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Study of Soil with Bamboo as A Reinforcement Material In Flexible Pavements

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ABSTRACT: This study tests the mechanical properties of fresh bamboo to explore its suitability for reinforcing subgrade of flexible pavement. A series of experiments will be performed using a bamboo species Meshi (local name) and dhophil bamboo soil specimens (Black cotton soil and laterite soil) with bamboo grids that are similar to geogrids. This paper deals with the efficiency of using bamboo as a reinforcement in beam and column. Bamboo is one of the oldest traditional building materials; bamboo is a versatile material because of its high strength-to-weight ratio, easy workability, and availability. The mechanical tests will include tensile and flexural tests on bamboo strips, Standard Proctor test and CBR test on soil specimens with and without bamboo strips.

KEYWORDS: Meshi bamboo, Dhophil bamboo, Black cotton and Laterite soil, CBR, Standard Proctor Flexural, Tensile

1) INTRODUCTION

The construction of various infrastructure projects on soft ground has almost become inevitable due to the shortage of land in this rapidly growing world. Soft ground engineering offers enormous challenges to engineers across the globe. Ground improvement techniques are the largely preferred techniques for loading-bearing applications in soft soils. Engineers and scientists are constantly looking for new ground improvement techniques that are cheaper compared with present techniques such as vibrogeosynthetic, (geogrids, geocell geomembranes, and geotextile). This technique provides high tensile strength to the soil. Though these techniques have good durability, excellent mechanical behaviour, and easy laying operation, they increase the cost of engineering projects. Compaction, vacuum consolidation, does not comply with current environmental protection standards. Therefore, in recent years, some research has considered natural green building materials as an alternative to these above techniques. Natural green building materials are advantageous with respect to energy conservation, low cost, and renewable.

The use of wood in soil stabilization is not a new concept. The world-famous monument TAJ MAHAL is built on a gigantic wooden slab made up of Ebony wood supported on a deep wall foundation. The massive solid foundation of The Taj Mahal, including the wooden shock absorbers, has defied the onslaught of time, keeping the superstructure stable for more than three and a half centuries without any deterioration. Generally, in geotechnical engineering applications, bamboo is used in two ways. One is to use bamboo directly to build a foundation, as illustrated in the case of the Taj Mahal. The other way is to use bamboo as reinforcement in soft soil to increase its bearing capacity. Bamboo is one of the oldest traditional natural building materials used by mankind, which is cost-effective and can be successfully utilized for structural and non-structural applications. Bamboo is a biodegradable material; however, nowadays, techniques are available to increase the durability of bamboo. Due to a distinctive rhizome-dependent system, bamboos are one of the fastest-growing plants in the world, and their growth is three times faster than most other species of plants. Bamboo has a six-year life cycle. They are renewable and extremely versatile resources with multi-purpose usage. Bamboo as a building material is conventionally associated with the region of Southeast Asia and South America, where the climate is best suited for its cultivation.

II. OBJECTIVES

The aim of this project is to do a comparative study of soil with bamboo reinforcement and without bamboo reinforcement in flexible pavement.

- To compare properties of soil with and without use of bamboo reinforcement by conducting various mechanical test
- To increase load carrying capacity by load dispersion through reinforced sub-base on to the sub-grade.
- To reduce construction cost of flexible pavement by using bamboo reinforcement as an alternative to geo-grid.
- To increase service life of pavements.

III. THEORETICAL CONTENT

BAMBOO

Bamboo is a collective name for different species of Giant grasses. It is estimated that 60–90 genera of bamboo Exist, comprising approximately 1100–1500 species. These species come in various sizes and forms. Bamboo Mainly grows in tropical regions of Asia, Latin America And Africa. Locally available best species of bamboo in Pune are-

1. Dandrocalamum strictus.(Meshi bamboo)
2. Bambusa vulgaris.(Dhophil bamboo)

SOIL

Subgrade is the native material underneath of a Constructed road. Subgrade broadly consists of soil. In This study we are considered two types of soil that are –Black cotton soil and Laterite soil.

- Black cotton soil

Black cotton soil is one of major soil deposits of India. They exhibit height rate of swelling and shrinkage when Exposed to changes in moisture content and hence have Been found to be most troublesome from engineering Consideration.

- Laterite soil

Laterite is a soil and rock type rich In iron and aluminum and is commonly considered to Have formed in hot and wet tropical areas. Nearly all Laterites are of rusty-red coloration, because of high iron Oxide content. It is abundantly found in Konkan, Maharashtra.

DEFECTS IN FLEXIBLE PAVEMENT

- Cracking of Flexible Pavements
- Depressions in Flexible Pavements
- Potholes
- Rutting of Flexible Pavements
- Swelling of Flexible Pavements

In order to overcome the above problems, bamboo is added as reinforcing material. The function of reinforcement is to strengthen by additional assistance, material, or support. For the same reason that steel reinforcement is embedded in concrete, reinforcing materials can be incorporated into the base layer of flexible pavements so that the two materials act together to resist forces. Bamboo is a versatile material because of its high strength-to-weight ratio, easy workability and availability. Through research it has been found that some species of bamboo have ultimate tensile strength same as that of mild steel at yield point. Cellulose is the main component present in bamboo which is responsible for mechanical properties of bamboo.

IV. TEST CARRIED OUT ON SPECIMENS

The Tests Performed On Bamboo Specimens Are-

1. Tensile strength test
2. Flexural strength test



- Tensile Strength Test on Bamboo Specimen (IS 6874)

Significance of Tensile Strength

Tensile strength is a measurement of The force required to pull something such as rope, wire, or A structural beam to the point where it breaks .The tensile Strength of a material is the maximum amount of tensile Stress that it can take before failure .Tensile strength of The material is essential to determine its ability to Withstand tensile loads without failure.

- Flexural Strength Test on Bamboo Specimen (Is 1708 Part-5)

Significance Of Flexural Strength

The flexural strength represents the highest stress Experienced within the material at its moment of yield. Flexural strength of a material is determined to know its Ability to resist deformation under load.

Test Carried out on Soil specimens Are :

1. California Bearing Ratio Test (CBR)
 2. Standard Procter Test
- California Bearing Ratio Test

Significance Of California Bearing Ratio Test

The California Bearing Ratio (CBR) test is a Penetration test used to evaluate the subgrade strength of Roads and pavements. The results of these tests are used With the empirical curves to determine the thickness of Pavement and its component layers. This is the most Widely used method for the design of flexible pavements

- Standard Procter Test

Significance of standard Procter test

Standard Procter test is used for determination of the Relation between the water content and the dry density of Soils using light compaction.

V. RESULTS AND DISCUSSIONS

SOIL RESULT

- A. CBR TEST FOR LATERITE SOIL WITHOUT BAMBOO REINFORCEMENT
- Placement weight density = 1.838
 - Placement dry density = 1.46
 - Optimum moisture content = 26.50
 - Soil at natural moisture content = 3485
 - Soil at placement moisture content = 4135
 - Water added = 850
 - Passing sieve(mm)20-4.75 = 613gm
 - Passing sieve(mm) 4.75 = 2872gm

PENETRATION	LOAD	
	F	L
Mould NO		
0.5	20	13
1.0	28	19
1.5	32	23
2.0	35	29
2.5	38	33
3.0	43	37
4.0	45	45
5.0	49	49
6.0	51	51
7.5	53	55
10.0	50	54
12.5	56	68



B. CBR TEST FOR LATERITE SOIL WITH BAMBOO REINFORCEMENT

- Placement weight density = 1.838
- Placement dry density = 1.46
- Optimum moisture content = 26.50
- Soil at natural moisture content = 3485
- Soil at placement moisture content = 4135
- Water added = 850
- Passing sieve(mm)20-4.75 = 613gm
- Passing sieve(mm) 4.75 = 2872gm

PENETRATION	LOAD	
	Mould NO	F
0.5	20	13
1.0	28	19
1.5	32	23
2.0	35	29
2.5	38	33
3.0	43	37
4.0	45	45
5.0	49	49
6.0	51	51
7.5	53	55
10.0	50	54
12.5	56	68

C. CBR TEST FOR BLACK COTTON SOIL WITHOUT BAMBOO REINFORCEMENT

- Placement weight density = 1.732
- Placement dry density = 1.27
- Optimum moisture content = 36.470
- Soil at natural moisture content = 3057
- Soil at placement moisture content = 3849
- Water added = 1040
- Passing sieve(mm)20-4.75 = 948gm
- Passing sieve(mm) 4.75 = 21.09kg

PENETRATION	LOAD	
	Mould NO	F
0.5	20	13
1.0	28	19
1.5	32	23
2.0	35	29
2.5	38	33
3.0	43	37
4.0	45	45
5.0	49	49
6.0	51	51
7.5	53	55
10.0	50	54
12.5	56	68



D. CBR TEST FOR BLACK COTTON SOIL WITH BAMBOO REINFORCEMENT

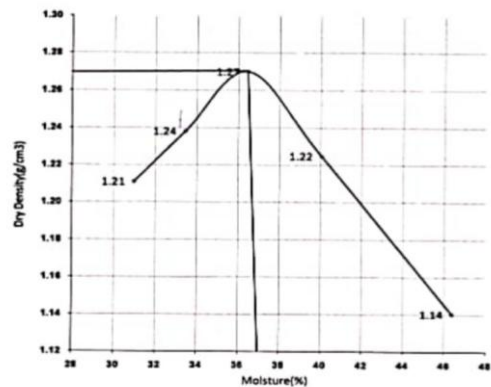
- Placement weight density = 1.732
- Placement dry density = 1.27
- Optimum moisture content = 36.470
- Soil at natural moisture content = 3057
- Soil at placement moisture content = 3849
- Water added = 1040
- Passing sieve(mm)20-4.75 = 948gm
- Passing sieve(mm) 4.75 = 21.09kg

PENETRATION	LOAD	
	F	L
Mould NO		
0.5	20	13
1.0	28	19
1.5	32	23
2.0	35	29
2.5	38	33
3.0	43	37
4.0	45	45
5.0	49	49
6.0	51	51
7.5	53	55
10.0	50	54
12.5	56	68

STANDARD PROCTER TEST

BLACK COTTON SOIL

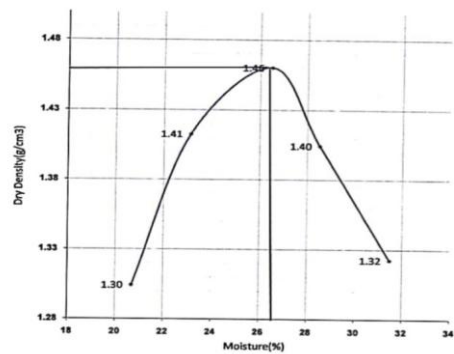
- Optimum Moisture Content =36.47%
- Maximum Dry Density=1.27 g/cc



OMC : 36.47%
MDD : 1.27 g/cc

LATERITE SOIL

- Optimum Moisture Content=26.20%
- Maximum Dry Density=1.46g/cc

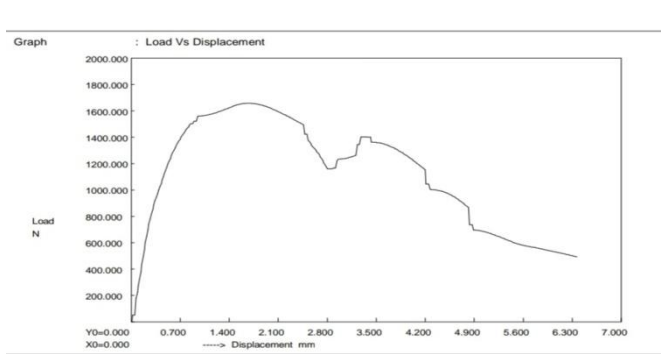


OMC : 26.20%
MDD : 1.46 g/cc

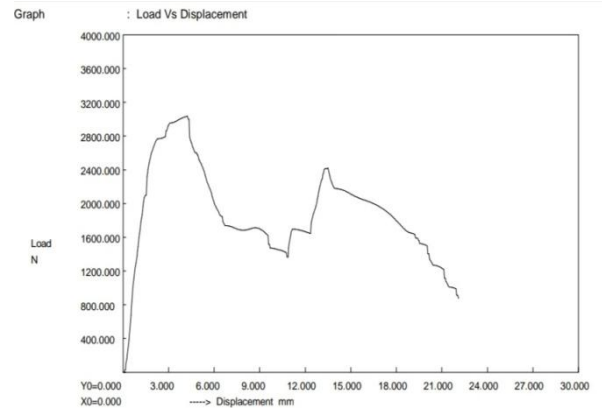


TENSILE AND FLEXURAL STRENGTH GRAPH

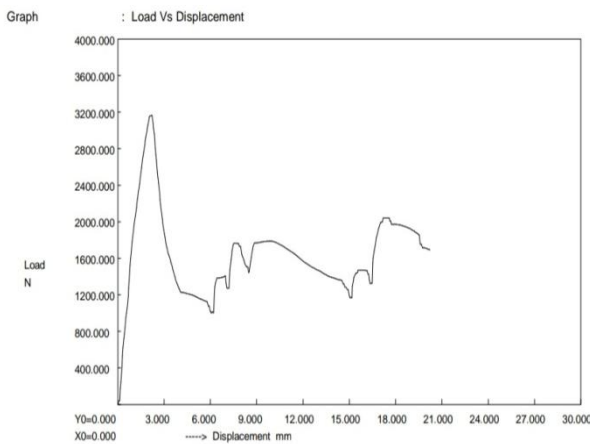
A. GRAPHS OF MESHI TENSILE STRENGTH



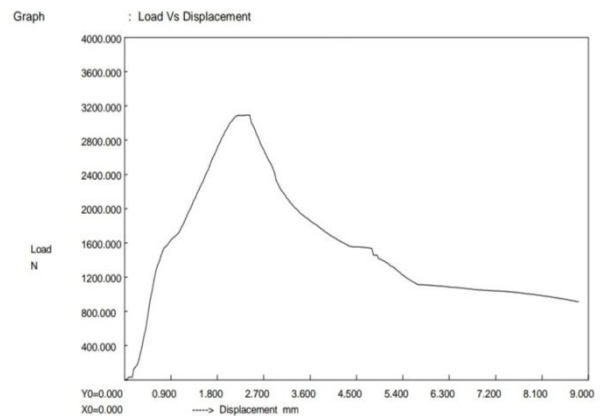
Sample no 1



Sample no 2

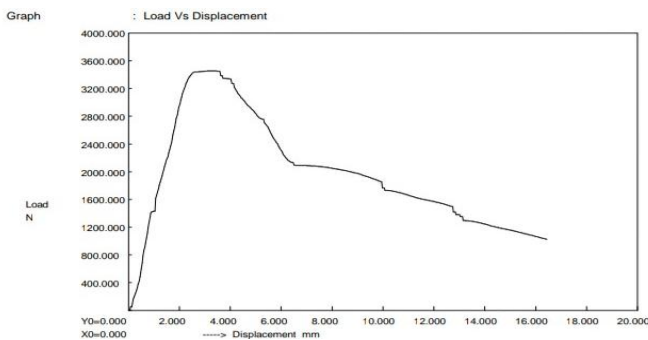


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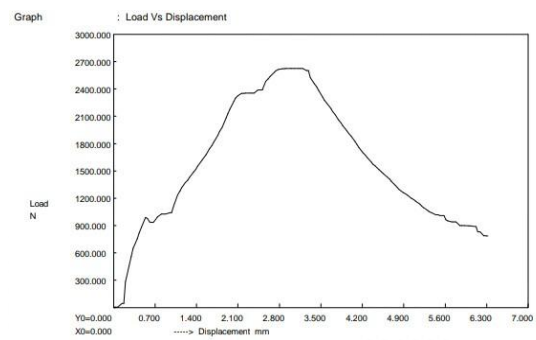


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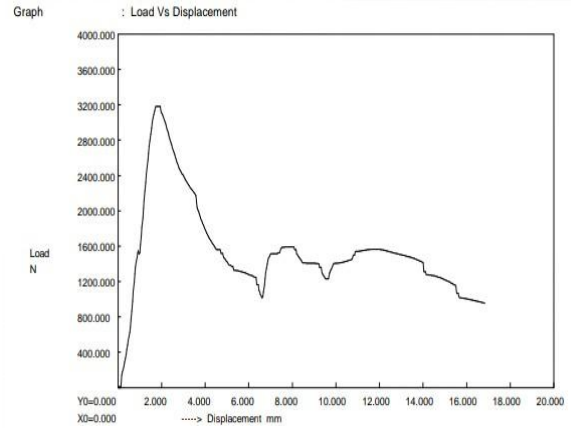
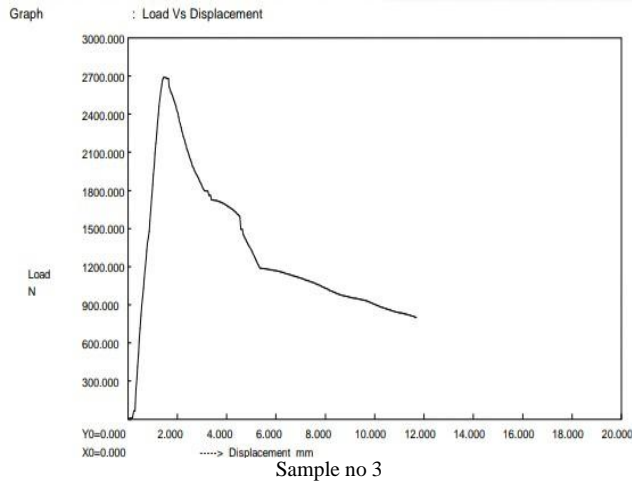
B. GRAPH OF DHOPHIL TENSILE STRENGTH



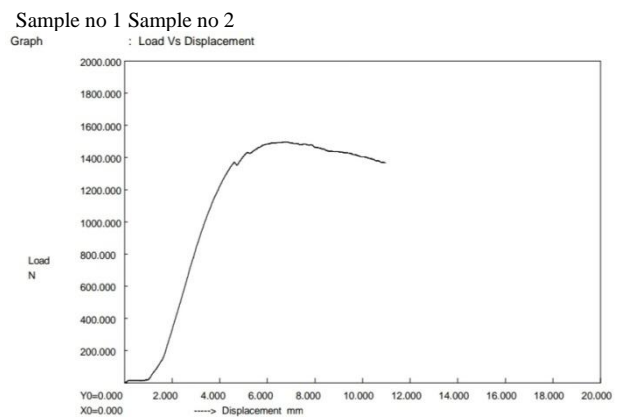
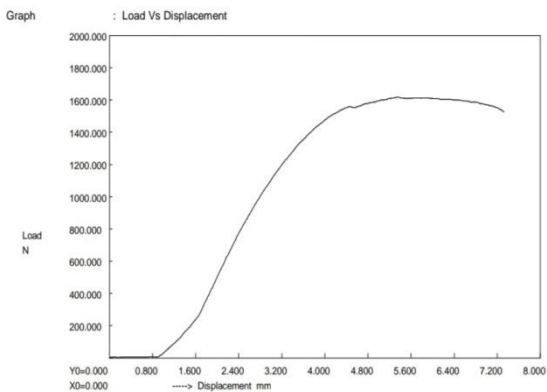
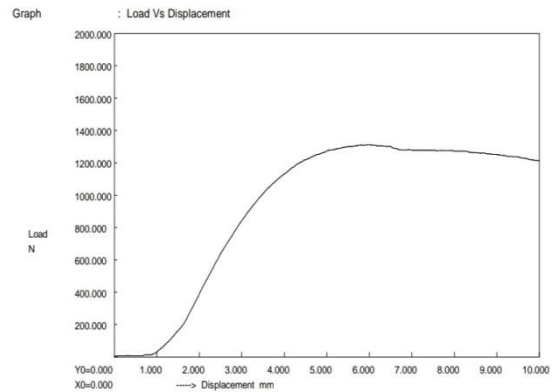
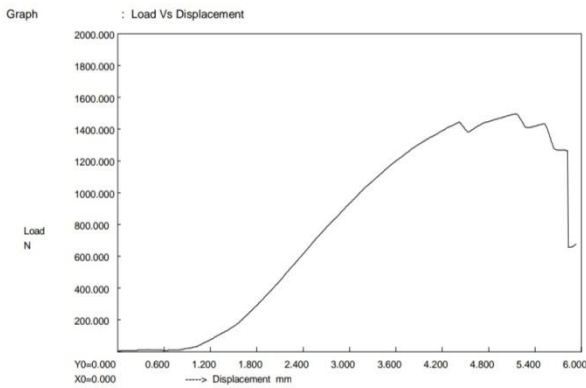
Sample no 1



Sample no 2

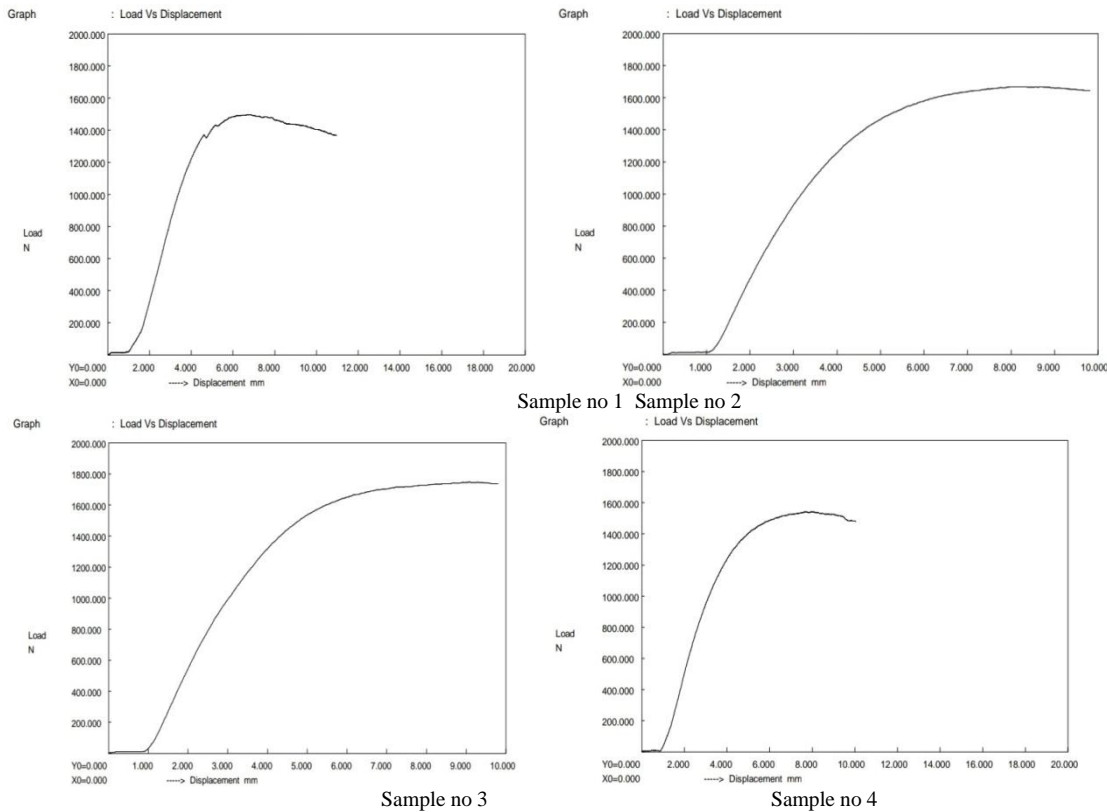


C. GRAPH OF MESHI FLEXURAL TEST





D. GRAPH OF DHOPHIL FLEXURAL TEST



VI.CONCLUSION

- Meshi bamboo species shows better tensile and Flexural strength as compare to Dhophil bambooSpecies.
- CBR value of Black cotton soil with bamboo Reinforcement do not show significant variation as Compare to CBR value of black cotton soil without Bamboo reinforcement.
- As there is no significant change in total thickness of Pavement in black cotton soil with bamboo Reinforcement it is not feasible to use bamboo as a Reinforcing material in black cotton soil.
- CBR value of Laterite soil with bamboo reinforcement Show desirable variation as compare to CBR value of Laterite soil without bamboo reinforcement.
- When bamboo reinforcement is used in laterite soil Subgrade, the total pavement thickness changes from 700mm to 540mm which is a desirable change.
- So, it is recommendable to use bamboo reinforcement In laterite soil subgrade.

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