Stabilization of Soil by Use of Geo-Jute as Soil Stabilizer

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Abstract— The existing soil at a particular location may not be suitable for the construction due to poor bearing capacity and higher compressibility. Particularly clays exhibit generally undesirable engineering properties. They tend to have low shear strengths and also loose shear strength further upon wetting or other physical disturbances. The improvement of soil at a site is indispensable due to rising cost of the land, and huge demand for high rise buildings. So recent research could be beneficial in finding the different ways of utilizing waste materials in most efficient ways like rice husk ash, fly ash, used tyres etc. So replacement of natural soils aggregates and cement with solid industrial by-product is highly desirable.

Keywords: Geo-jute, Jute Fiber, Black Cotton Soil, Red Soil, Soil Stabilization

I. INTRODUCTION

Soil is a mixture of organic matter, minerals, gases, liquids, and organisms that together support life. The earth's body of soil is the pseudosphere, which has four important function: it is a medium for plant growth, it is a means of water storage, supply and purification, it is a modifier of earth's atmosphere, it is a habitat for organisms, all of which, in turn, modify the soil.

In developing country like India due to the remarkable development in road infrastructure, Soil stabilization has become the major issue in construction activity. Stabilization is an unavoidable for the purpose of highway and runway construction, stabilization denotes improvement in both strength and durability which are related to performance. Stabilization is a method of processing available materials for the production of low-cost road design and construction, the emphasis is definitely placed upon the effective utilization of waste by products like Geo-Jute, and fly ash, with a view to decreasing the construction cost.

The prime objective of soil stabilization is to improve the California Bearing Ratio of in-situ soils by 4 to 6 times. The other prime objective of soil stabilization is to improve on-site materials to create a solid and strong sub-base and base courses. In certain regions of the world, typically developing countries and now more frequently in developed countries, soil stabilization is being used to construct the entire road.

Geo-Jute can play a vital role as they improve the bearing capacity, Jute plants are grown mostly in the gangetic delta in the eastern part of the Indian subcontinent. People used to consume its leaves as a vegetable and also as a household herbal remedy. Jute plant has an erect stalk with leaves. It thrives in hot and humid climate, especially in areas where rainfall is in plenty. It grows up to about three meters in height and matures within four to six months. In China, taller Jute plants are being cultivated resulting in higher fibre production.

A. Materials

1) Geo-jute fibre.
2) Black cotton soil.
3) Red soil.

II. METHODOLOGY

A. Collection of Material:

Geo-Jute: D.K. Enterprises, Hubli-Dharwad.
Red Soil: Magod, Ranebennur Taluk.
Black Cotton Soil: Magod, Ranebennur Taluk.

B. Testing:

Index properties such as specific gravity of soil samples is determined by using IS code 2720 and the particle size distribution by using sieve analysis as per IS code. Three trials were conducted and average of there is obtained for the sake of accuracy. The standard proctor test was conducted to determine the optimum moisture content (OMC) and maximum dry density (MDD) as per IS code. The Atterberg limits were calculated by using Casagrande's for liquid limit and plastic limit of the soil samples as per IS code. Tests had conducted to Direct shear to determine the cohesion of the soil sample as per IS code.

III. RESULTS

A. Specific Gravity of Soils:

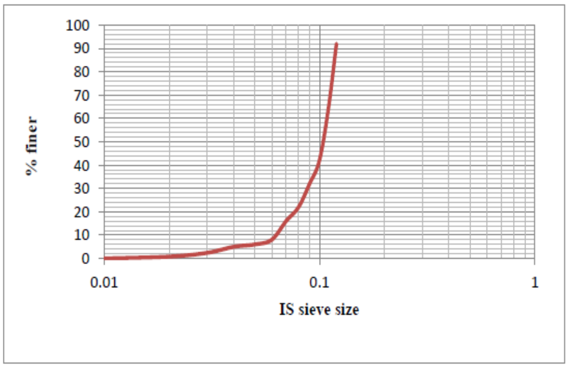
SL NO	NAME OF THE SOIL	SPECIFIC GRAVITY (G)
1	Red soil	3
2	Black cotton soil	2.92

B. Grain size distribution:

The grain size distribution test was conducted to determine the particle size distribution of soil samples.

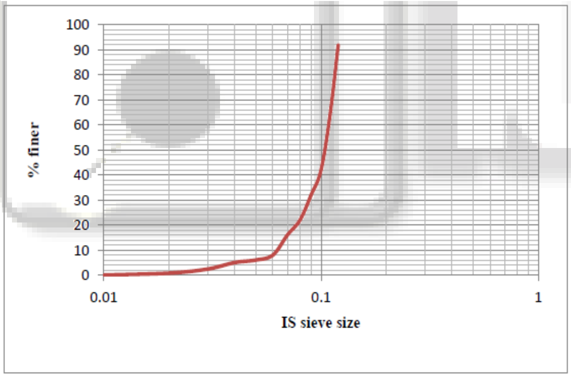
C. Red Soil:

SL NO	IS Sieve size in mm	Weight of soil retained (gm)	% weight of soil retained	Cumulative % retained C	Cumulative % of passing N=100-C
1	20	0	0	0	100
2	10	130	13	13	87
3	4.75	230	23	36	64
4	2	160	16	52	48
5	1	140	14	66	34
6	.6	70	7	73	27
7	.425	172	17.2	90.2	9.2
8	.3	34	3.4	93.6	6.4
9	.212	14	1.4	95	5
10	.150	22	2.2	97.2	2.8
11	.075	20	2.0	99.2	.8
12	pan	8	.8	100	0



D. *Black Cotton Soil:*

SL NO	IS Sieve size in mm	Weight of soil retained (gm)	% weight of soil retained	Cumulative % retained C	Cumulative % of passing N=100-C
1	20	80	8	8	92
2	10	280	28	36	64
3	4.75	220	22	58	42
4	2	100	10	68	32
5	1	100	10	78	22
6	.6	60	6	84	16
7	.425	80	8	92	8
8	.3	20	2	94	6
9	.212	10	1	95	5
10	.150	26	2.6	97.6	2.4
11	.075	16	1.6	99.2	.8
12	pan	8	.8	100	0



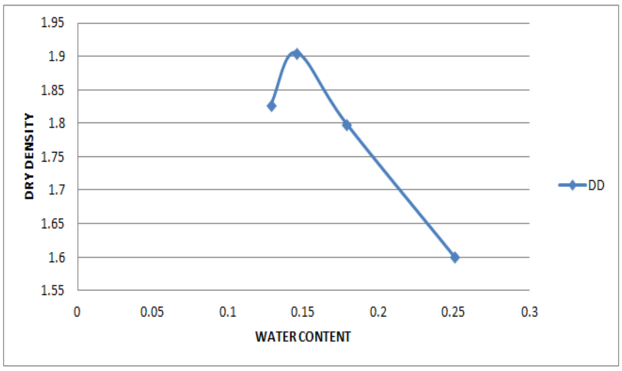
E. *Atterberge Limits:*

SL NO	Name of the Soil	LL in %	PL in %
1	Red soil	28	40
2	Black cotton soil	49	25

F. *Compaction Test:*

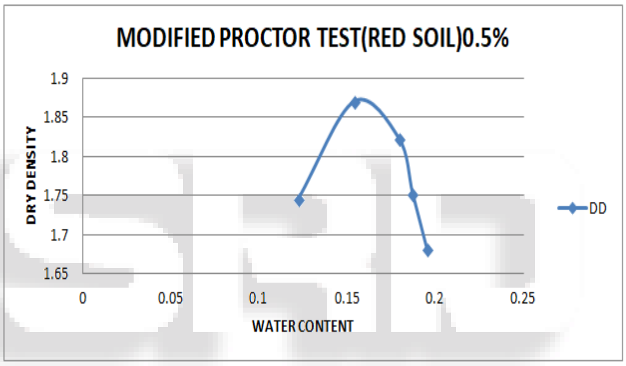
RED SOIL: Conventional

Volume of the mould	V cc	2250	2250	2250	2250
Empty weight of mould with base	W1 g	5520	5520	5520	5520
Trail number		1	2	3	4
Weight of mould with base + compacted soil	W2 g	10340	10400	10280	10040
Weight of compacted soil	Wc=W2-W1 g	4820	4880	4760	4520
Bulk density	γb=Wc/V g/cc	2.14	2.17	2.12	2.0
Water content	W%	12.8	14.4	17.5	20
Dry density	γd=γb/(1+w) g/cc	1.82	1.90	1.80	1.67



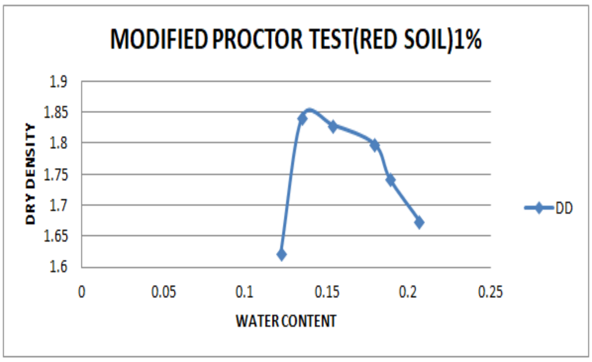
With jute fibre 0.5%:

Volume of the mould	V cc	2250	2250	2250	2250	2250
Empty weight of mould with base	W1 g	5520	5520	5520	5520	5520
Trail number		1	2	3	4	5
Weight of mould with base + compacted soil	W2 g	9940	10300	10360	10200	10060
Weight of compacted soil	Wc=W2-W1 g	4420	4780	4840	4680	4540
Bulk density	γb=Wc/V g/cc	1.96	2.12	2.15	2.08	2.01
Water content	W%	12.2	15.3	17.9	18.6	19.5
Dry density	γd=γb/(1+w) g/cc	1.74	1.87	1.82	1.75	1.68



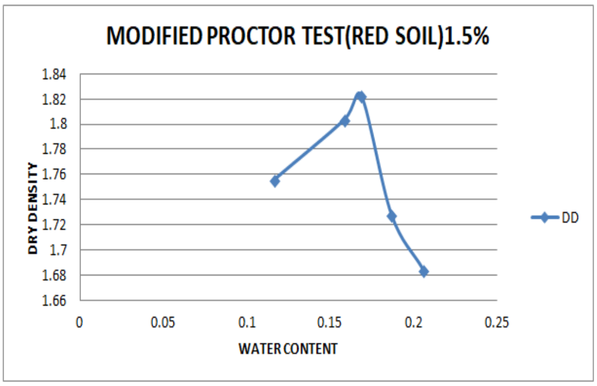
With jute fibre 1.0%:

Volume of the mould	V cc	2250	2250	2250	2250	2250	2250
Empty weight of mould with base	W1 g	5520	5520	5520	5520	5520	5520
Trail number		1	2	3	4	5	6
Weight of mould with base + compacted soil	W2 g	9620	10240	10260	10280	10180	10060
Weight of compacted soil	Wc=W2-W1 g	4100	4720	4740	4760	4660	4540
Bulk density	γb=Wc/V g/cc	1.82	2.09	2.11	2.12	2.07	2.02
Water content	W%	12.2	15.4	16.3	17.9	18.8	20.6
Dry density	γd=γb/(1+w) g/cc	1.6	1.84	1.82	1.79	1.74	1.67



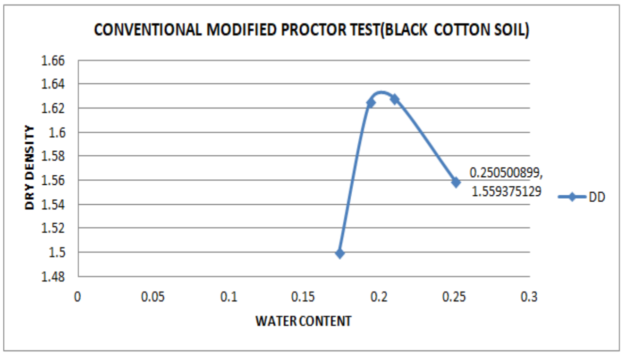
With jute fibre 1.5%:

Volume of the mould	V cc	2250	2250	2250	2250	2250
Empty weight of mould with base	W1 g	5520	5520	5520	5520	5520
Trail number		1	2	3	4	5
Weight of mould with base + compacted soil	W2 g	9936	10240	10320	10140	10100
Weight of compacted soil	Wc=W2-W1 g	4416	4720	4800	4620	4580
Bulk density	γb=Wc/V g/cc	1.96	2.09	2.13	2.05	2.03
Water content	W%	11.63	15.8	16.8	18.6	20.5
Dry density	γd=γb/(1+w) g/cc	1.75	1.8	1.82	1.72	1.68



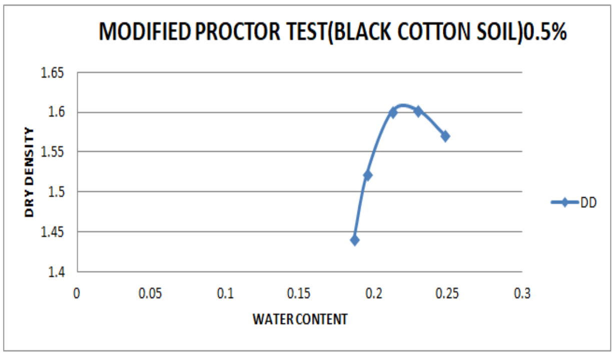
BLACK COTTON SOIL: Conventional

Volume of the mould	V cc	2250	2250	2250	2250
Empty weight of mould with base	W1 g	5520	5520	5520	5520
Trail number		1	2	3	4
Weight of mould with base + compacted soil	W2 g	9480	9880	9960	9900
Weight of compacted soil	Wc=W2-W1 g	3960	4360	4440	4380
Bulk density	γb=Wc/V g/cc	1.76	1.94	1.97	1.95
Water content	W%	16.7	19.6	21	25
Dry density	γd=γb/(1+w) g/cc	1.51	1.62	1.63	1.56



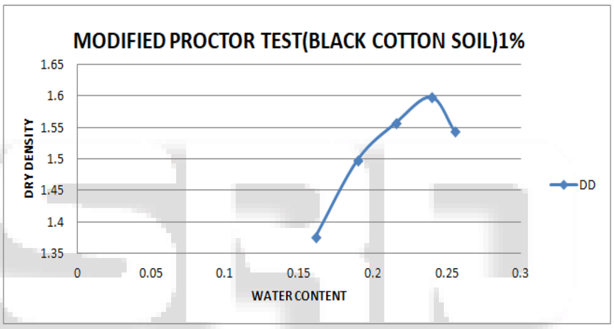
With geo-jute 0.5%:

Volume of the mould	V cc	2250	2250	2250	2250	2250
Empty weight of mould with base	W1 g	5520	5520	5520	5520	5520
Trail number		1	2	3	4	5
Weight of mould with base + compacted soil	W2 g	9360	9620	9880	9960	9940
Weight of compacted soil	Wc=W2-W1 g	3840	4100	4360	4440	4420
Bulk density	γb=Wc/V g/cc	1.71	1.82	1.94	1.97	1.96
Water content	W%	18.65	19.52	21.2	22.96	24.74
Dry density	γd=γb/(1+w) g/cc	1.44	1.52	1.6	1.602	1.57



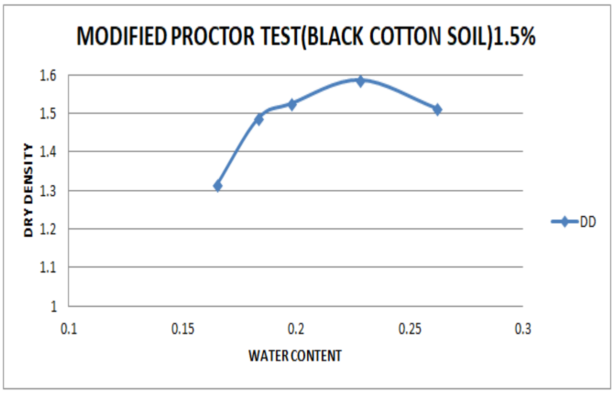
With geo-jute 1.0%:

Volume of the mould	V cc	2250	2250	2250	2250	2250
Empty weight of mould with base	W1 g	5520	5520	5520	5520	5520
Trail number		1	2	3	4	5
Weight of mould with base + compacted soil	W2 g	9240	9530	9750	9940	9880
Weight of compacted soil	Wc=W2-W1 g	3720	4010	4230	4420	4360
Bulk density	γb=Wc/V g/cc	1.65	1.78	1.88	1.96	1.93
Water content	W%	16.09	18.92	21.5	23.88	25.47
Dry density	γd=γb/(1+w) g/cc	1.37	1.49	1.55	1.59	1.54



With geo-jute 1.5%:

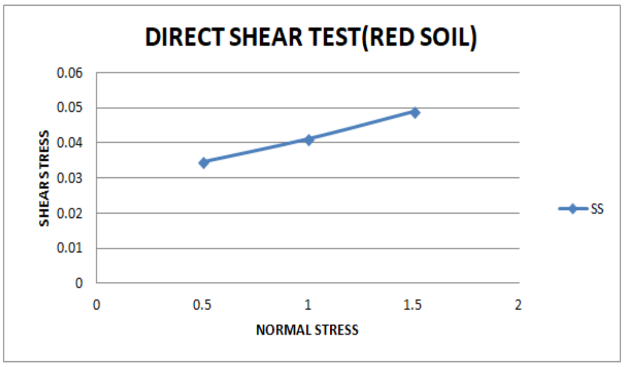
Volume of the mould	V cc	2250	2250	2250	2250	2250
Empty weight of mould with base	W1 g	5520	5520	5520	5520	5520
Trail number		1	2	3	4	5
Weight of mould with base + compacted soil	W2 g	9120	9480	9780	9920	9820
Weight of compacted soil	Wc=W2-W1 g	3600	3960	4260	4400	4300
Bulk density	γb=Wc/V g/cc	1.6	1.76	1.89	1.95	1.91
Water content	W%	16.5	18.3	19.8	22.8	26.2
Dry density	γd=γb/(1+w) g/cc	1.31	1.48	1.52	1.58	1.51



G. Direct Shear:

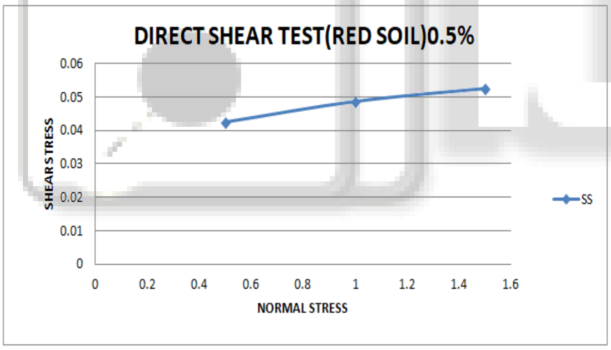
Red soil: Conventional

SL.NO	NORMAL STRESS σ Kg/cm²	SHEAR STRESS AT FAILURE τ Kg/cm²
1	0.5	0.034
2	1.0	0.041
3	1.5	0.048



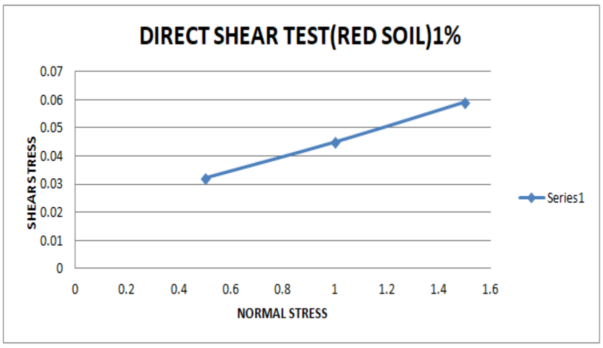
With jute 0.5%:

SL.NO	NORMAL STRESS σ Kg/cm²	SHEAR STRESS AT FAILURE τ Kg/cm²
1	0.5	0.042
2	1.0	0.048
3	1.5	0.052



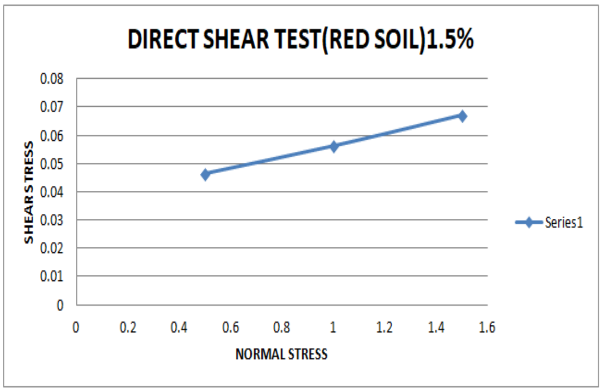
With jute 1.0%:

SL.NO	NORMAL STRESS σ Kg/cm²	SHEAR STRESS AT FAILURE τ Kg/cm²
1	0.5	0.032
2	1.0	0.045
3	1.5	0.059



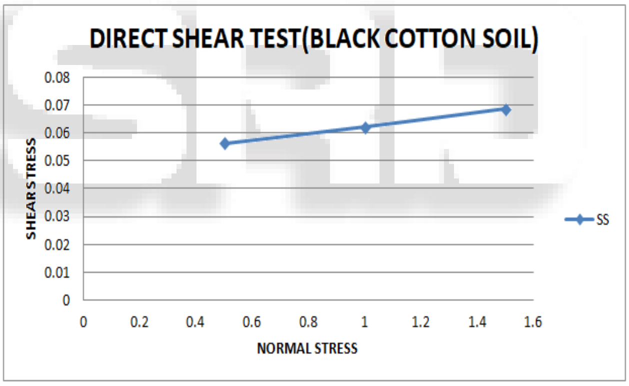
With jute 1.5%:

SL.NO	NORMAL STRESS σ Kg/cm²	SHEAR STRESS AT FAILURE τ Kg/cm²
1	0.5	0.046
2	1.0	0.056
3	1.5	0.067



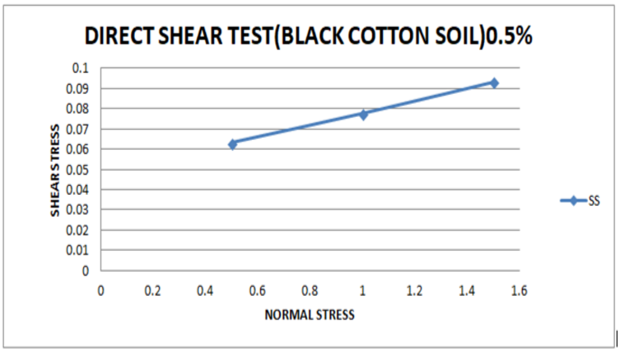
Black cotton soil: Conventional

SL.NO	NORMAL STRESS σ Kg/cm²	SHEAR STRESS AT FAILURE τ Kg/cm²
1	0.5	0.056
2	1.0	0.06
3	1.5	0.068



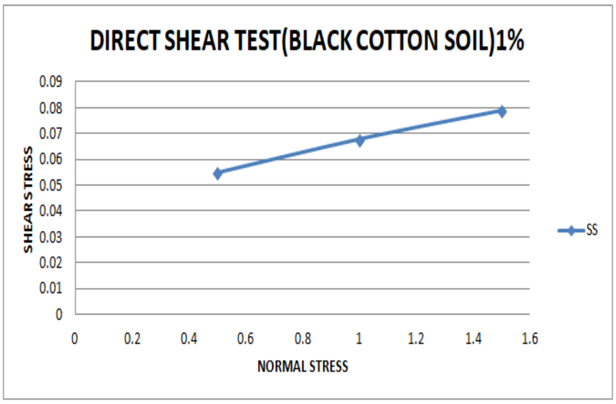
With jute 0.5%:

SL.NO	NORMAL STRESS σ Kg/cm²	SHEAR STRESS AT FAILURE τ Kg/cm²
1	0.5	0.063
2	1.0	0.077
3	1.5	0.093



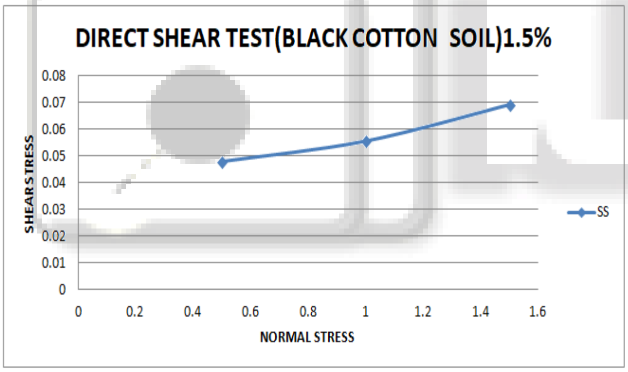
With jute 1.0%:

SL.NO	NORMAL STRESS σ Kg/cm²	SHEAR STRESS AT FAILURE τ Kg/cm²
1	0.5	0.054
2	1.0	0.067
3	1.5	0.079



With jute 1.5%:

SL.NO	NORMAL STRESS σ Kg/cm²	SHEAR STRESS AT FAILURE τ Kg/cm²
1	0.5	0.047
2	1.0	0.055
3	1.5	0.069



Results of C and ϕ values of soils:

SL NO	Name of the Soil	Jute %	Cohesion C kg/cm²	Angle of internal friction ϕ
1	Red soil	0.0	0.027	19°
		0.5	0.036	14°
		1.0	0.019	34°
		1.5	0.036	27°
2	Black cotton soil	0.0	0.05	17°
		0.5	0.048	35°
		1.0	0.043	31°
		1.5	0.037	28°

IV. CONCLUSIONS

Based on the direct shear test carried out on the different types of soils by using geo-jute the following conclusions were obtained:

1) The study determines the application of geo-jute on the different type of soil. The geo-jute increases the bearing capacity of soils.
2) By increasing the jute fiber content percentages MDD decreases and OMC increases.
3) The experiments increases in the performance of the soils in the dry condition. Use of geo-jute as reinforcement to the poor soils to increase the maximum load carrying capacity.
4) Geo-jute is bio-degradable, it also increase the service life of soil in construction. Reduces lateral spreading of the base course also increases confinement leading to the stiffer base.
5) It acts as drainage layer to remove excess water from softening the subgrade.

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