Stabilization of expansive soil by using lumber waste and lime and Rice husk

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Abstract **Expansive soils may cause the following problems in structures or construction projects: structural damage to lightweight structures such as sidewalks and driveways. lifting of buildings, damage to basements, and building settlement. cracks in walls and ceilings and the main problem associated with expansive soil is detoriate soil and causes various problem**

The main objective of this study is to investigate the use of lumber waste and lime and Rice husk waste with expansive soil materials in geotechnical applications and to evaluate the effects of shear strength of u soil by carrying out with laboratory testing such as atterberg limit and compaction factor test and direct shear test on soil samples with mix proportion includes 0%,6%,12%,18% of lumber dust and Rice husk ash. The results obtained are compared for the samples and inferences are drawn towards the usability and effectiveness of a replacement for soil stabilization and foundation, as a cost effective approach.

I INTRODUCTION

soil stabilization is the process of altering some soil properties by different methods, mechanical or chemical in order to produce an improved soil material which has all the desired engineering properties.

Soils are generally stabilized to increase their strength and durability or to prevent erosion and dust formation in soils. The main aim is the creation of a soil material or system that will hold under the design use conditions and for the designed life of the engineering project. The properties of soil vary a great deal at different places or in certain cases even at one place; the success of soil stabilization depends on soil testing. Various methods are employed to stabilize soil and the method should be verified in the lab with the soil material before applying it on the field. Principles of Soil Stabilization: Evaluating the soil properties of the area under consideration. Deciding the property of soil which needs to be altered to get the design value and choose the effective and economical method for stabilization. Designing the Stabilized soil mix sample and testing it in the lab for intended stability and durability values frame sentence Soil properties vary a great deal and construction of structures depends a lot on the bearing capacity of the soil, hence, we need to stabilize the soil which makes it easier to predict the load bearing capacity of the soil and even improve the load bearing capacity. The gradation of the soil is also a very important property to keep in mind while working with soils. The soils may be well-graded which is desirable as it has less number of voids or uniformly graded which though sounds stable but has more voids. Thus, it is better to mix different types of soils together to improve the soil strength properties. It is very expensive to replace the inferior soil entirely soil and hence, soil stabilization is the thing to look for in these cases. It improves the strength of the soil, thus, increasing the soil bearing capacity. It is more economical both in terms of cost and energy to increase the bearing capacity of the soil rather than going for deep foundation or raft foundation. It is also used to provide more stability to the soil in slopes or other such places. Sometimes soil stabilization is also used to prevent soil erosion or formation of dust, which is very useful especially in dry and arid weather. Stabilization is also done for soil water-proofing; this prevents water from entering into the soil and hence helps the soil from losing its strength. It helps in reducing the soil volume change due to change in temperature or moisture content.

Stabilization improves the workability and the durability

1.1 Methods

- Mechanical method of Stabilization

In this procedure, soils of different gradations are mixed together to obtain the desired property in the soil. This may be done at the site or at some other place from where it can be transported easily. The final mixture is then compacted by the usual methods to get the required density.

- Additive method of stabilization

It refers to the addition of manufactured products into the soil, which in proper quantities enhances the quality of the soil. Materials such as cement, lime, bitumen, fly ash etc. are used as chemical additives. Sometimes different fibers are also used as reinforcements in the soil. The addition of these fibers takes place by two methods;

a) Oriented fiber reinforcement-

The fibers are arranged in some order and all the fibers are placed in the same orientation. The fibers are laid layer by layer in this type of orientation. Continuous fibers in the form of sheets, strips or bars etc. are used systematically in this type of arrangement.

b) Random fiber reinforcement-

This arrangement has discrete fibers distributed randomly in the soil mass. The mixing is done until the soil and the reinforcement form a more or less homogeneous mixture. Materials used in this type of reinforcements are generally derived from paper, nylon, metals or other materials having varied physical properties.

Randomly distributed fibers have some advantages over the systematically distributed fibers. Somehow this way of reinforcement is similar to addition of admixtures such as cement, lime etc. Besides being easy to add and mix, this method also offers strength isotropy, decreases chance of potential weak planes which occur in the other case and provides ductility to soil.

OBJECTIVE

•Improves the strength of the soil by waste materials such as lumber dust Rice husk and, thus, increasing the soil bearing capacity

•It is more economical both in terms of cost and energy to increase the bearing capacity of the soil rather than going for deep foundation or raft foundation

•It helps in reducing the soil volume change due to change in temperature or moisture content.

II MATERIALS

Expansive soil

Expansive soil or clay is considered to be one of the more problematic soils and it causes damage to various civil engineering structures because of its swelling and shrinking potential when it comes into contact with water. Expansive soils behave differently from other normal soils due to their tendency to swell and shrink. Because of this swelling and shrinking behaviour, expansive soils may cause the following problems in structures

Lumber dust

Sawdust (or wood dust) is a by-product or waste product of woodworking operations such as sawing, sanding, milling, planing, and routing. It is composed of small chippings of wood. These operations can be performed by woodworking machinery, portable power tools or by use of hand tools. Wood dust is also the byproduct of certain animals, birds and insects which live in wood, such as the woodpecker and carpenter ant. In some manufacturing industries it can be a significant fire hazard and source of occupational dust exposure.

Lime

Lime is one of the additives which are widely used in the stabilization of soil. Lime is chemically known as calcium oxide (cao) and commonly known as quick lime. It is a white caustic alkaline crystal at room temperature. The lime used in our study was fined grained hydrated high calcium lime having formulae ca (oh) 2. The main contribution of lime to strength of soil is form its ability decrease the apparent amount of fines in a soil causing flocculation and agglomeration of clay particles lime also create cementation between soil particles, higher the surface area of soil the more effective the process of lime cementation. Lime is easily available and thus it was used

Rice husk Ash

RHA is grayish-black in color due to unburned carbon. At burning temperatures of 550–800 °C, amorphous silica is formed, while crystalline silica is produced at higher temperatures. The specific gravity of RHA varies from 2.11 to 2.27; it is highly porous and light weight, with a high specific surface area

III METHODOLOGY

Step 1: Problem identification with expansive soil

Step 2: Literature survey and finalizing Paper which is useful for our research work

Step3: Finalizing compositions as the final compositions was 0%, 6%,12% 18%
Step 4: Mixing proportion and making samples
Step5: performing test such as specific gravity, compaction direct shear test and liquid limit, plastic limit shrinkage limit
Step6: comparing Result and conclusion.

IV EXPERIMENTALINVESTIGATIONS

Specific Gravity
Liqiuid lmit
Plastic limit
Shrinkage limit
Compaction
Direct shear strength

V MATERIALS COLLECTIONS

Soil sample-1
Location: Behind academic block, ISL Engineering
Soil sample- 2
Location's block campus , ISL Engineering campus

VI PREPARATION OF SAMPLES

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 The different values adopted in the present study for the percentage of lumber waste, rice husk ash, lime are 0, 6%,12%,18%In the preparation of samples, if lumber waste, rice husk ash , lime is not used then, the air-dried soil was mixed with an amount of water that depends on the OMC of the soil. If lumber waste, rice husk ash , lime was used, the adopted content of waste was first mixed into the air-dried soil in small increments by hand, making sure that all the element were mixed thoroughly, so that a fairly homogenous mixture is obtained, and then the required water was added.

SPECIFIC GRAVITY

The specific gravity of soil is the ratio between the weight of the soil solids and weight of equal volume of water. It is measured by the help of a volumetric flask in a very simple experimental setup where the volume of the soil is found out and its weight is divided by the weight of equal volume of water.

Specific Gravity $G = \frac{W2-W1}{(W4-W1)-(W3-W2)}$

W1- Weight of bottle in gms
W2- Weight of bottle + Dry soil in gms W3- Weight of bottle + Soil + Water W4- Weight of bottle + Water
Specific gravity is always measured in room temperature and reported to the nearest 0.1.

LIQUID LIMIT

The Casagrande tool cuts a groove of size 2mm wide at the bottom and 11 mm wide at the top and 8 mm high. The number of blows used for the two soil samples to come in contact is noted down. Graph is plotted taking number of blows on a logarithmic scale on the abscissa and water content on the ordinate. Liquid limit corresponds to 25 blows from the graph.

PLASTIC LIMIT

This is determined by rolling out soil till its diameter reaches approximately 3 mm and measuring water content for the soil which crumbles on reaching this diameter. Plasticity index (Ip) was also calculated with the help of liquid limit and plastic limit;
$Ip = wL - wP$ wL- Liquid limit wP- Plastic limit

PROCTOR COMPACTION TEST

This experiment gives a clear relationship between the dry density of the soil and the moisture content of the soil. The experimental setup consists of (i) cylindrical metal mould (internal diameter- 10.15 cm and internal height-11.7 cm), (ii) detachable base plate, (iii) collar (5 cm effective height), (iv) rammer (2.5 kg). Compaction process helps in increasing the bulk density by driving out the air from the voids. The theory used in the experiment is that for any compactive effort, the dry density depends upon the moisture content in the soil. The maximum dry density (MDD) is achieved when the soil is compacted at relatively high moisture content and almost all the air is driven out, this moisture content is called optimum moisture content (OMC). After plotting the data from the experiment with water content as the abscissa and dry density as the ordinate, we can obtain the OMC and MDD. The equations used in this experiment are as follows:

Specific Gravity

Soil sample- 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- 3

Soil sample- 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**		

Table- 4

Wet density = weight of wet soil in mould (gms)
volume of mould(cc)
Moisture content % = weight of water (gms)
weight of dry soil (gms)
Dry density γd (gm/cc)

DIRECT SHEAR TEST

This test is used to find out the cohesion (c) and the angle of internal friction (φ) of the soil, these are the soil shear strength parameters. The shear strength is one of the most important soil properties and it is required whenever any structure depends on the soil shearing resistance. The test is conducted by putting the soil at OMC and MDD inside the shear box which is made up of two independent parts. A constant normal load (ς) is applied to obtain one value of c and φ. Horizontal load (shearing load) is increased at a constant rate and is applied till the failure point is reached.

This load when divided with the area gives the shear strength 'τ' for that particular normal load. The equation goes as follows:

$\tau = c + \sigma * \tan(\varphi)$

After repeating the experiment for different normal loads (ς) we obtain a plot which is a straight line with slope equal to angle of internal friction (φ) and intercept equal to the cohesion (c). Direct shear test is the easiest and the quickest way to determine the shear strength parameters of a soil sample. The preparation of the sample is also very easy in this experiment.

VII RESULT AND DISCUSSION

Soil sample- 2

Sample No.	1	2	3	4	5
Mass of empty can	13.24	12.56	13.53	13.26	12.96
Mass of can + wet soil in gms.	54.92	53.02	53.06	45.12	51.48
Mass of can + dry soil in gms.	42.00	40.68	41.28	35.74	39.65
Mass of soil solids	28.76	28.12	27.75	22.53	26.69
Mass of pore water	12.92	12.34	11.78	9.33	11.83
Water content (%)	44.95	43.91	42.45	41.40	44.33
No. of blows	18	23	30	35	21

Table- 6

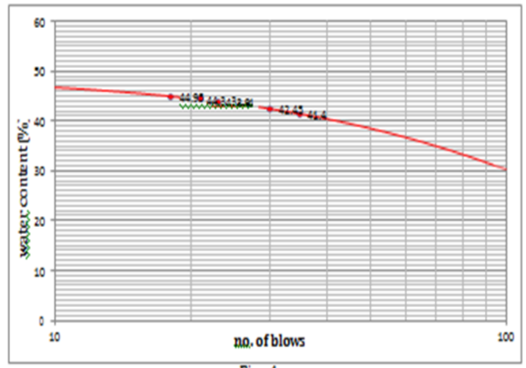


Fig. 4

Liquid limit as obtained from graph = **43.491**
(corresponding to 25 blows)

Plastic Limit

Soil sample- 1

Sample No.	1	2	3
Mass of empty can	5.54	5.86	5.47
Mass of (can+wet soil) in gms.	9.4	10.6	9.9
Mass of (can + dry soil) in gms.	8.7	9.7	9.1
Mass of soil solids	3.1	3.8	3.6
Mass of pore water	0.7	0.9	0.8
Water content (%)	22.38	23.43	21.94
Average Plastic Index	**22.58**		

Table- 7

Soil sample-2

Sample No.	1	2	3
Mass of empty can	5.62	5.67	5.76
Mass of (can+wet soil) in gms.	10.60	9.80	9.50
Mass of (can + dry soil) in gms.	9.80	9.10	8.90
Mass of soil solids	4.18	3.43	3.14
Mass of pore water	0.80	0.70	0.60
Water content (%)	19.14	20.41	19.12
Average Plastic Index	**19.56**		

Table- 8

Plasticity Index

Soil sample- 1

$I_p = W_L - W_P = 28.90 - 22.58 = 6.32$

Soil sample- 2

$I_p = W_L - W_P = 43.91 - 19.56 = 24.35$

According to USUC classification of soils,

Soil sample- 1
ML: silt, low plasticity

Soil sample- 2
CL: clay, low plasticiy

Index Properties

Liquid Limit

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

Table- 5

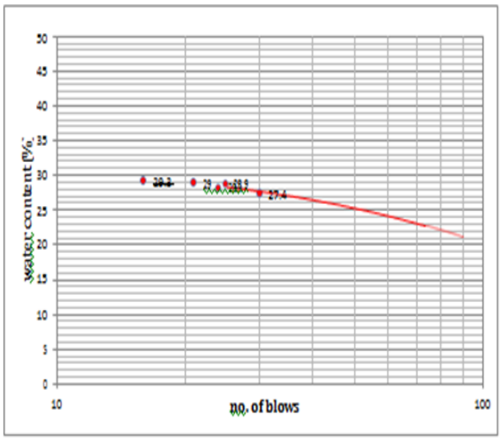


Fig. 3

Liquid limit as obtained from graph = **28.90**
(corresponding to 25 blows)

Standard Proctor Compaction Test

Soil 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-X_1	8.79	10.65	12.59	13.61	15.75
Dry density Y_d=Y_t/1 + (W/100) gm/cc	1.81	1.86	1.91	1.85	1.82

Table- 11

Soil 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 Yd= Yt/(1+ (W/100)) gm/cc	1.79	1.86	1.96	1.875	1.83

Table- 12

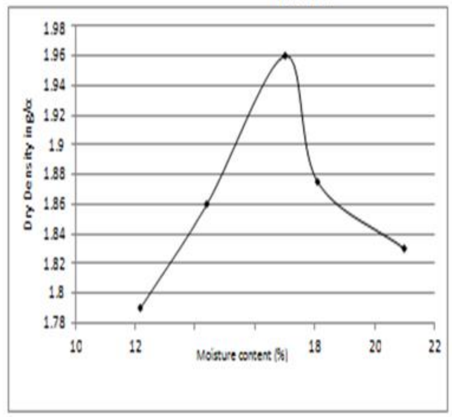
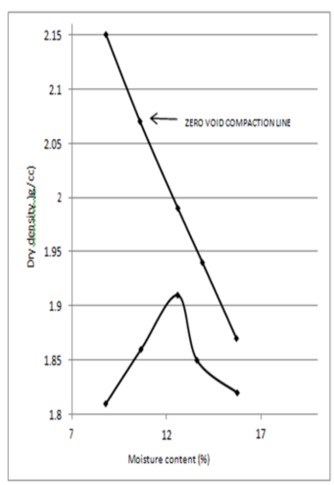


Fig. - 8

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



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

Direct Shear Test

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

Table- 13

i) Normal soil

Sample No.	Normal Stress(kg/cm²)	Proving ring reading	Shear Load (N)	Shear Load (kg)	Shear Stress (kg/cm²)
1	0.5	54	206.58	21.06	0.59
2	1	84	321.35	32.76	0.91
3	1.5	106	405.51	41.34	1.14
4	2	168	451.42	46.02	1.27

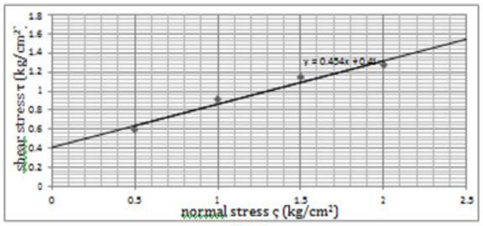


Fig. - 9

Computing from graph,

Cohesion (C) = 0.325 kg/cm² ; Angle of internal friction (φ) = 47.72˚

VII. ACKNOWLEDGEMENT

We would like to thank VTU for providing this opportunity to work on this project. We also acknowledge our guide assistant professor departmentof ETE department JNNCE Shimoga for giving the knowledge about this project and also co-operating in implementing this research oriented-research.

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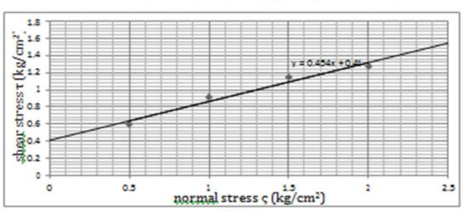


Fig. - 9

Computing from graph,

Cohesion (C) = 0.325 kg/cm² ; Angle of internal friction (φ) = 47.72˚

ii) Reinforcement = 6% (Lumber waste +ricehuskash + lime)%

Sample no.	Normal load (ς)	Proving constant	Shear load (N)	Shear load (kg)	Shear stress (kg/cm²)
1	0.5	76	290.27	29.62	0.83
2	1.0	120	458.19	46.75	1.31
3	1.5	160	612.08	62.45	1.75
4	2.0	206	786.96	80.30	2.25

Table- 14

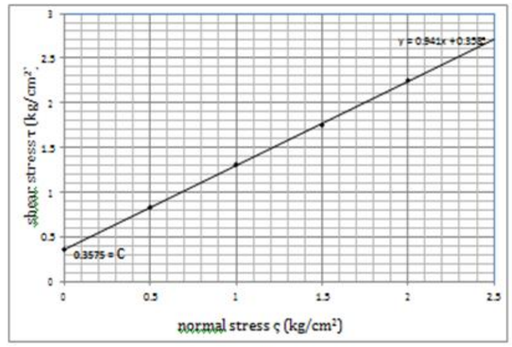


Fig. - 10

Computing from graph,

Cohesion (C) = 0.3575 kg/cm²

Angle of internal friction (φ) = 48.101˚

Discussions

The relationship between shear strength parameters and 6% (Lumber waste +ricehuskash + lime)%-

(a) cohesion and content Soil

sample- 1

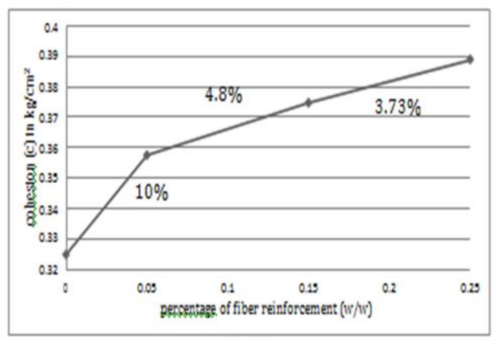


Fig. - 25

Soil sample- 2

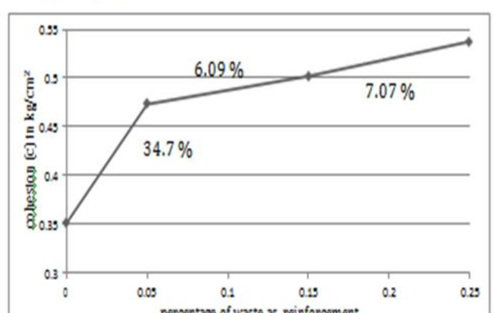


Fig. - 26

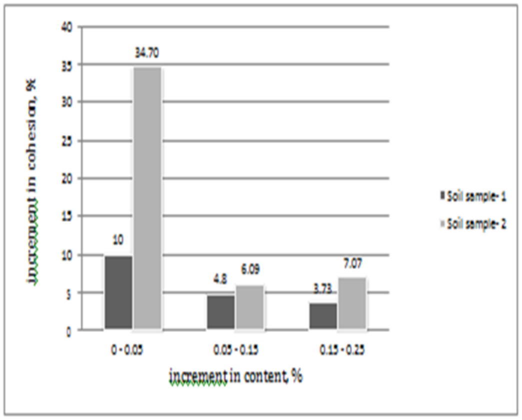
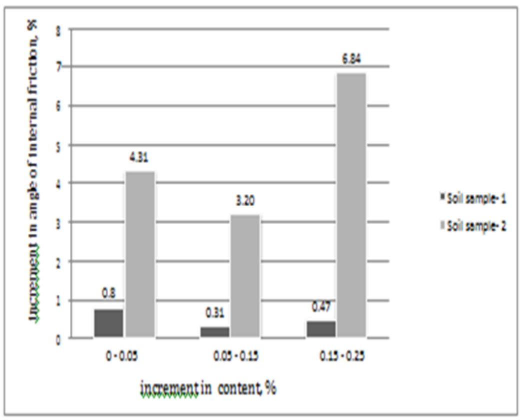


Fig. - 31



Inferences from Direct Shear Test

Soil sample- 1

Cohesion value increases from 0.325 kg/cm2 to 0.3887 kg/cm2, a net 19.6%

The increment graph shows a gradual decline in slope.

The angle of internal friction increases from 47.72 to 48.483 degrees, a net 1.59%

The increment in shear strength of soil due to reinforcement is marginal.

Soil sample- 2

Cohesion value increases from 0.3513 kg/cm2 to 0.5375 kg/cm2, a net 53.0%

The increment graph for cohesion shows a gradual decline in slope.

The angle of internal friction increases from 27.82 to 32 degrees, a net 15.02%

The increment graph for φ shows a variation in slope- alternate rise and fall.

The increment in shear strength of soil due to reinforcement is substantial.

(b) angle of internal friction and contentSoil sample- 1

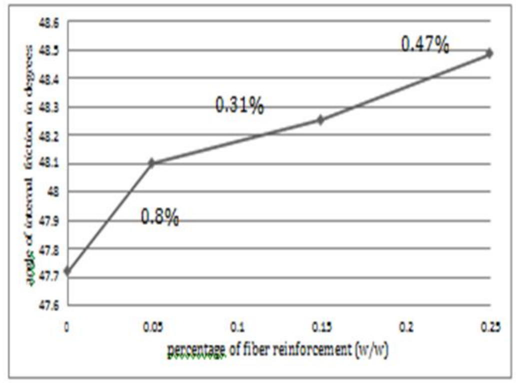


Fig. - 27

Soil sample- 2

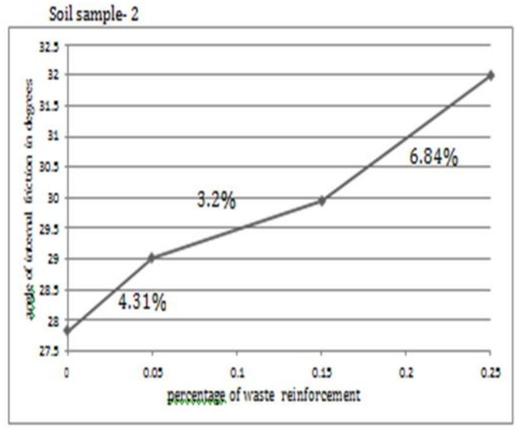


Fig. - 26

Comparison of shear parameters between soil sample- 1 and soil sample- 2

VIIICONCLUSIONS

On the basis of present experimental study, the following conclusions are drawn:

1. Based on direct shear test on soil sample- 1, with 6% (Lumber waste +ricehuskash + lime)reinforcement of 6%, 12% and 18%, the increase in cohesion was found to be 8%, 4.8% and 3.73% respectively (illustrated in figure- 25). The increase in the internal angle of friction (φ) was found to be 0.8%, 0.31% and 0. 47% respectively (illustrated in figure- 27). Since the net increase in the values of c and φ were observed to be 19.6%, from 0.325 kg/cm2 to 0.3887 kg/cm2 and 1.59%, from 47.72 to 48.483 degrees respectively, for such a soil, randomly distributed is not recommended.
2. The shear strength parameters of soil sample- 2 were determined by direct shear test. Figure- 26

illustrates that the increase in the value of cohesion for fiber reinforcement of 6%, 12% and 18% are 34.7%, 6.09% and 7.07% respectively. Figure 27 illustrates that the increase in the internal angle of friction (φ) was found to be 0.8%, 0.31% and 0. 47% respectively. Thus, a net increase in the values of c and φ were observed to be 53%, from 0.3513 kg/cm2 to 0.5375 kg/cm2 and 15.02%, from 27.82 to 32 degrees. Therefore, the use of 6% (Lumber waste +ricehuskash + lime)% as reinforcement for soils like soil sample- 2 is recommended.

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