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COMPARATIVE STUDY OF SOIL WITH AND WITHOUT BAMBOO REINFORCEMENT IN SUBGRADE OF FLEXIBLE PAVEMENT

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Abstract: - This study deals with the comparative study of soil subgrade with and without bamboo reinforcement of flexible pavements. For this purpose various tests are conducted to find the mechanical properties of bamboo. The bamboo species considered are Meshi and Dhopil. The mechanical properties of bamboo considered under study are tensile strength, compressive strength & flexural strength. The aim of these tests is to explore the suitability of bamboo as a reinforcing material for sub-grade of pavement. The type of soils used are black cotton soil & Laterite soil. Standard Proctor test is performed on soils to obtain OMC at MDD. Using results of Standard Proctor test, California Bearing Ratio test (CBR) will be performed using the bamboo species and soil specimen.

From comparative study of CBR values, we will came to know the load bearing capacity of soil with and without bamboo reinforcement. The IS codes considered in this study are IS 6874-2008 for bamboo, IS 2720 (part-16)-1979 & IRC 37-2001 for CBR test.

Keywords: - *Soft clay, reinforcement, flexural, tensile, compressive, CBR.*

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1. INTRODUCTION

Because of rapid urbanization in the 21st century, the construction of various infrastructure projects on soft ground has almost become inevitable due to shortage of land. Soft ground engineering offers enormous challenges to the engineers across the globe. Ground improvement techniques are the largely preferred techniques for load bearing application in soft soils. Engineers and scientist are constantly looking for new ground improvement techniques that are cheaper compared with present techniques such as vibro, geosynthetic, (geogrids, geocells, geomembranes, and geotextile). This technique provides high tensile strength to the soil. Though these techniques have good durability, excellent mechanical behavior, and easy laying operation, it increases cost of engineering projects. 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 use.

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 application. Bamboo is 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 resource with multi-purpose usage. Bamboo as a building material is conventionally associated with the region of Southeast Asia and South America where climate is best suitable for its cultivation.

OBJECTIVES:

1. To Study CBR value of soil with and without use of bamboo reinforcement in flexible pavement.

2. To Study load carrying mechanism of bamboo reinforcement.

3. To design the road pavement economically with and without bamboo reinforcement.

II LITERATURE REVIEW

The main objective of the study was Type peat soils classified as poorly as the foundation construction, because of the low shear strength, high water content, high compression and low bearing capacity. Use in bamboo grid in an alternative to improve the stability of the construction on the peat soil. This research was conducted in laboratory. Natural bamboo material is used as reinforcement obtain tensile strength. The use of bamboo grid as soil reinforcement can increase the value of unconfined compressive strength. Bearing capacity of foundation at the time of 10% reduction in the width of the foundation is increasing in line with the increase in the number of grid bamboo reinforcement.(1)

This paper is primarily focused on physical and mechanical properties of fresh bamboo to explore its suitability for reinforcing the embankment of highway. A series of experiments is performed using a bamboo species *(Sinocalamus affinis*) and soil specimen with bamboo grids that are similar to geogrids. Based on physical and mechanical test results, appropriate cutting age of fresh bamboo is two years and more. In addition, the compressive strength for bamboo grid –reinforced soil is significantly greater than that of prime soil, and could effectively prevent filling embankments from settling. In addition, its increased shear resistance could suppress a slip shear failure in the filling embankment.(2)

This paper deals with efficiency of using bamboo as a reinforcement in beam and column. Bamboo is one of the oldest traditional building material also bamboo is a versatile material because of its high strength to weight ratio, easy workability and availability. But bamboo needs to chemically treated due to their low natural durability. Study concludes that the tensile stress of seasoned bamboo is about 70N/mm2, about one-third of that of steel, with low ductility and a total strain of 5% compared with an average strain in steel of 12%. The experimental results shows that the application of impervious surface coating like bitumen makes it more resistance to deterioration and sand coating further increase the bonding, which in turn translates to good strength.(3)

This paper deals with the experimental and analytical studies carried out to explore the possibility of using naturally available bamboo to increase the bearing capacity of the soft soil. Tensile strength of the bamboo was found to be nine times higher than geocells and geogrids. It is always beneficial to use the combination of bamboo cell and bamboo grid than using them alone. The ultimate bearing capacity of the clay bed rein-forced with combination of bamboo cell and bamboo grid is 1.2–1.5 times higher than that of the geocell and geogrid reinforced clay beds. The tensile strength and surface roughness of bamboo were found 9 times and 3 times respectively higher than geocells material. This paper conclude that the settelement of the clay bed was reduced by 97% due to the insertion of the combination of bamboo cell and grid.(4)

III THEOROTICAL CONTENT

3.1 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. Meshi (Dandrocalamum strictus).
2. Dhopil (Bambusa vulgaris).

The mechanical properties of bamboo specimen

1. Meshi
   Density:- 600-700kg/m^3
   Tensile strength:- 95.78 MPa
   Compressive strength:- 56-66 MPa
   Flexural strength:- 177.14 MPa
   Shear strength:- 13-15 MPa
   Modulus of elasticity:- 13730-17650 MPa
2. Dhopil
   Density:- 590 kg/m^3
   Tensile strength:- 94.3 MPa
   Compressive strength:- 43.57 MPa
   Flexural strength:- 34.43 MPa

Shear strength:- 1.7-4.4 MPa

Modulus of elasticity:-10405.3 MPa

The tests performed on bamboo specimens are-

1. Tensile strength test
2. Flexural strength test
3. Compressive strength test

3.1.1 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.

3.1.2 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.

3.1.3 Compressive Strength Test On Bamboo Specimen (Is 6874)

❖ **Significance Of compressive Strength**

Compressive strength or compression strength is the capacity of a material or structure to withstand loads tending to reduce size, as opposed to tensile strength. Compressive strength test is used to determine the maximum compressive stress that under gradually applied load a given solid material will sustain without fracture.

3.2 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.

Test Performed on Soil Specimen Are as follows-

1. Standard Proctor test
2. California Bearing Ratio Test (CBR)

3.2.1 Standard Procter test (IS 2720 PART-7)

❖ **Significance of standard Proctor test**

Standard Proctor test is used for determination of the relation between the water content and the dry density of soils using light compaction.

3.2.2 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 pavement.

IV CONCLUSIONS

- ❖ Meshi bamboo species shows better tensile and flexural strength as compare to Dhopil bamboo species.
- ❖ 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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