Use of Coir Fiber And Wheat Husk Ash To Improve the Characteristics of Clayey Soil

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Abstract

Soil is the origin of everything. As we know everything is dependent on nature, and as a civil engineer we know that soil plays a vital role in construction. When we erect any structure over the soil, firstly we check the behavior and attribute of soil that how much strength is present in the soil so that it can bear structure load which will be erected over this soil. There are several types of soil which have different- different qualities, some soils have greater strength and some have lower, if the strength of soil is lower than our requirement then we constrained to increase the strength of the soil as per our structure requirement. In this research paper we performed various test on soil to know its properties or strength by using agricultural waste material such as wheat husk ash (WHA) as a stabilized material in soil with varying percentages 4%, 8%, 12%,16%. Use of Coconut Coir Fiber for improving soil property is advantageous because they are cheap, locally available and eco-friendly. In this study, the stabilizing effect of Coir Fiber on soil properties has been Experimental studied.

Keeping this in view an experimental study is conducted on locally available i.e. expansive soil mixed with varying percentage of Coconut Coir Fiber.

Soil samples for California bearing ratio (CBR) tests and UCS are prepared at its maximum dry density (MDD) corresponding to its optimum moisture content (OMC in the CBR mould and UCS sampler without and with Coconut Coir Fiber. The percentage of Coconut Coir Fiber by dry weight of soil is taken as 1%, 1.5%, 2% and 2.5% and corresponding to each Coconut Coir Fiber content soaked CBR tests and UCS tests are conducted in the laboratory. Tests result indicates that soaked CBR and UCS value of soil increases with the increase in Coconut Coir Fiber content. Adding of Coconut Coir Fiber and Wheat Husk Ash results in less thickness of pavement due to increase in CBR of mix and reduce the cost of construction and hence economy of the construction of highway will be achieved. This is because of composite effect of Coconut Coir Fiber and Wheat Husk Ash changes the brittle behaviour of the soil to ductile behaviour.

Keywords :- *clayey soil, wheat hush ash and coir fiber*

I. INTRODUCTION

Soil is a significant component in the construction scenario. The longevity of a structure is directly dependent on the soil upon which it rests, therefore, it is necessary to ensure that the soil over which any structure is constructed, is firm or stable enough. Soil stabilization is a set of methods devised to improve the stability of soil. Various stabilization techniques prevail in the construction field utilizing diverse materials of varying properties. The basic construction material of the geotechnical engineer's design foundation is the soil.

In many set of circumstances, road service layers, foundation layers and construction material cannot utilize the soil directly. The rising cost of the land, and huge demand for high rise buildings makes the improvement of soil at a site unavoidable. Therefore, it is required to revamp the quality of the soil.

The expansive soil used in this research also known as black cotton soil. This soil is taken as it contains particles of montmorillonite, which absorbs water easily and thus, attains contraction and shrinking property. The humidify and scorch process of a subgrade layer comprised of black cotton (BC) soil which results into failure of pavements in form of colonization and rupture.

Therefore, soil is binded to suppress the effect of such particle, which is responsible for the high percentage of expansiveness and cracks thus, it is dangerous for the construction. Therefore, it is important either to remove the existing soil and replace it with a non-expansive soil or to improve the important properties of the existing soil by stabilitity prior to construction of a road on such subjugate.

This study, particularly aims at testing the viability of utilizing waste materials such as wheat Husk Ash and Coir Fiber which are eco-friendly as well as economical, for soil stabilization.

II. LITERATURE REVIEW

FF. Mona Malekzadeh et al (2009)

Reported that optimum water content is not influenced by polypropylene fiber inclusion, where as maximum dry density has been reduced. This can be attributed to the reduction of average unit weight of

solids in the soil-fiber mixture. Studying the influence of polypropylene fiber on swell characteristics, the overall conclusion is that one-dimensional swell decreases considerably with 1% fiber addition. Unconfined compressive strength increases with polypropylene fiber inclusions. Maximum value of cohesion can be observed with 1% fiber content which is approximately 1.5 times of the unreinforced soil. From the analysis of split tensile strength test, it is observed that the maximum value of the tensile strength obtained for 1% fiber inclusion is 2.7 times of the unreinforced soil.Increase in the ratio of tensile strength to compressive strength indicates that polypropylene fiber for cement is more effective in improving tensile than the compressive strength. Thus fiber enhances the ductile behavior of soils, reducing shrinkage settlements during desiccation, hence detrimental damages to structures, such as roads and pavements may be prevented.

Mr. Santosh et al. (2012)
Reported that Addition of different % of Wheat Husk Ash (WHA) the water content decrease up to a limit afterwards again it increases. This is more effective for addition of 9% (optimum) WHA. Addition of different % of WHA the dry density increases up to a limit afterwards again it decreases. This is more effective for addition of 9% (optimum) WHA. The stress against different days for varying % WHA, for varying % of WHA, as number of day's increases stress also increases. This is more effective for 7days.

Savitha A.L. et al. (2013)
Conducted compaction tests and UCS tests on Black Cotton soil using coarse and fine fly ash. They varied the percentage of fly ash from 5% to 25% with increase of 5% at a time. Curing was done for 1,7,14,28 days. They reported that the strength obtained by fine fly ash was 25% more than that of coarse fly ash. On increasing water content up to 30%, the dry density decreases and if water content is increased further the dry density decreases gradually. The MDD was 1.35 g/cc for 5% fly ash mixed with 95% soil and lowest density was 0.6g/cc for 30% fly ash mixed with 70% soil.

Agrawal M.L. et al. (2013)
Performed compaction tests and CBR test on black cotton soil. They varied the percentage of flyash from 10% to 50% with increase of 10% at a time. They investigated that the MDD increases with increment in fly ash up to 20% , and with more addition it decreases. The increase in CBR value and dry density is maximum for 30% fly ash mixture with black cotton soil. On increasing percentage of fly ash, there is decrease in the liquid limit of black cotton soil, resulting in reduced swelling of soil.

Yanbin Li et al. (2014)
Performed compaction test and triaxial shear test on silty clay. They used 0.5%, 1%, 1.5% sisal fiber with lengths 5mm, 10mm and 15 mm. They reported that the stress increased with increase in strain when 1.0% fiber content is taken and they observed no decrease in stress when the strain exceeded 1.0%.They reported that silty clay reinforced with sisal fiber has 20% more strength than non-reinforced clay when 1.0% fiber content of length 10 mm is considered.

Kumar R. et al. (2014)studied the effect of sisal fibers on the UCS value of bentonite. He reported that there can be an increase in the UCS value of bentonite by adding lime, phosphogypsum and sisal fibres. The highest UCS value was obtained at 8% lime, 8% phosphogypsum and 1% sisal fibers. UCS value increased with increment in fibre from 0.5 to 2% fiber.

Abadi et al. (2014)
Conducted compaction test and California bearing ratio test on clay. He varied the percentage of fly ash from 5% to 25% with increase of 5% at a time. He reported that the MDD of clay increased with increment in ash till 15%, then decreased to 1.53 at 20% ash. The OMC decreased until 15 %,then after that it started to increase. CBR value reduces slightly when soil ash mixture contains more than 15% ash.

Swarup J. et al.(2015)
Performedcompaction tests and CBR tests on the black cotton soil. They used sisal fiber (0.25%, 0.5%, 0.75%, 1%, 2%, 3%), NaOH (3%, 6%, 9%, 12%,15%) and flyash 20% by weight of dry soil. They concluded that optimum value of NaOH is 9%, 12N. Normal soil matrix gives the maximum CBR values at nearly 11% of fiber content but due to this stabilization technique, the maximum amount of CBR value can be attained at less amount of fiber content i.e. at 0.2%.

III. MATERIALS

A. Clayey soil

The clayey soil used in this investigation were collected from Samba district of J&K from where Basantar River flows (India). The soil was brought to lab in bags and soil was dried in oven for one day followed by pulverization. Soil was pulverized to pass the soil through 4.75 mm size sieve and stored in such way that, there is very minor chances of absorption of moisture by soil. Sieve analysis tests were conducted on soil to find out the soil classification and according to the soil results soil can be classified as CI (intermediate compressible clayey soil). The Engineering properties of the soil are given in Table 3.1.

Properties of virgin soil

S No.	Properties	Results
1	Specific gravity	2.62
3	Liquid Limit (%)	45
4	Plastic Limit (%)	24
5	Plasticity index (%)	21
6	Classification of soil	CI
7	Maximum Dry Density (gm/cc)	1.762
8	Optimum Moisture Content (%)	15.89
9	UCS (kpa)	82.06
10	CBR value (%)	2.9

B. COIR FIBER

Coir fibers are found between the hard, internal shell and the outer coat of a coconut. The individual fibre cells are narrow and hollow, with thick walls made of cellulose. They are pale when immature, but later become hardened and yellowed as a layer of lignin is deposited on their walls. Each cell is about 1 mm (0.04 in) long and 10 to 20 µm (0.0004 to 0.0008 in) in diameter. Fibres are typically 10 to 30 centimetres (4 to 12 in) long.

The two varieties of coir are brown and white. Brown coir harvested from fully ripened coconuts is thick, strong and has high abrasion resistance. It is typically used in mats, brushes and sacking. Mature brown coir fibers contain more lignin and less cellulose than fibres such as flax and cotton, so are stronger but less flexible.

White coir fibers harvested from coconuts before they are ripe are white or light brown in colour and are smoother and finer, but also weaker. They are generally spun to make yarn used in mats or rope.

The coir fibre is relatively waterproof, and is one of the few natural fibres resistant to damage by saltwater.

Source of Coir Fiber

Coir fiber is taken from Jawahar nagar jaipur (Rajasthan).

C. WHEAT HUSK ASH

Source of Wheat Husk Ash

Wheat Husk Ash is taken from locally area by burning locally available wheat husk in an open kiln for about twenty four hours. After complete burning, the burnt material was sieved through I.S.425 micron sieve and minus 425 -fraction was taken for the study.

Chemical properties of WHA at 600 °C

S. No	Compound	Value(%)
1	Silicon Oxide(SiO_2)	43.22
2	Potassium Oxide(K_2O)	11.30
3	magnesium Oxide(MgO)	0.99
4	Iron Oxide(Fe_2O_3)	0.84
5	Sodium Oxide (Na_2O)	0.16
6	Calcium oxide(Cao)	5.46

D. METHODOLOGY

Following tests are to be conducted on virgin soil as well as soil containing different proportion of calcium carbide and fly ash to determine the various parameters proposed in the objectives ;

I. Determination of soil index properties
   - Liquid limit test
   - Plastic limit test
   - Specific gravity

II. Determination of maximum dry density (MDD) and corresponding optimum moisture content (OMC) of soil by Proctor compaction test.

III. Determination of strength parameters i.e. CBR value and unconfined compressive strength (UCS).

RESULTS

This chapter provides the details and information about the various tests that were performed in this chapter. It also provides the details that how the various resources are utilize and processed in the present study. It also gives the details of mix proportions ratios. The most profitable perspective in this part is after effects of different tests are additionally included this section. The results included standard proctor test (O.M.C and M.D.D), UCS and CBR test results.

MIX PROPORTION USED

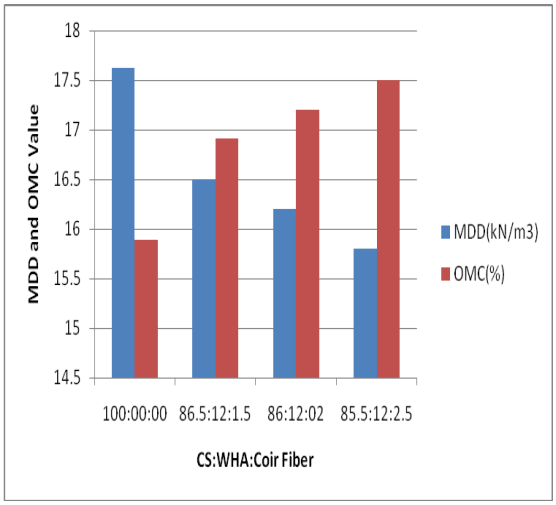
In this experimental study, the ratio used for Wheat husk ash is 4%, 8%,12% and 16% while for Coir fiber it is 2%, 2.5%, 3% and 3.5%.

Various mix proportion of the present study

Sr. No.	Designation(CS: WHA: Coir fiber)
1.	100:0:0
2.	96:4:0
3	92:08:0
4.	88:12:0
5.	84:16:0
6.	98:0:02
7.	97.5:0:2.5
8.	97:0:03
9.	96.5:0:3.5
10	86.5:12:1.5
11.	86:12:2
12.	85.5:12:2.5

STANDARD PROCTOR TEST

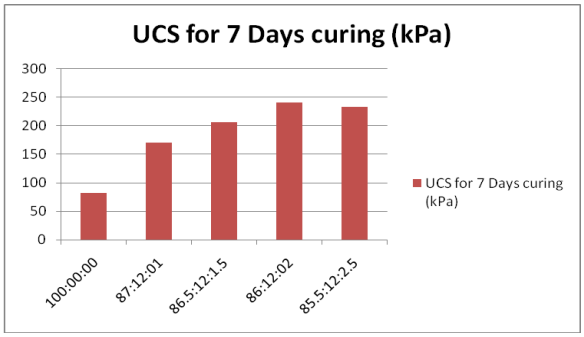
CS: WHA: Coir fiber	MDD(kN/m^3)	OMC(%)
100:0:0	17.62	15.89
86.5:12:1.5	16.5	16.91
86:12:2	16.2	17.20
85.5:12:2.5	15.8	17.50



UCS OF CLAYEY SOIL, WHEAT HUSK ASH AND COIR FIBER

UCS Results of Clayey Soil with Different Proportion of Wheat husk ash & Coir fiber

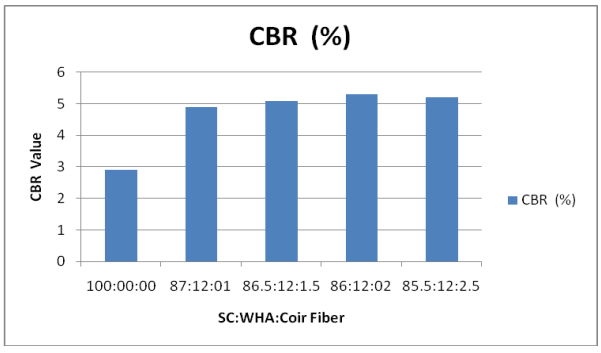
CS : W.A : Coir fiber	Curing (Days)	UCS(kPa)
100 : 00 : 00	7	82.6
87 : 12 : 01	7	170.56
86.5:12:1.5	7	205.81
86:12:2	7	241.25
85.5:12:2.5	7	233.05



CALFORNIA BEARING RATIO

Results of CBR value for clayey soil sample.

Mix Proportions (CS:WHA:Coir fiber)	CBR (%)
100:0:0	2.9
87:12:01	4.9
86.5:12:1.5	5.1
86:12:2	5.3
85.5:12:2.5	5.2



DISCUSSIONS

An increase of OMC from 15.89 to 18.10% and decrease of M.D.D. from 1.762 to 1.63 g/cc when the percentages of Wheat husk ash are used as 4% ,8%, 12% and 16% respectively. In this value of MDD is decreased up to 12% wheat husk ash, after that it increases. Therefore, value of 12% is taken optimum

With Wheat husk ash kept constant at 12% MDD decreases with an addition of Coir fiber content in soil mix. The reason behind of such behavior is Coir fiber is lighter in weight and it has high water absorption properties because of presence of calcium oxide and hence OMC increases with increase of coir fib The UCS values of virgin soil also improves considerably by keeping wheat husk ash value fixed at12% and coir fiber in %ages 2,2.5,3 and 3.5. The value increases from 82.6 kN/m² to 241.25 kN/m² with the addition of wheat husk ash and coir fiber upto 6% and then further addition of coir fiber content decreases UCS value. Therefore woodash12% and coir fiber 3% is taken as optimum.

The reason behind of this when wheat husk ash and coir fibre comes in contact with water, pozzolanic reactions takes place during the curing period. With further increase in the amount of coir fibre, U.C.S. value starts decreasing because of lumps are formed with extra addition of coir fiber in 3% coir fiber with 12% wood ash.

The CBR value of virgin soil is 2.9 and it increase to 1.71 times when wheat husk ash 12% and coir fiber 2% is added to virgin soil. This enhancement in CBR may be because of the gradual formation of hydration compounds in the soil due to the reaction between the stabilizers and the essentials particle present in the soil. The increase in CBR value from 4.9 to 5.3 when wheat husk ash is fixed at 12% and coir fiber added at different ratios i.e. 1, 1.5, 2 after that it decreases. As a result of coir fiber is a light material and with increment the amount of lumps are formed.

CONCLUSIONS

In this study, a series of Standard Proctor test, unconfined compression strength test and the CBR test was carried out to calibrate the effect of two chemical additives namely Coir fiber and wheat husk ash on the clayey soil sample. The results showed that Coir fiber and wheat husk ash could improve the UCS value, Dry density and CBR Percentage of clayey soil sample.

The different percentages of Coir fiber and wheat husk ash used in this study were 02%, 2.5%, 3% & 3.5% and 4%, 8%, 12% and 16%. Finally, the value of wheat husk ash was fixed to 12% with variation of Coir fiber(1%, 1.5%, 2% and 2.5%) to clayey soil.

The addition of the fixed quantity of wheat husk ash 12% with changing the content of Coir fiber increases the value of optimum moisture content and decreases the value of maximum dry density.

The UCS value increases with an increase of Coir fiber content along with a fixed quantity of wheat husk ash. The maximum value of UCS was found at 02% Coir fiber and 12% wheat husk ash. Further increase of Coir fiber content in soil would decrease the UCS value.

Based on the CBR test results, the value of CBR increases from 2.9 to 5.3.

The optimum value of California Bearing Ratio was found at 02% Coir fiber and 12% wheat husk ash.

Hence, the addition of Coir fiber and wheat husk ash makes the soil mixes durable, economical and effective for soil stabilization process if these two materials are easily available near to the site.

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REFERENCES

[1] All paArvind Kumar., Baljit Singh Walia(2007), “Influence of Fly Ash, Lime, and Polyester Fibers on Compaction and Strength Properties of Expansive Soil”, Journal of Material in Civil Engineering, Vol 19, pp 242-248, ASCE.

[2] H.N. Ramesh ., K.V. Manoj Krishna and H.V.Mamatha (2011), “Strength Performance of Lime and Sodium Hydroxide Treated-Coir Fiber Reinforced Soil”, Indian Geotechnical Conference, Vol J- 31, pp 523-525.

[3] K.R. Manjunath(2013), “ Effect Of Random Inclusion Of Sisal Fiber On Strength Behavior Of BlackCotton Soil”. (IJERT), ISSN 2278-0181 vol.2 issue 7.

[4] A.L. Savitha(2013), “conducted compaction tests and UCS tests on Black Cotton soil using coarse and fine fly ash”.

[5] Himanshu Gupta (2017), “an experimental study of Natural Soil Subgrade Stabilized with Wheat Husk Ash And Polypropylene”(IJRASET), ISSN 2321-9653 vol.5 issue 12.

[6] N.J. Shamle, C.J. Dados, S.E. Iwoh, J.G. Nangbes and A.U Awode“Comparative Assessment of the Yields of Silica from Husk Ashes of Digitariaexilis (acha), wheat and rice” Journal of Applied Chemistry (IOSR-JAC) January 2014, e-ISSN: 2278-5736.Volume 7, Issue 7 Ver. III. , PP 01-04, DOI: 10.9790/5736-07730104.

[7] S. Manimaran, Gayathiri .K, Sinduja.R, Vengadesh.S“Role of Additives in Expansive Soil to Improve Stabilization Performance Using Biomass Silica” International Journal for Scientific Research & Development,2015,Vol. 3, Issue 04,ISSN 2321-0613.

[8] Mr. Santosh, Prof. Vishwanath C.S. “Stabilization of Expansive Soil by using Wheat Husk Ash and Granulated Blast Furnace Slag” International Journal for Scientific Research & Development,2015, Vol. 3, Issue 04,ISSN (online): 2321-0613.

[9] Jiguang Zhang, Guodong Bo , Zhongfeng Zhang, Fanyu Kong, Yi Wang and GuomingShen “Effects of Straw Incorporation on Soil Nutrients, Enzymes, and Aggregate Stability in Tobacco Fields of China” Sustainability,2016, 710; doi:10.3390/su8080710.