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Soil Stabilization Using Geosynthetic Material (Bamboo Fibers)

Mayur A. Anpat, Vishwajeet K. Nimbalkar, Mayur R. Shendkar, Pratik R. Shendkar. Prof. Suraj C. Tandale[1-5]

Department of Civil Engineering/Trinity Academy of Engineering, Haveli, Pune[1-5]

Abstract - Soil stabilization is the process which involves enhancing the physical properties of the soil in order to improve its strength, durability etc. by blending or mixing with additives. The different types of method used for soil stabilization are: Soil stabilization with cement, Soil stabilization with lime, Soil stabilization using bitumen, Chemical stabilization, and a new emerging technology of stabilization by Geo textiles and Geo synthetic fibers. In this study, we are making use of bamboo fibers as geo synthetic material for stabilization of soil. With the use of bamboo fibers to the soil the CBR values will improve, and thickness of pavement layer also gets reduced. Bamboo fibers is such a geosynthetic material which is easily available, ecofriendly, and also cost effective. With the use of soil stabilization method in construction the overall cost gets reduced when compared to the ordinary method of construction. The liquid limit of the soil, MDD of the soil, OMC, shear strength of the soil, CBR value of the soil was found. From the limited laboratory study conducted we concluded that the 0.75% of bamboo fiber can substantially improve the properties of Black cotton soil. The advantages of this project are that to add bamboo fiber in soil stabilization is economically cheap as well as a superior concrete can be made.

Index Terms - Soil, Geosynthetic Material, Bamboo Fiber, Strength, Durability, Utilization of Bamboo Fiber, Environmentally Friendly

I.INTRODUCTION

A developing country like India which has a large geographical area and population, demands vast infrastructure i.e. network of roads and buildings. Everywhere land is being utilized for various structure from ordinary house to skyscrapers, bridges to airports and from rural roads to expressways.

In India, soils are classified into six groups namely alluvial soil, marine soil, laterite and lateritic deposits, expansive soils, sand dunes and boulder deposits. On an average 1 lakh sq.km area is covered by lateritic soil deposits, 3 lakh sq.km area is covered by black cotton soil, and 5 lakh sq.km area is covered by sand dunes. Encountering land having soft soil for construction leads to an attention towards adopting ground improvement techniques such as soil stabilization.

Weathering and decomposition from chemical changes that occur when water, oxygen and carbon dioxide gradually combine with minerals within the rock formation, thus it is breaking down to sand, silt, and clay. Transportation of soil materials by wind, water, and ice forms different soil formations such as those found in river deltas, sand dunes and glacial deposits. Temperature, rainfall, and drainage play important roles in the formation of soils as in the different climatic regions. Under different drainage regimes, different soils will be formed from the same original rock formation.

Soil stabilization is the process which involves enhancing the physical properties of the soil in order to improve its strength, durability etc. by blending or mixing it with additives. The different types of methods used for soil stabilization are: Soil stabilization using cement, Soil stabilization using lime, Soil stabilization using bitumen, Chemical stabilization and a new emerging technology of stabilization that is stabilization of soil by using Geo textiles and Geosynthetic fibers.

Geosynthetic are synthetic products made from various types of polymers which may be either Woven or Non-Woven. These are used to enhance the characteristics of soil and have provided a practical way of constructing civil engineering structures economically.

In this study, we are making use of bamboo fibers as geo synthetic material for stabilization of soil. With the introduction of bamboo fibers to the soil the CBR values may improve, and thickness of pavement layer also may get reduced. It may also reduce the intensity of stress on subgrade. Bamboo fibers is such a geosynthetic material which is easily available, eco- friendly, and also cost effective. With the application of soil stabilization technique in construction process the overall cost may get reduced when compared to the ordinary method of construction.

Need for The Study

- To find an alternative solution for Soil Stabilization.

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- To reduce Artificial Fiber and produce eco- friendly Natural Fiber.
- To provide high strength Soil than ordinary Black Cotton Soil.
- To develop an eco-friendly product at low cost.
- Optimization of Bamboo Fiber in valuable product.

II. MATERIAS

In this chapter varies materials and method of conducting the test was discussed in detail and detailed methodology of the work was presented.

Materials Used

- Bamboo fiber
- Black Cotton Soil
- Geotextiles
- Lime
- Geogrid
- Jute Fiber

Soil Stabilization with Cement

The soil stabilized with cement is known as soil cement. The cementing action is believed to be the result of chemical reactions of cement with siliceous soil during hydration reaction. The appropriate amounts of cement needed for different types of soils may be as follows: Gravels – 5 to 10%, Sands – 7 to 12%, Silts – 12 to 15%, and Clays – 12 – 20% are used to find the results of the tests should be performed.

The quantity of cement for a compressive strength of 25 to 30 kg/cm2 should normally be sufficient for tropical climate for soil stabilization. If the layer of soil having surface area of A (m2), thickness H (cm) and dry density rd.(tones/m3), has to be stabilized with p percentage of cement by weight on the basis of dry soil, cement mixture will be((100XP)/(1+P)) and the amount of cement required for soil stabilization is given by Amount

Lime

Slaked lime is very actual in treating heavy plastic clayey soils. Lime may be used alone or in mixture with cement, bitumen or fly ash. Sandy soils can also be stabilized with these combinations. Lime has been mainly used for stabilizing the road bases and the subgrade.

Lime changes the nature of the adsorbed layer and provides pozzolanic action. Plasticity index of highly plastic soils are reduced by the addition of lime with soil. Normally 2 to 8% of lime may be required for coarse grained soils and 5 to 8% of lime may be required for plastic soils. The amount of fly ash as admixture may vary from 8 to 20% of the weight of the soil.

Geotextiles

The effectiveness of use of geotextiles as reinforcement material for stabilization of soil for different engineering works. Their objectives were to study and introduce the properties of Geotextiles (such as Physical property, Mechanical property, Hydraulic property, Endurance property and Durability property), Fibers of Geotextiles, (they are natural and synthetic fibers), Types of Geotextiles, functions of Geotextiles, application of geotextiles and impact of geotextiles on environment. They have concluded that, due to the versatility of functions of geotextiles they can be used in many important civil engineering works. The use of geotextiles not only reduces construction cost but also reduce maintenance cost.

Bamboo Fiber

Bamboo fiber is a regenerated cellulosic fiber produced from bamboo. Starchy pulp is produced from bamboo stems and leaves through a process of alkaline hydrolysis and multi-phase bleaching. Further chemical processes produce bamboo fiber.

Source of Glass

- Waste Decorative items of Bamboo
- Wastage from Bamboo Factory and Bamboo Dust.
- Bamboo Chair polishing and Bamboo Boats and Bamboo door manufacturing shop

Properties of Material

The physical properties, chemical properties and chemical composition of Glass Powder are presented in table 1& 2.

Table 1. Chemical Properties of Bamboo Fiber

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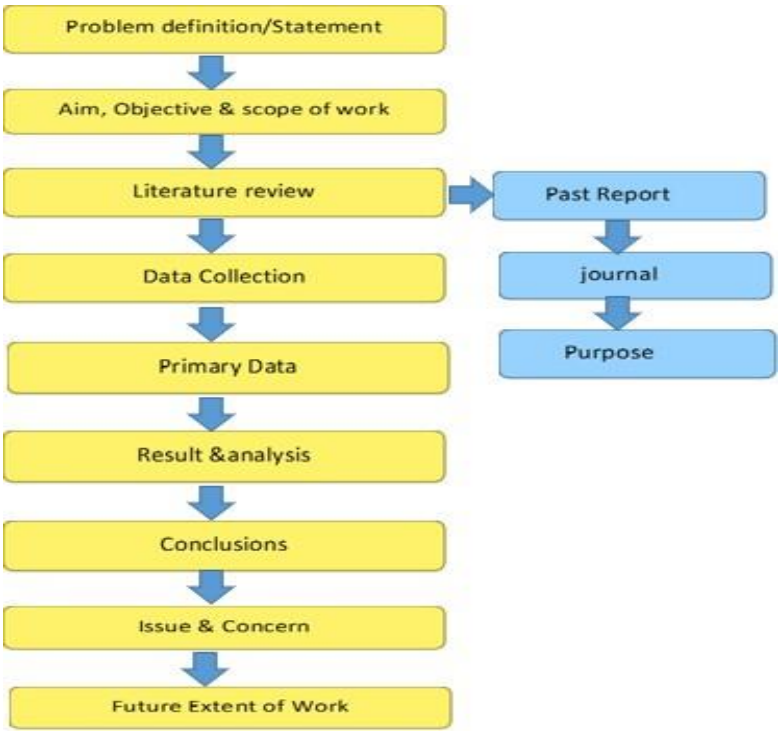
Sr. No	Chemical Properties of Bamboo Fiber	
1	pH	5.72 to 6.61
2	Colour	Yellowish Gold

Table 2. Physical Properties of Bamboo Fiber

Sr. No	Chemical Properties of Bamboo Fiber	
1	pH	5.72 to 6.61
2	Colour	Yellow Gold

III. METHODOLOGY

The whole process of project work is shown step by step. The methodology is explained in the following figure.



IV. MIX PROPORTION EXPERIMENTAL INVESTIGATION

CBR Test

In this chapter mix-design of Soli and the experimental investigation work carried outby help of IS 10262- 2009 on the test specimen to study the strength related properties of concrete was discussed in detail.

Table 3. Mix Design

Penetration (mm)	Trial 3	Division	Load (kg)
0	0	0	0
0.5	4.2	21	33.6
1	6.2	31	49.6
1.5	7.6	38	60.8
2	8.6	43	68.8
2.5	9.8	49	78.4
3	10.6	53	84.8

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4	12	60	96
5	13.2	66	105.6
7.5	15.4	77	123.2
10	17.2	86	137.6
12.5	18.8	94	150.4

The mixing process was done using an electrically operated concrete mixer of 0.041 m3 capacity. The concrete making and mixing in the laboratory was done with accordance to ASTMC-192. The batching procedure was as follows:

1. Add Soil mixing for about 2-3 minutes.
2. Add Bamboo Fiber than mixing for about 1-2 minutes.
3. Add approximately two-thirds of water slowly and mix for 2-3minutes.
4. Add fiber with water than mixing for 2-3 minutes. Load as obtained from graph at 2.5 mm penetration = 78.4 kg

CBR of Specimen = (78.4/1370) *100=5.41%

Load as obtained from graph at 5 mm penetration =
105.6 kg

CBR of Specimen = (105.6/2055) *100=5.12%

Black cotton soil added with fibers 1.0% by weight the following observations were made:

OMC = 16.9%

The CBR value of soil alone was found to be 1.82%

Dial gauge reading	Strain(ϵ)	Proving ring reading	corrected area	Load(N)	Axial Stress (Mpa)
0	0.000	0	11.341	0.000	0.000
50	0.064	1	11.341	3.417	0.301
100	0.128	2	11.341	6.834	0.603
150	0.192	2.6	11.341	8.884	0.783
200	0.256	3	11.341	10.251	0.904
250	0.321	3.2	11.341	10.934	0.964
300	0.385	3.4	11.341	11.618	1.024
350	0.449	3.4	11.341	11.618	1.024
400	0.513	3.2	11.341	10.934	0.964

Table 4: Unconfined Compression Test on Cohesive soil

The CBR value of the soil with addition of 0.25%, 0.5%, 0.75% and 1.0%, bamboo fibers by weight of soil are found to be 3.49%, 3.96%, 5.41% and 3.96% respectively.

The CBR value of the soil with addition of 0.25%, 0.5%, 0.75% and 1.0%, bamboo fibers by weight of soil are found to be increased by 91.75%, 117.5%, 197.25% and 117.5% respectively.

Unconfined Compression Test

w c =16%, h= 7.8cm, d= 3.8cm, h1= 6.9cm, d1=4.1cm load per div.= 3.417 kNf=65°

The shear strength of soil alone was found to be 1.024 MPa.

The shear strength of the soil with addition of 0.25%, 0.5%, 0.75% and 1.0%, bamboo fibers by weight of soil is found to be 0.629, 0.629, 0.663 and 0.964% respectively.

The shear strength of the soil with the addition of 0.25%, 0.5%, 0.75% and 1% of bamboo fibers is found to be decreased by 38.57%, 38.57%, 35.25%and 5.85%.

Standard Proctor Test

The MDD of the soil with addition of 0.25%, 0.5%, 0.75% and 1.0%, bamboo fibers by weight of soil are found to be 1.788 g/cc, 1.788g/cc, 1.804 g/cc and
2.108 g/cc respectively and the corresponding OMC is found to be 13.5%, 13.5%, 12.5% and 10.6% respectively.

The MDD of the soil with addition of 0.25%, 0.5% bamboo fibers by weight of soil are found to be decreased by

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0.83% and 0.75%, 1.0% bamboo fibers by weight of soil are found to be increased by 0.11 % and 16.98% respectively and the corresponding OMC is decreased by 15.62%, 21.87% and 33.75% respectively.
The optimum moisture content (OMC) and maximum dry density (MDD) of soil alone was found to be 16% and 1.802 g/cc respectively.

Durability Test
Durability of concrete may be defined as the ability of concrete to resist weathering action, chemical attack, and abrasion while maintaining its desired engineering properties.
The ability of concrete to withstand the conditions for which it is designed without deterioration for a long period of years is known as durability. Durability is defined as the capability of concrete to resist weathering action, chemical attack and abrasion while maintaining its desired engineering properties.

V. CONCLUSION

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

- There is substantial increase in MDD with increase in addition of fibers upto 0.75% by weight beyond which it decreased.
- There is substantial decrease in OMC with increase in addition of fibers.
- In unconfined compression test it was observed that the shear strength of the soil has increased with the increase in percentage of bamboo fibers, when compared to that of shear strength of soil tested without fiber.
- The California bearing ratio (CBR) of the soil alone is obtained as 1.82% and it increased to 5.41% after stabilizing it with optimum percentage of bamboo fibers.
- The percentage increase in CBR value after stabilizing it with optimum percentage of fibers is 197.25%.
- In the case of Cohesive soil there is substantial increase in MDD with increase in addition of fibers.

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[1] Vivek S. Kakadiya is a scholar in the field of Department of Civil Engineering, Bhagwan Mahavir College of Engg. & Tech., Surat, Gujarat. My current research is undertaken on Experimental Investigation on Soil Stabilization using Geosynthetic material (Bamboo Fiber).
[2] Pushpendra T. Mishra is a scholar in the field of Department of Civil Engineering, Bhagwan Mahavir College of Eng. & Tech., Surat, Gujarat. My current research is undertaken on Experimental Investigation on Soil Stabilization using Geosynthetic material (Bamboo Fiber)
[3] Prachi T. Joshi is a scholar in the field of Department of Civil Engineering, Bhagwan Mahavir College of Engg. & Tech., Surat, Gujarat. My current research is undertaken on Experimental Investigation on Soil Stabilization using Geosynthetic material (Bamboo Fiber)