GREEN SURFACE WITH TREATED COIR FIBER MORTAR AND BLACK COTTON FIBER FOR STRENGTHERN BASEMENT

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Abstract: Civil construction and Environmental friendly approaches are travelling to reach the destination of Green Building (Eco Friendly). Reinforcement technique is making drastic changes in the civil industries. Number of wastes are increasing daily due to Agriculture waste, Plastic waste, Food waste, liquid waste and so on. This research has taken Reinforcement method and uses the Agriculture waste with chemical properties and Black cotton soil. The Green approach always refers the renewable sources and natural sources, hence here we have chosen natural and mostly available Black Cotton soil and coir fiber. The reason of selected Coir fiber is, it is a recyclable one, low cost/waste material, natural cooling one (very low-thermal conduct), low weight and high strength ratio. In the same way these study increases the bearing capacity of black cotton soil. In rapidly growth of population in our country the infrastructures of urban & rural developments are very difficult to build. It is observed that on drying, the black cotton soil develops cracks of varying depth. Most of the constructed buildings and other civil engineering structures have to be carried out on weak or soft soil. The recent development in the use of advanced composites in the improvement of soil is increasing on the basis of specific requirements and national needs. This paper introducing the coir fiber reinforcement for increasing the bearing capacity of the soil and coir fibres are treated with chemicals, it shows the results of increasing the properties of strength of soil.

Keywords: Coir fiber, Black Cotton Soil (Clay soil), Reinforcement, Chemical, Mortal, Reusable waste

Introduction

Soil is the crucial element in mother earth. The soil is an all the civil engineering work's back bone and always depending river soil (nature). Some of the expansive soils are available in India (selected area) and also in many other countries. Meanwhile all types of soil's sample and strengthen properties are not commonly sharing with everyone (public). If pose soils used for constructions then it will make dangerous foundation problems. If proper precautions have not been taken then need to face super structure's damage cause.Reinforcement combination of coir fiber and Black Cotton soil mortar will give a strengthen mix for industrial flooring and road transporting work.

1. Related Research

After trimming, the four components including the untreated, 0.25% fibre-reinforced, 8% lime-stabilized and 0.25% fibre–8% lime ones were subjected to SEM analysis. In order to clearly
observe the soil fabric of four different specimens, there is no fibre included. An increase in fibre content leads to increases in strength, shrinkage potential and toughness of soil while results in the reduction of swelling potential. With an increase in the fibre content, the strength of the stabilized soil increases **(Yi Cai, 2006).**
Cemented sand was reinforced with randomly distributed PVA fibers for improving the strength and the brittle behaviour of the sand. A series of unconfined compression tests were carried out on lightly cemented specimens with randomly distributed PVA fibers that bond well to cement. The combination of the fiber ratio and the cement ratio on the strength and the ductility of cemented sand were investigated. The fiber-reinforced cemented sand with 2% cement ratio is 3.5 times stronger than non-fiber-reinforced cemented sand. The effect of fiber inclusion is most apparent in the 2% cemented samples **(Sung, 2011)**.
Soil with Fiber mixed concrete or mortar using in all other countries for many other hidden aspects. Soil with Fiber mixed (fiber + sand/silt/clay) combination produce effective result with all types of soils. The coir fiber is one of the natural and hardest fiber. Coir fiber is highly available (high content of lignin); coir have more advantageous in different application for, reinforcement, erosion control and stabilization of soil and is preferred to any other natural fibers **(Singh and Mittal, 2014)**.

2. Material and Methods

Black cotton soil and coir fiber are selected as materials for mortal, this combination of matrix retain their chemical bond and physical bond.

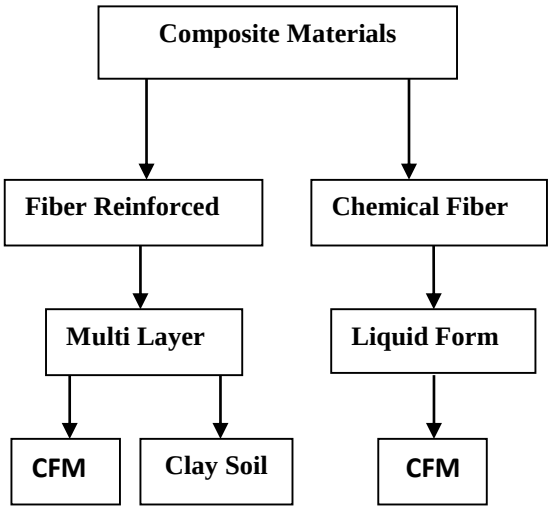

Figure 1: Classification of Composite

Fibers are the principal load carrying members, while the surrounding matrix keeps them in a desired location and orientation, acts as a load transfer medium between them, and protects them from environmental damages due to elevated temperature and humidity. Thus even though the fibers provide reinforcement to matrix, the later also serves a number of useful functions in fiber reinforced composites.

Two intrinsically different materials will be mixed to form a new material called composite material, which is different from both but better in properties. The two constituents of the composites are called as matrix and resin. Matrix, it is the main constituent of composites materials mainly responsible for its mechanical properties. Adhesive/Resin normally it is a synthetic polymer with an objective to bind the matrix elements**(Tsai, 1980)**. Composites materials are preferred over contemporary metallic materials due to their higher strength- to- weight ratio, light weight, long lie, low cost, design flexibility**(Lubin, 1982)**.

Black cotton soil is an inexpensive one and high potential for shrinking or swelling as a result of changing moisture content **(Table.1)**. The high moisture content can maintain wetting stabilization with black cotton soil in order to saturate soil and thus prevent potential expansion. Oils and with low hydraulic conductivity may take years to saturate. On the other hand soils with high hydraulic conductivity may never become sufficiently wet.

Coir fiber stabilization has been used extensively in black cotton soil stabilization. The addition of coir fiber reinforcement results in several stabilizing reactions. The solubility of silica increases alkaline environment and silica available in the cementing agent. The coir fibre also provides a divalent cation which forms Casilicates and Ca-Al hydrates that increase soil strength.

Table 1: Index properties of Black cotton soil

Properties	Values
Liquid Limit,*LL*(%)	59.50
Plastic Limit, PL(%)	28.09
Shrinkage Limit,SL(%)	10.34
Specific gravity, G	2.62
Optimum Moisture Content, (%)	23.0
Maximum dry unit weight, (KN/m^3)	14.47
Plasticity index, PI(%)	30.8
Silt and Clay content, (%)	68.0
Sand, (%)	32.0

2.1 Plan of Action with Black cotton soil and Coir fiber

Natural fibers usage in civil engineering construction practice is often advantageous as they are cheap, locally available, biodegradable and eco-friendly. Among the available natural fibers, coir is produced in large quantities in India and this has better mechanical properties, such as tensile strength. In paper, results on the strength and stiffness behaviour of soil reinforced with coir fibers are presented. Soil samples reinforced with coir fibers of different sizes and made into black cotton soil specimens were tested in triaxial shear apparatus to determine the strength and stiffness. Black Cotton Soil response due to coir fiber inclusion and the results were

compared with that of unreinforced soils. The results show that addition of coir (1–2%) as random reinforcing material increases both strength and stiffness of clay soil. In addition, available theoretical models for prediction of strength of fiber-reinforced soil are examined in relation to the results of the present investigation. Analysis shows that the available models are not adequate to capture the strength and stiffness response of coir fiber-reinforced soil.

2.2 Coir fiber reinforcement mortar

Coir Fiber holds much of its tensile strength when with wet condition (before dry). Elongation is much higher when the coir with low tenacity. The degradation of coir depends on the average of embedment, the climatic conditions and is found to retain 80% of its tensile strength after 0.5 years of embedment in clay. Coir fiber produces better resilient response next to synthetic fibers by higher coefficient of friction. If usage of coir percentage increased, simultaneously water absorption percentage levels also increase (**Alkali treatment**). Tensile strength of coir reinforced soil (fig.2) increases with an increase in the percentage of coir. **(Hejazi et al, 2012)**.

Figure 2: Dry Coir fiber (under sun light)

The following procedures are producing aggregate for the mortar (coir fiber). The Coir fiber will be made dry through sun light energy for grinding as aggregate. Dried coir fiber will be grinding with 2.5mm and this coir fiber alone using as fine aggregate for the mortal. After this the grained coir fiber (fig.3) will be ready for chemical bond. Coir fiber itself has its own chemical composition (Table.2).

Figure 3: Grained coir fiber (2.5mm)

Table 2:Chemical composition of coir fiber

Properties	percentage
Total water solubles	26.00
Pectin etc. soluble in water	14.20
Hemi-celluloses	8.50
Lignin	29.23
Cellulose	23.81

Different soils have different qualities and characters due to the percentage of gravels, sands, silt and clay they contain. Gravels and sands enhance the strength of the mortal but they have very low cohesion. Clay does not have strength but it is a natural binder to bind all the particles in the soil. In order to make a durable compressed earth block, we need to be very careful about the selection of the soils. In this research we have selected Black Cotton soil and Lime, coir fiber for aggregate (Table.2).

2.3 Lime (As Stabilizer):

Lime is used as a stabilizer and are mixed in the cumulative increasing percentage by weight of soil taken to prepare a standard specimen mould as per IS, to conduct Compaction & UCC tests. Lime varies widely in its quality when collected from different sources or collected in batches from the same source. In order to keep uniformity in the quality of lime, high calcium calcite lime has been used throughout the investigations. Lime contents calcium oxide or calcium hydroxide. Presence of lime in a sufficient quantity is required to form silicates and aluminates of calcium. Lack of lime with cement property, concrete will set with short time period and strength of cement also reduces. Lime added with coir fiber for fine aggregate (fig.4).

Figure 4: Composite of aggregate

Table 3: Compaction characterstics of TCF with and without lime

MIX DESIGNATION	MDD(g/cc)	OMC (%)
TREATED COIR FIBER WITHOUT LIME		
0.5%TCF+BCS	1.551426	23.81898
1%TCF+BCS	1.51	25.28528
2%TCF+BCS	1.457756	27.72368
3%TCF+BCS	1.45	28.17131
TREATED COIR FIBER WITH LIME		
0.5%TCF+3%L+BCS	1.527793	25.73427
1%TCF+3%L+BCS	1.481509	25.811
2%TCF+3%L+BCS	1.43	26
3%TCF+3%L+BCS	1.42	28

The Compaction test were conducted on Black cotton Soil with increasing percentage of lime to determine the optimum lime for the Black Cotton soil used in the present study (fig.5).

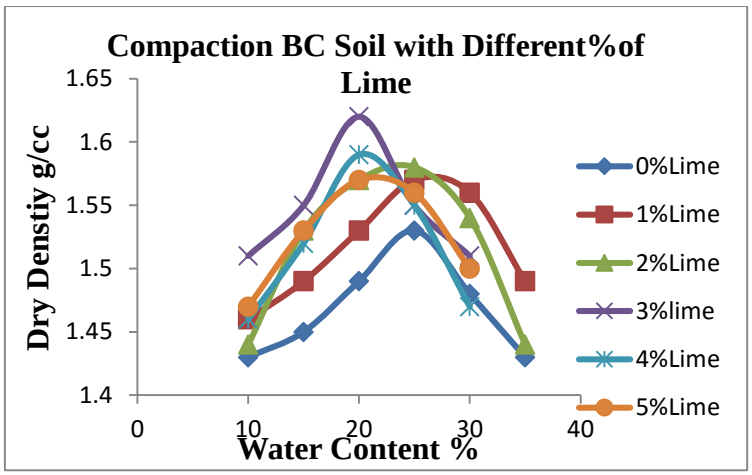

Figure 5: Compaction charecteristics OfBlack CottonSoil with Different % of Lime

Compaction test were done using Black Cotton soil reinforced with untreated coir fiber and epoxy resin coated coir fibers. Fig (6) shows typical compaction curves obtained for Black Cotton soil + Treated coir fibers + Surface treated coir fibers.

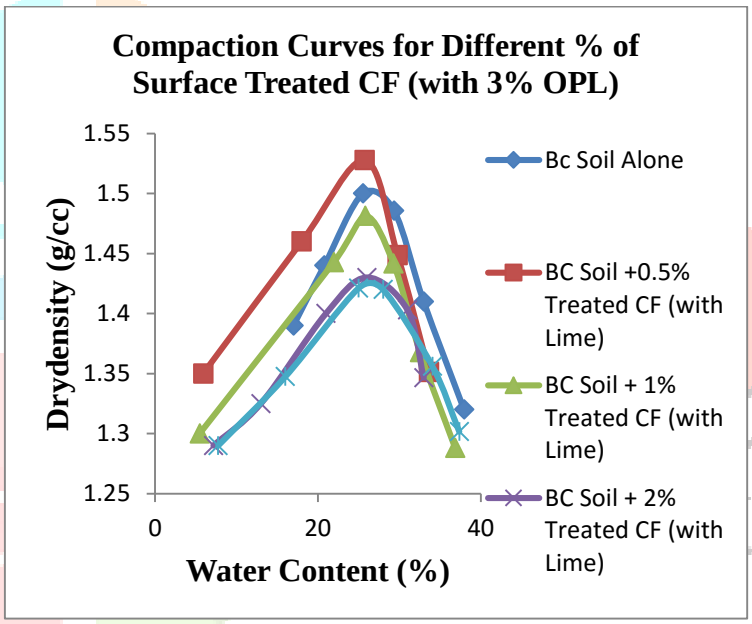

Figure 6: Compaction Characterstics for different % of TCF-L

3. Experimental Study

The alkaline activator solution was prepared by mixing NaOH solution, Na2SiO3 **(Chandran, 2016)** and CaSO4.2H2O solution until a homogeneous solution was achieved. Then, the alkaline activator was mixed with coir fiber in the mechanical mixer for about 5 min approximately. Gypsum is a mineral and is hydrated calcium sulphate in chemical form. Gypsum plays a very important role in controlling the rate of hardening of the cement or concrete. Here, this mortar adding gypsum for quick dry.

Figure 7: Alkaline activator solution (NaOH, Na2SiO3, CaSO4.2H2O)

3.1 Polymer modification of mortar:

To produce polymer modified mortar dispersion (emulsion or latex) form a mixing with coir fiber-chemical bond. Polymer modified mortar have considerable attraction because their process technology is similar to original cement mortar. Fig.9 Composite aggregation (Coir fiber and Lime) and alkalin solution properties mixing with 1:2.6 ratio, this will produce mortal. Coir fiber used percentage ranges is 0.5%, 1 %, 2 % , & 3 % for testing. Black Cotton soil should be in particle form (fig. 8).

Figure 8: SampleBlack CottonSoil

Test and implementation of this research methodology taken on room's floor with coir fiber mortar (Chemical bond) + Black Cotton Soil property. Firstly, Coir Fiber Mortar (CFM) needs to be sprayed in the floor. On this Black Cotton Soil needs to be applied gradually up to 3 inches. After this, again the CFM needs to be sprayed on it. This whole things needs to be ramming with plate compactor or with vibrating machine. After ramped it needs to be idle for 30 minutes. The above actions need to be performed three to four times. The procedures with CFM and Black Cotton Soil for basement will be over.

(a) CFM Layer **(b) Spreading Black cotton Soil** **(c) Raming**

Figure 9: Floor Laying with Coir fiber mortar (with Clay soil)

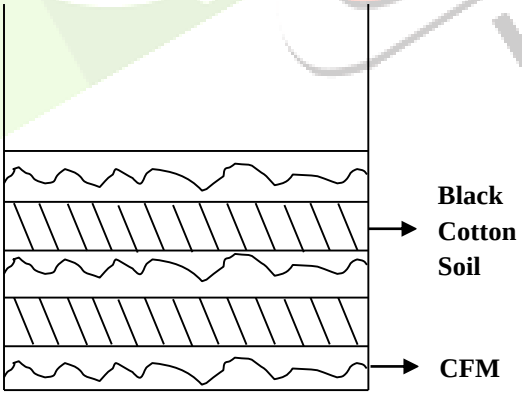

Figure 10: Layers of Basement level

Fig.11 shows variation UCS (Unconfined compressive strength) with curing in days for both Black Cotton soil without lime & with lime & reinforced with treated coir fiber at different percentages. It can be seen that the UCCS (unconfined compressive stress) becomes maximum at 7 days curing for both Black Cotton Soil without and with lime at 0.5% fiber content with increase in fiber content this is a marginal reduction in UCS at 7 days curing. For Black Cotton soil without lime use of treated coir indicates no significant change in UCS even at 30 and 60 days curing. This indicates that the effect of treatment of coir fiber increases non biodegradability of coir fiber in soils which is required in many civil engineering applications whereas the treated coir fiber can be used as reinforcement to soils. However use of treated coir fibers for Black Cotton soil admixed with lime indicates a significant reduction in UCS with curing beyond 7 days. This indicates probable effect of lime reaction when added to Black Cotton soil may cause a reduction in tensile strength of coir fibers however it can be noted that UCS of Black Cotton soil admixed with lime & reinforced with coir fiber beyond 15 days curing is almost falls in the range of those obtained for Black Cotton soil reinforced with treated coir fiber without lime. The use of Black Cotton soil + 3% optimum lime + treated coir fiber at 7 days curing were significantly higher than those obtained for Black Cotton soil without lime + treated coir fiber this is attributed to the fact that addition of lime itself increases UCS of Black Cotton Soil. It can be summed up from these results in addition of treated coir fiber is more

beneficial in reinforced with Black Cotton Soil. without lime as it can retain the strength for longer durations than when mixed with Black Cottons oil with optimum lime content.

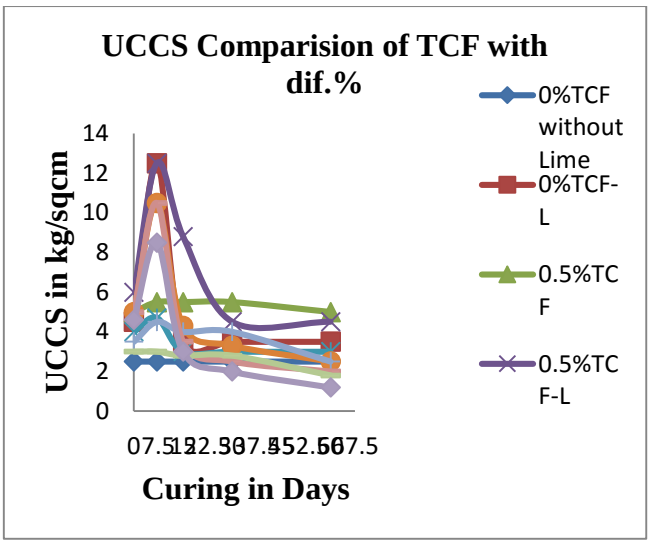

Figure 11: UCCS Comparision of TCF with dif.%

Conclusion

India, endowed with an abundant availability of coir fiber has focused on development of natural composites. This development is based on forest resources and ensuring good economic return of natural fibers. Government and related organizations should take proper steps in enhancing the research and using Coir as reinforcing material in construction. Reduction in water absorption of coir fiber increases interfacial characteristics of coir fiber and soil particles due to consequent reduction in water absorption which is essential for reinforced soils with natural fibers. Use of coir fibers as reinforcement in Black Cotton Soil without lime increases ductility of the reinforced soil which is required in many civil engineering applications. Ductility of reinforced Black Cotton Soil with lime is observed only at high % of fiber content this is probably due to the well known reaction of addition of lime to Black Cotton Soil makes the soil a brittle material. Use of treated coir fiber in Black Cotton Soil without lime is more beneficial as it can retain the UCS for a longer duration. In further study we can add fly ash with mortar or fine aggregate for getting the another result set.

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