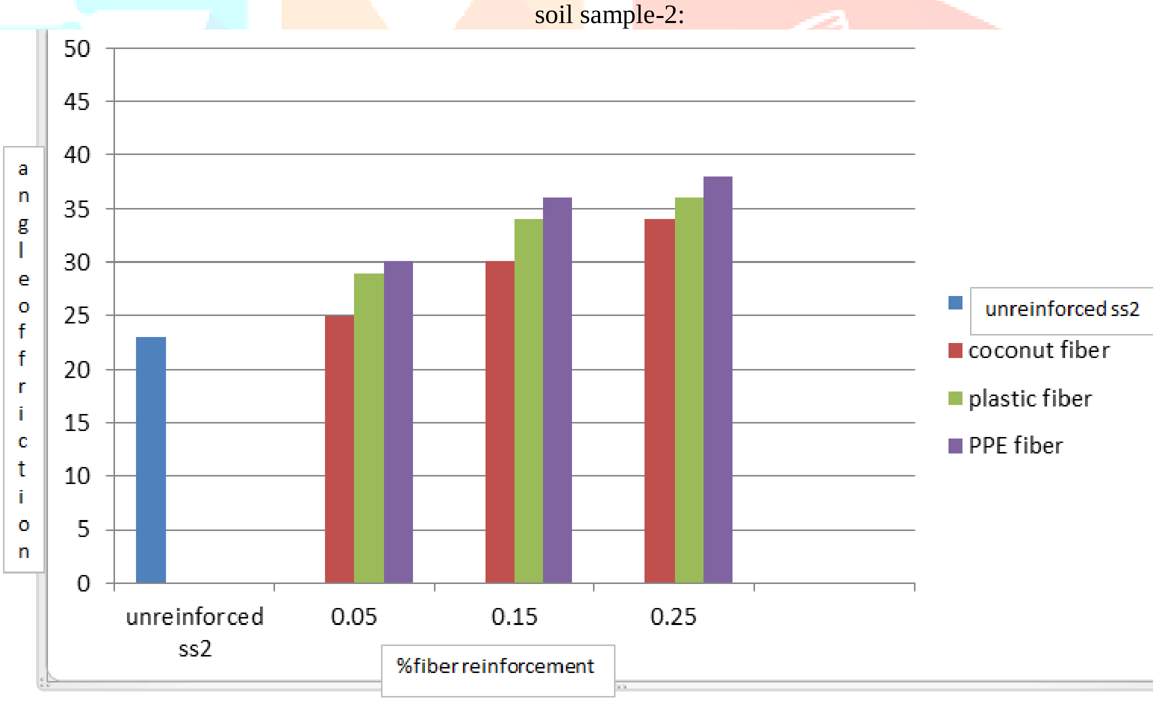
As the %percentage of fiber reinforcement increases from 0.05% to 0.25% theangle of internal friction increases hence in soil sample -1 the angle of inernal friction increases from 32 to 46 from the results in PPE fiber. The increase in angle of internal friction is more in PPE fiber than other two fibers (plastifiber,coconut fiber) in soil sample-1.



Angle of internal friction :
For soil sample-2:

As the %percentage of fiber reinforcement increases from 0.05% to 0.25% theangle of internal friction increases hence in soil sample -1 the angle of inernal friction increases from 29 to 38 from the results in PPE fiber. The increase in angle of internal friction is more in PPE fiber than other two fibers (plastifiber,coconut fiber) in soil sample-2.

soil sample-2:

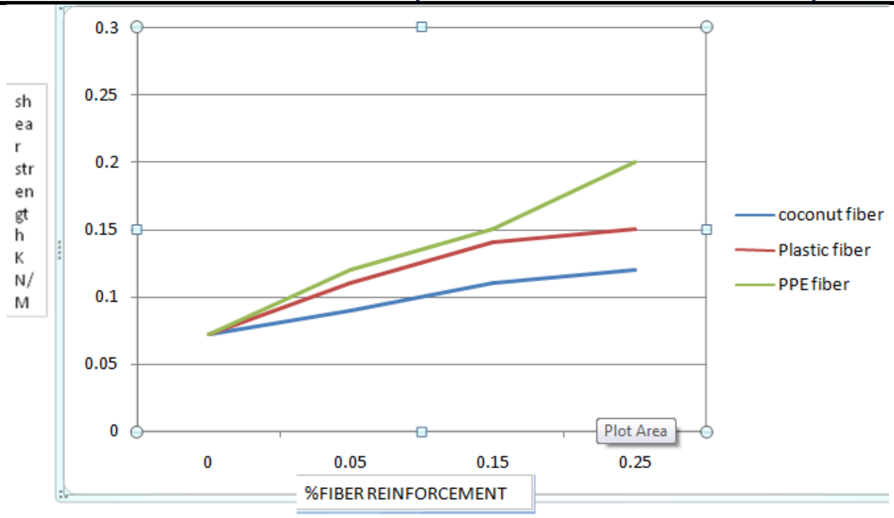


5.5RELATION BETWEEN SHEAR STREGNTH AND %FIBER REINFORCEMENT OF THREE FIBERS(PPE,PLASTIC,COCONUT) FOR SOIL SAMPLE -1.

Soil sample-1:

From experimental investion results A graph is plotted by taking shear strength on y –axis and %fiberof three fiber reinforcement 0.05%,0.15%,0.25% of three fiber.

soil sample -1:

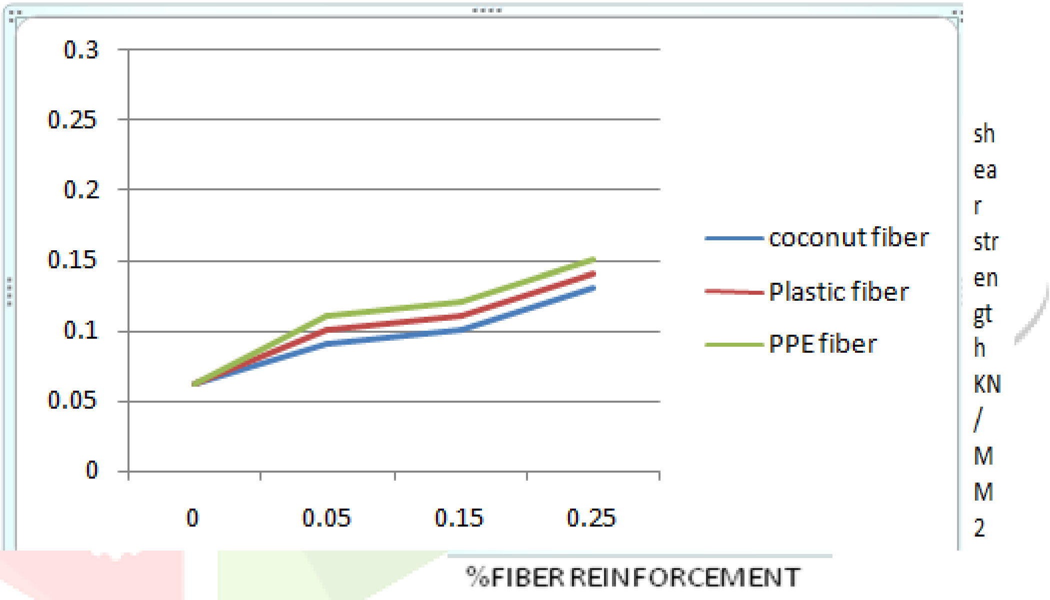


From the above graph it is found that PPE fiber has more shear strength than other three fibers and is maximum in soil sample-1.

5.6RELATION BETWEEN SHEAR STREGNTH AND %FIBER REINFORCEMENT OF THREE FIBERS(PPE,PLASTIC,COCONUT) FOR SOIL SAMPLE -2.

From experimental investion results A graph is plotted by taking shear strength on y –axis and %fiberof three fiber reinforcement 0.05%,0.15%,0.25% of three fiber

Soil sample-2



From the above graph it is found that PPE fiber has more shear strength than other three fibers and but lesser shear strength than soil sample-1.

Summary :

In this chapter, the results obtained from the experimental program are tabulated and are represented in the form of graphs. The results were studied and based on the study, the conclusions were drawn. The conclusions for the present study are given in the next chapter.

6.Conclusion

1.when direct shear stress was conducted on soil sample-1 the shear strength we obtained is 0.071N/mm^{2}with cohesion (c)=0.061N/mm^2,Ø=24°.

2.By adding different fibers like PP fiber,plastic&coconut fiber at different %percentages i.e,0.05,0.15,0.25 we observed following variation in c ,Ø and shear strength values.

1.There is maximum decrease in cohesion value by 84% was observed when soil was mixed with 0.25%of PP fiber.

2.There is a maximum increase in angle of friction value by 91% was observed when soil was mixed with 0.25%of PP fiber.

3. BYy adding the 0.25%fiber reinforcement of PP fiber in soil sample-1 the shear strength value was increased to 0.2 N/mm$^{2.}$.

3.when direct shear stress was conducted on soil sample-2 the shear strength we obtained is 0.0624N/mm^{2}with cohesion (c)=0.061N/mm^2,Ø=23°.

4.By adding different fibers like PP fiber ,plastic &coconut fiber at different %percentages i.e,0.05,0.15,0.25 we observed following variation in c ,Ø and shear strength values.

1.There is maximum decrease in cohesion value by 74% was observed when soil was mixed with 0.25%of PP fiber.

2.There is a maximum increase in angle of friction value by 65% was observed when soil was mixed with 0.25%of PP fiber.

3. BY adding the 0.25%fiber reinforcement of PP fiber in soil sample-2 the shear strength value was increased to 0.15 N/mm^{2}.

6.From experimental study we conclude that soil sample-1 had more shear strength than soil sample-2 when pp fiber are used as reinforcement at 0.25%.

7.PP fibers are giving better results when compared to the coconut and plastic fibers because of their light weight, high strength, corrosion resistance.

8.PP fibers are 100% synthetic fibers which are low cost and chemically inert.

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