



e-ISSN: 2319-8753 | p-ISSN: 2347-6710

IJIRSET

International Journal of Innovative Research in
SCIENCE | ENGINEERING | TECHNOLOGY

INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

Volume 11, Issue 8, August 2022

ISSN INTERNATIONAL
STANDARD
SERIAL
NUMBER
INDIA

Impact Factor: 8.118

 9940 572 462

 6381 907 438

 ijirset@gmail.com

 www.ijirset.com

Performance Evaluation of Soil Properties Reinforced with Coconut Coir

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ABSTRACT: Soil is most commonly used material in civil engineering field. Different types of soils are present on earth is dependent upon size, texture and various engineering properties. Soil is red because of the presence of ferric oxide. For stabilization of soil natural fiber “coir” which is obtained from coconut husk is desirable. Soil is reinforced with coconut coir is effective solution for stabilization and to increase the strength of soil. Various index engineering tests have been conducted i.e., specific gravity test, liquid limit test, plastic limit test, standard proctor test, modified proctor test, direct shear test, unconfined Compressive Strength test, California Bearing Ratio test for reinforced and unreinforced soil was performed and evaluated. The UCS and direct shear value for soil reinforced with 0.5 % coir was found to be maximum. As percentage of coir increases, Maximum dry density decreases and optimum moisture content increases. The CBR value is maximum when coir is placed at 1/3rd height from bottom of mould. Stabilization is done to improve soil density.

KEYWORDS : Red Soil, Stabilization, Coir Fibre.

I. INTRODUCTION

Coir is a natural fibre gifted by God to us. Coir fibre is extracted from the outer layer (husk) of the fruit of coconut tree *Cocos Nucifera* L. The coconut husk consists of a smooth waterproof outer skin (epicarp) and fibrous zone (mesocarp). Coir fibres recovered from fully ripened coconuts yield brown coir. Strong and highly resistant to abrasion. Now, development of transportation is important factor in India, due to urbanization and population in last few decades which plays a major role in road construction. As a result, to provide wide connectivity through road network with the increasing population, road construction is being done on almost all types of soils. At present, it has become a necessity to construct pavements even on loose soil or expansive soil, for making roads on a large scale. However, these loose and expansive soils can be modified by using natural resources which makes the soil more durable, increases the strength of the soil, makes the process more environment friendly, and also reduces the overall cost of construction. Among all the natural resources, presently coir fibre is becoming more popular as a reinforced material because of its easy availability, good wearing resistance and stability, skid resistance and longer durability. Coir is the fibrous material found between the hard, internal shell and the outer coat of a coconut, being a biodegradable and environment friendly material, can virtually replaceable by any of the modern polymeric substitute. Our country's agricultural and economic development mainly depends on its transporting network. India has a rural oriented economy with 74% of its population living in villages and about 3,300 out of the 25,000 village habitants were without any all-weather road access. It also plays a key role in the reduction of poverty. Natural geotextiles like coir and jute is good alternative to geosynthetics due to its low cost, easy availability and eco-friendliness. Geotextiles are considered as cost effective, durable, and easy to use. Nowadays, geotextiles are of ever-growing indispensability in geotechnical engineering. This paper reviews composition and function of geotextiles in geotechnical engineering. In addition, based on literatures including the most recent data, the discussion turns to recent development of geotextiles, with emphasis on green geotextiles, intelligent geotextiles, and high-performance geotextiles. The development of these new geotextiles and their application in geotechnical engineering are reviewed.

II. LITRETURE REVIEW

Lot of research work has been done related to the research work and searched various research papers which wererelated to use of various waste materials in sub grade soil. Following are some researches that were closely relatedto our work:

1) **Er. Neeraj Kumar, et.al., (2021)** In this research they have performed the test to improve the soil stability. They made use of waste material which are more effective. They used jute and coir for stabilized for soil to withstand greater loads and reduce cost, made subgrade soil stronger. Objective is to strengthen embankment for highway subgrade and for safer utilization of waste material that is jute and coir and made cost effective and finally after the research it is found that jute or coir is suitable and enhance the properties of the soil.

2) **M. Jyothi, T. Thiyagarajan.et.al. (2019):** Coconut shell (CS) and coconut fibre (CF) are new waste materialsthat used in construction of pavement. The coconut shell has good weather resistant and hence can be used as construction materials. But coconut fibre has cellulose content about 36 – 43% but with twice amount of lignin (41- 45%) that provides greater resistance and hardness. Coconut fibre increases the stability, skid resistance and resilient modulus while coconut shell will improve the indirect tensile strength and creep behaviour of the modified asphalt pavement. Coconut shell was added with varying percentage such as 5%,10%,15%,20% and coconut fibre such as 0.5 %,1%, 1.5% ,2 %. And based on Marshall stability, CS and CF replacement at 21.5% gives the highest stability and least air voids which prevents cracking, plastic flow and bitumen bleeding.

3) **Ishfaq Ahmad Mir and ER Abhishek Bawa (2018)** “Utilization of Waste Coconut Coir fibre in soil reinforcement” (IJCIET): Coconut Fiber is a waste material that remains after extraction of useful coconut. It haslength about 6 to 8 inches and the density 1.40 g/cc. The Coconut coir fibre contains lignin 45.84%, cellulose 43.44%, hemicellulose 0.025%, pectins and other compounds 0.03%. The percentages of the coconut Fiber used in the soil are 0%, 0.3, 0.5%, 0.8% and 1.1%.and the tests conducted on the clayey soil are Liquid Limit, Plastic Limit, Standard Proctor Test and California Bearing Ratio (CBR) and found out that soil samples reached the highest values of all the parameters when the percentages of coconut fibre added to 1.4%. The OMC and Dry Density of the soil got increased from 11% to 21% and 1570 mg/cm³ to 1752 mg/cm³ respectively. CBR values have also increased from 1.96% to 4.48% for 2.5mm penetration and 1.68% to 4.16% for 5mm penetration with increase in the coconut fibre content.

4) **Anu J. Sari.et.al (2017)** In this paper they have done experiment on Soaked and Un soaked soil with and without coir Geotextile. They have conducted CBR test on both of them. The coir is placed at different height like 1/3 h, 1/2h, 2/3h from the top of the mould. For soaked soil CBR values increased compared to unsoaked soil sample. They concluded that the maximum improvement CBR value is obtained. When geotextile is placed at 1/3 h for soaked soil at 1/3h is 13.58% and unsoaked soil id 4.79%

5) **R.R. Sing.et.al (2014)** In this paper they have conducted the Lab rotary test i.e. (Unconfined compression test and California Bearing Ratio) test on Clayey soil mixed with varying percentages of coconut coir fibre. The percentage of coir fibre dry weight of soil 0.25%, 50%, 0.75%, 1%. Corresponding to soaked and un soaked CBR and UCS tests conducted on laboratory. This indicates the both un soaked and soaked CBR and UCS values increases with increase in Fibre content. For soaked (4.75% ton 9.22%) of soil mix with 1% of Coir Fibre and forUCS, soil increase 2.75kg/cm to 6.33kg/cm with addition of Coconut Coir Fibre. Addition of coconut Coir Fibre Reduces Cost of construction and Economy of construction will be achieved.

III. MATERIALS AND METHODOLOGY

MATERIALS

1. **Coir-** The Coir (Geotextile) material is used in the sub base soil of road to increase the strength of the soil and to reduce erosion. Coir is a natural fiber derived from the coconut husk. Coir fibers resemble the wood fibers in terms of physical properties and chemical composition. Coconut fibers are the Hard and the strongest among all natural fibers, it can be spun and woven into different types of mattings and mats. Coir fibers are categorized in two ways. The husks of fully ripened coconuts yield to brown coir. Brown coir is Strong and highly resistant to abrasion. On the other hand, white coir comes from the husks of coconuts harvested shortly before they ripen. Actually, it is white in colour, this fiber is softer and less strong than brown coir. Both brown and white coir consist of fibers ranging in length from 4-12 inches (10-30 cm).



Fig.1. View of coconut coir fibre

EXTRACTION OF COIR FIBER

Coir is extracted from the coconut husk, namely its outermost layer of the coconut. To extract the coir fiber from the outer layer of the coconut husk they are soaked in water to soften and loosen them. the process is done naturally also. The coir fibers are soaked in water or salt water then they are dried thoroughly. Once the fiber is loosened they are lead into machines for the coir fiber extraction from the outer layer of the coconut husk

TYPES OF COIR FIBERS

a) White coir fiber: Is made from the coconut husk that have been soaked in water for a maximum of ten months. The soaking process is usually done in rivers or a pit filled with water. The plats tissues surrounding the fibers are broken up by microorganisms, thereby loosening them. This process is called getting. Once it has been cleaned and dried it can be spun into yarn.

b) Brown coir fiber: The process is also similar to the white fiber, but the main difference is that the mature coconut husk is used in extraction of coir fiber. The brown coir fiber, they are also softened by soaking the husks in water, but it has a little change in the process. The mature husk should need to be soaked in the slowly moving water instead of stagnant water. This makes the husk swell to loosen them and soften them. Once softened the long and the short fibers are softened the process is called wet milling.

Quality

The different fibre extraction processes yield different but also varying qualities of fibres generally 56-65 per cent long fibres of over 150 mm (up to 350 mm staple length) and 5-8 per cent short fibres of under 50 mm. The fibre fineness varies between 50 and 300 µm. The fibres are composed of individual fibre cells of about 1 mm length and 5-8 µm diameter. The tensile strength of coir is relatively low when compared to sisal or abaca fibres, but it is less impaired by immersion in water. Coir fibre has the advantage of stretching beyond its elastic limit without rupturing, as well as having the power to take up a permanent stretch. Its resistance to microbial degradation and salt water is unique.

Table.1. Physical properties of coir fibre

Lignin	45.84%
Cellulose	43.44%
Hemi-Cellulose	0.25%
Pectin's and related Compound	3.0%
Water soluble	5.25%
Ash	2.22%

Table.2. Chemical properties of coir fibre

Length in inches	6-8
Density (g/cc)	1.40
Tenacity(g/Tex)	10.0
Breaking Elongation%	30%
Diameter in mm	0.1 to 0.5
Rigidity of Modulus	1.8924 dyne/cm ²

2. Red soil

Red soils denote the largest soil group of [India](#), covering an area of about 350,000 sq.km (10.6% of India's area) across the Peninsula. India is rich with red soils in their southern, eastern, and northern regions. Red soil is the type of soil that develops in a warm temperature. Iron content that is responsible for its colour red soil has higher iron, aluminium, lime content most of the red soil has come into existence due to weathering of incident crystalline igneous rocks, moist climate under deciduous or mixed forest, having thin organic and organic- mineral layer overlying a yellowish-brown leached layer resting on a diluvium layer. These are generally derived from crystalline. Their colour is mainly due to ferric oxide. Red soils are an important resource because they make up such a large portion of farmland on the earth



Features of red soil:

- Red soil is porous and has a high percentage of iron oxide.
- Red soil is found to be shallow and its pH value ranges from 6.6 to 8.0.
- Red soil has better drainage capacity compared to other soils and the soil is porous, fine grained and fertile in nature.
- Red soils also have higher iron, lime content and aluminium.
- Red soil has a high acidic nature.

Chemical composition of Red soil:

Composition	Percentage (%)
Iron	3.61
Aluminium	2.92
Organic matter	1.01
Magnesium	0.20
Lime	0.56
Potash	0.24

3.2 METHODOLOGY

In the project work we started the work by collecting the soil sample from SGBIT college campus and we collected the soil sample from the depth of 2ft below the ground surface. And then further the basic engineering tests are performed on the soil sample.. While collecting the soil sample the In-Situ test like core cutter test performed by collecting the soil in the field. Then once the soil samples are dried, we lead to further tests like Sieve analysis, Cone penetration, Unconfined compressive test, Plastic limit, Specific gravity test by density bottle, California bearing test. After obtaining the values the results are calculated and graphs are plotted.

These tests have been performed on both the treated and untreated soil. On treated soil UCS, compaction and CBR test is performed, then both the values are compared with the untreated Soil values.

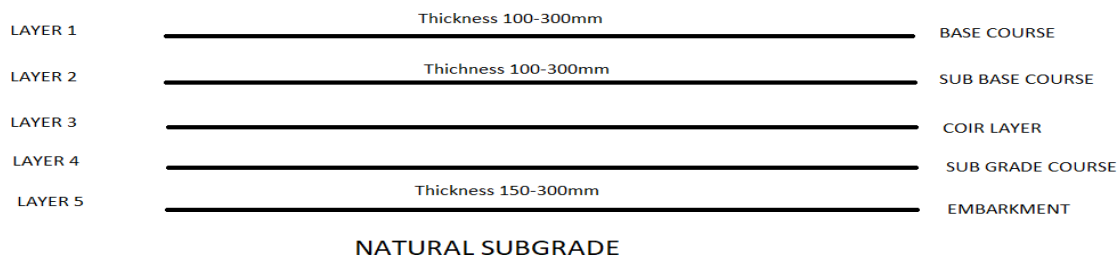


Fig.2.Layers of Road with coir placement

FOUR STAGES OF ROAD CONSTRUCTION

STAGE 1- The construction area is to be cleaned. Then the road dimension like alignment, pavement and footpath are marked. Then the ground is excavated if the road level is lower than the ground level or the soil is filled if the road level is higher than the ground level. If soil is loose at the elevations, compaction is done using rollers. The elevation and



drainage chambers are to be constructed in the subgrade layer.

Compaction is done to obtain the level of the road.

STAGE 2- the coir layer is layed above the sub grade layer.

STAGE 3- sub-base layer is the next layer above the coir layer

Here the material quality and traffic load determine the thickness of the road.in this layer the load is distributed uniformly on the subgrade.

STAGE 4- base coarse lies above the sub-base course. It acts as the foundation for the surface course. The thickness depends upon the traffic load. The base course is thinner the sub-base course. The base course has good quality of crushed aggregates. The base coarse material is layed and the compaction is done. The speed of the roller must not be more than 5-10km per hour.

SURFACE COARSE-This is the top layer it bears all the wear and tear due to traffic on the road the tack coat is layed and compaction is done.

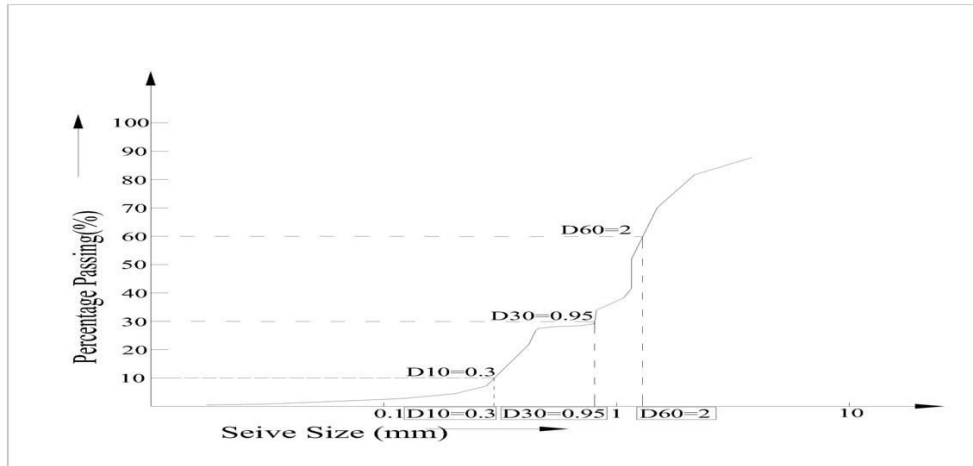
TESTING RESULTS:

1. GRAIN SIZE SIEVE ANALYSIS BY SIEVE ANALYSIS METHOD

Sl No.	IS Sieves(mm)	Weight of sieve (g)	Weight of sieve + soilretained (g)	Weight of soil retained (g)	% soil retained	Cumulative % soil Retained	% passing
1	4.75	0.394	0.640	0.236	23.6	23.7	76.4
2	2.36	0.336	0.468	0.146	14.6	38.2	61.8
3	1.18	0.338	0.600	0.252	25.2	63.4	36.6
4	0.600	0.318	0.468	0.130	13.0	76.4	23.6
5	0.425	0.338	0.472	0.134	13.4	89.8	10.2
6	0.300	0.338	0.388	0.050	5.0	94.8	5.2
7	0.212	0.310	0.334	0.024	2.40	97.2	2.80
8	0.150	0.308	0.320	0.012	1.20	98.4	1.6
9	0.075	0.318	0.328	0.010	1.00	99.4	0.6
10	Pan	0.264	0.272	0.008	0.8	100	0

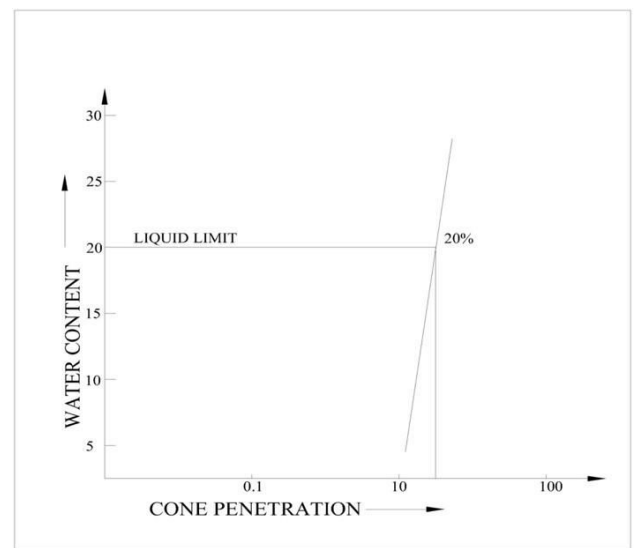


Fig .2. Sieve size versus Percentage passing curve of the selected soil sample.



2. LIQUID LIMIT TEST BY CONE PENETROMETER

Details	1	2	3	4
Amount of water added (%)	5	10	15	20
Quantity of water to be added (ml)	13.5	27	50.5	64
Cone penetration = Final reading – Initial reading	13.3	14.8	18.2	19.5
Container No.	26	22	10	14
Weight of Container with lid (W1)	11	10.2	11.8	10.4
Weight of Container with lid + Wet soil (W2) g	28	30	35	37
Weight of Container with lid + dry soil (W3) g	24	25	26	28
Water content, $W = \frac{W2 - W3}{W3 - W1} \times 100$ (%)	30	33.7	56.4	50.5



3. SPECIFIC GRAVITY BY DENSITY BOTTLE METHOD

4. PLASTIC LIMIT



Determination No.	1	2	3
Mass of Density bottle (M ₁) g	0.046	0.046	0.046
Mass of (Density bottle + dry soil) (M ₂) g	0.100	0.110	0.105
Mass of (Density bottle + Dry soil + water) (M ₃) g	0.192	0.212	0.207
Mass of (Density bottle + water) (M ₄) g	0.164	0.164	0.164
Specific gravity at room temperature (G _T) = $\frac{(M_2 - M_1)}{(M_4 - M_1) - (M_3 - M_2)}$	2.070	2.030	2.017
Average specific gravity at room temperature, G _T	2.039		
Correction factor, K ₄ = $\frac{G_w \text{ at } t^{\circ}c}{G_w \text{ at } 4^{\circ}c}$	0.995		
Average specific gravity, G ₄ =K ₄ x G _T	2.059	2.019	2.006

Details	1	2	3
Container No.	A	B	C
Weight of Container with lid (M ₁), g	19	18	13
Weight of Container + Wet soil (M ₂), g	29	26	25
Weight of Container + dry soil (M ₃), g	26	24	22
Plastic limit = Water content, W _P =(M ₂ -M ₃)/(M ₃ -M ₁), g	42.85	33.3	33.34
Average, W _P (%)	35.50		

5. UNCONFINED TEST ON UNTREATED SOIL SAMPLE

Elapsed time (min)	Determination of dial gauge reading Div. (mm)	Axial deformation Δl (mm)	Axial strain $E = \frac{\Delta L}{L_0} \times 100(\%)$	Corrected area AC= $A_0(1 - E)$ (Cm ²)	Proving ring dial readings (div)	Axial Load (kg)	Axial compressive stress (Kg/cm ²)
0	0	0.0	0	10.17	0	0	0
50	50	0.5	0.69	10.24	12	12.430	1.213
100	100	1.0	1.37	10.3	28	29.008	2.800
150	150	1.5	2.05	10.37	32	33.152	3.196
200	200	2.0	2.74	10.45	28	29.00	2.770
250	250	2.5	3.42	10.63	20	20.72	1.950



6. PERMEABILITY TEST RESULTS

% Of Coir	Initial Head in cm (h ₁)	Final Head in cm (h ₂)	Time	Coefficient of Permeability
0.0% of Coir	75	56	10	0.2250
0.25% of Coir	79	54	10	0.3189
0.50% of Coir	85	47	10	0.5611
0.75% of Coir	90	51	10	0.5450
1.0% of Coir	95	83	10	0.1481

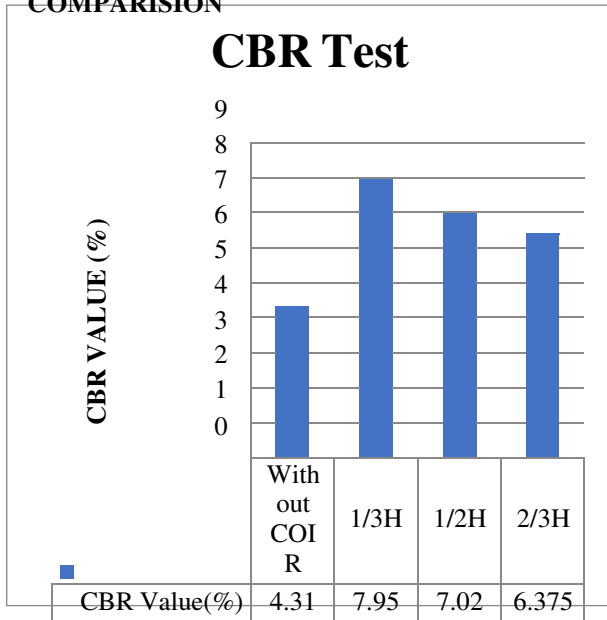
7. DIRECT SHEAR TEST

Normal load	Proving ring reading	Shear force	Shear stress
0.0% Of Coir	0.5	60	14.95
	1.0	104	26.81
	1.5	135	34.65
0.25% Of Coir	0.5	70	18.25
	1.0	130	33.90
	1.5	155	38.50
0.50% Of Coir	0.5	83	21.00
	1.0	144	37.15
	1.5	185	42.31
0.75% Of Coir	0.5	59	16.01
	1.0	112	28.14
	1.5	128	32.12
1.0% Of Coir	0.5	49	12.95
	1.0	98	25.98
	1.5	115	29.13

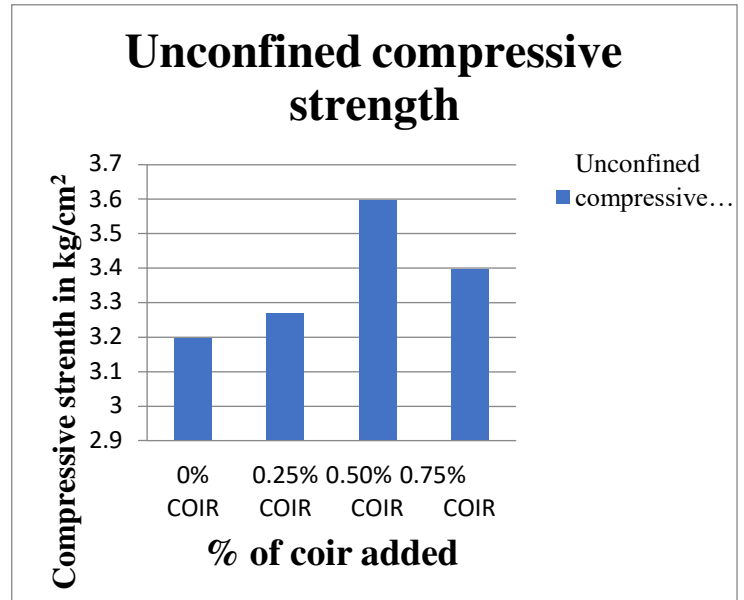


IV. RESULTS

8.CBR TEST COMPARISION GRAPH
COMPARISION



9. UCS TEST



10. STANDARD PROCTOR TEST COMPARISION GRAPH

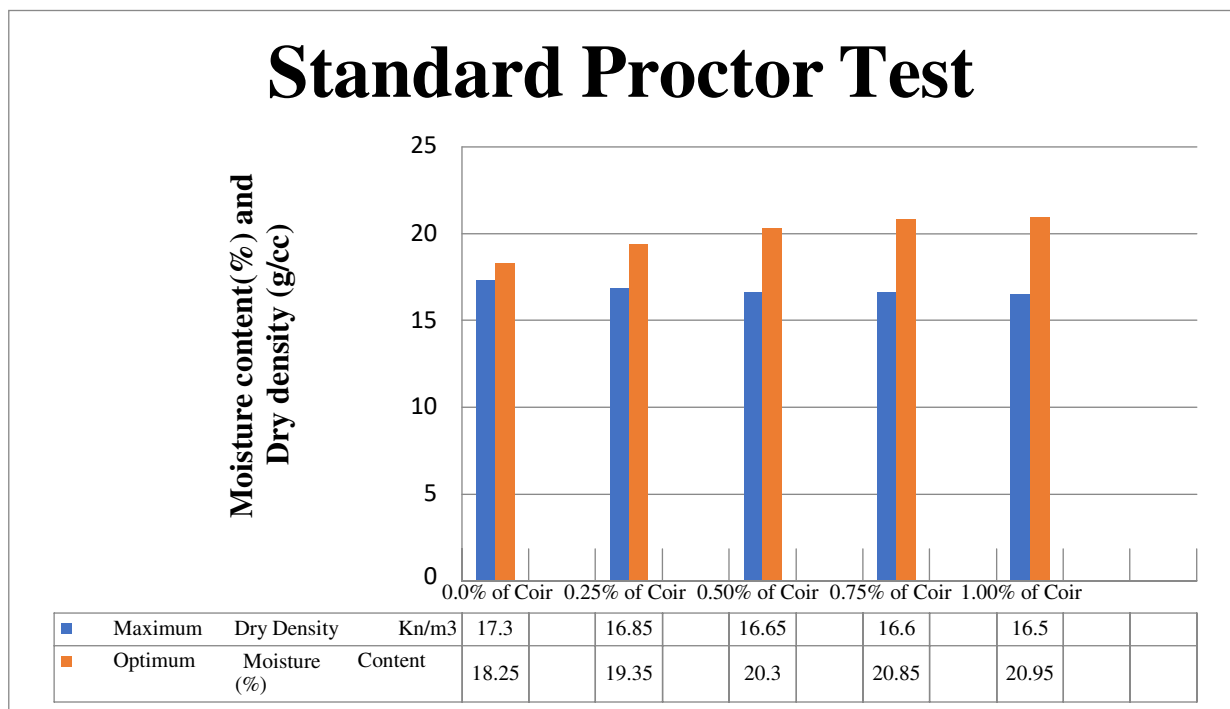


Fig.11. Standard proctor test comparison with curve graph

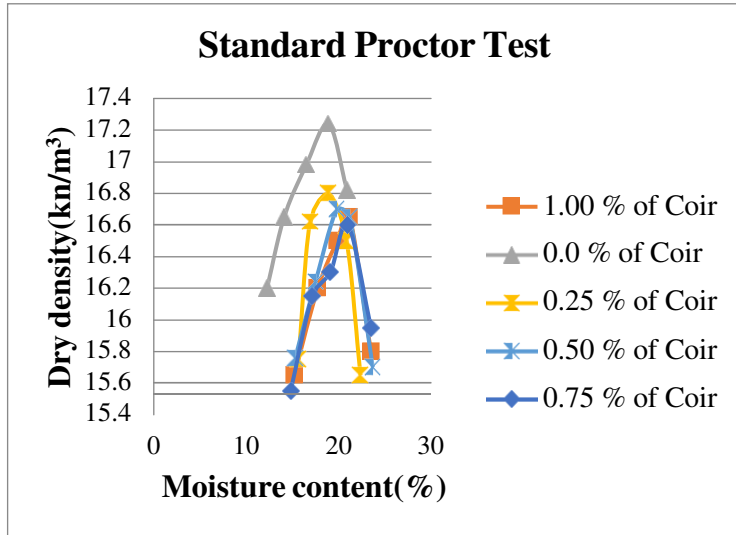


Fig.12. Direct shear comparison graph

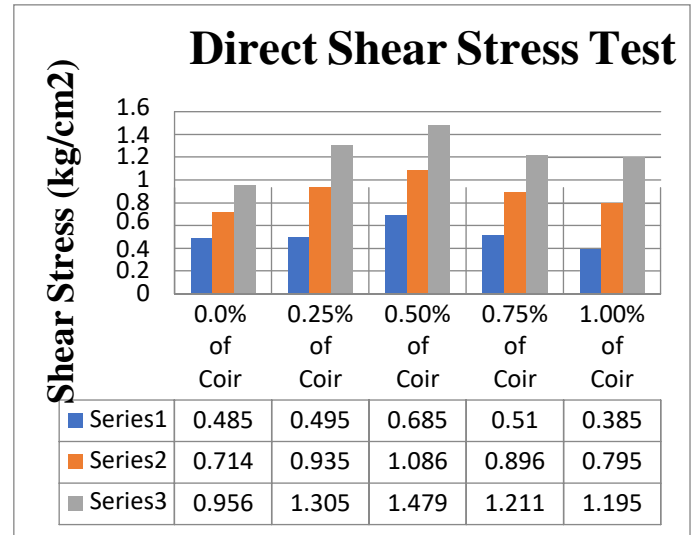


Fig.13 Direct shear test comparison with curve graph

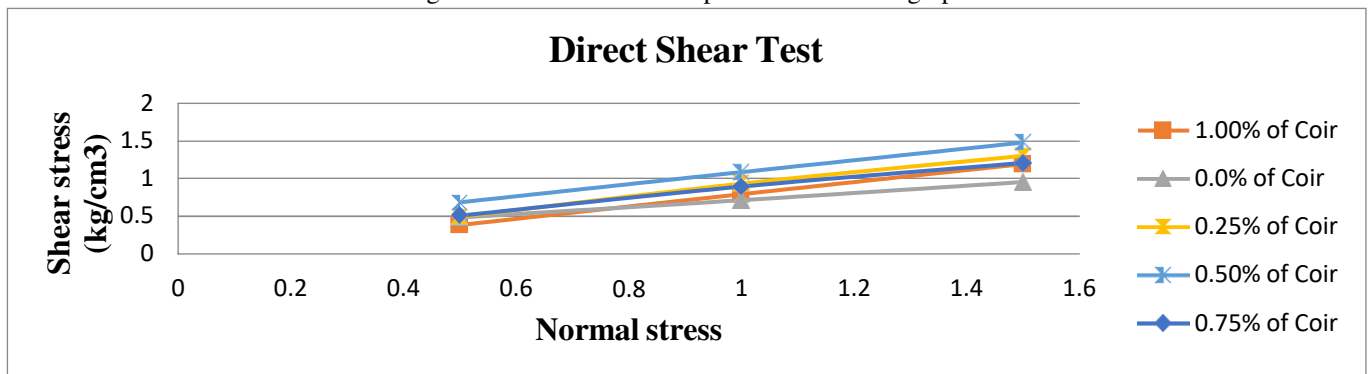




Table 14. Engineering and Index properties value of the soil sample

SL. No	Property	Value
1.	Grain size distribution	
	(a)Gravel (%)	69.1
	(b)sand (%)	25.46
	(c) silt + clay (%)	5.31
2.	Liquid limits (%)	40
3.	Plastic limits (%)	36.50
4.	Specific gravity	2.051
5.	Compaction characteristics	
	(a)maximum dry unit weight (KN/m ³)	17.69
	(b)optimum moisture content (%)	15.45
7.	California bearing ratio value (%) in soaked soil	
	(a)2.5mm Penetration	4.6
	(b)5mm penetration	4.4
8.	Unconfined compressive strength (Kg/cm ²)	3.196
9.	Co-efficient of permeability	0.2250
10.	Direct shear	C _u =0.4 kg/cm ²
		Ø=18 ⁰

VI. CONCLUSION

The present study has shown quite encouraging results and following important conclusions can be drawn from the study:

- Coir Fibre is a waste material which can be utilize in a stabilization of clay soil.
- The strength of soil-coir mix increases with increasing the percentage of coir Fibre.
- The California Bearing Ratio of the selected soil sample gives the maximum value when 0.50 % of coir was added at 1/3rd height of the mould.
- As the percentage of coir added, the optimum moisture content increase with the decrease in the Dry Density of the soil sample.

REFERENCES

1. Er. Neeraj Kumar, Uzma Farooq.et.al: “Soil stabilization with jute and coir for highway subgrade review”.(IRJET), Volume-8, issue-03, mar-2021
2. M. Jyothi, T. Thiagarajan.et.al. “Flexible Pavement Using Coconut Shell and Coir Fibre” (JETIR) volume-6, issue-4, April-2019.
3. Ishfaq Ahmad Mir and ER Abhishek Bawa, “Utilization of Waste Coconut Coir fibre in soil reinforcement” (IJCIET), Volume-9, issue-9, sept-2018.



4. Anu J. Sari and Aparna Sai.J.et.al: “Subgrade Soil improvement using coir Geotextiles and Geocells” (ETCEA) volume 5, issue- 8, apr-2018.
5. R.R. Sing, Shelly Mittal.et.al “Stabilization of soil by Coconut Coir” (IJET), volume 3, issue-6, May-2014.
6. IS CODE BOOKS (Part II, III, V, VIII).



INNO SPACE
SJIF Scientific Journal Impact Factor
Impact Factor: 8.118



ISSN INTERNATIONAL
STANDARD
SERIAL
NUMBER
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