Experimental Study on Bamboo Reinforcement in Retaining Wall

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Abstract— A retaining wall is a structure designed and constructed to resist the lateral earth pressure of soil. These walls are used in a variety of applications including right-of-way restrictions, protection of existing structures that must remain in place, grade separations, new highway embankment construction, roadway widening, stabilization of slopes, protection of environmentally sensitive areas, staging, and temporary support including excavation or underwater construction support, etc Recently, in the attention in response to global warming issues and sustainable society, the manufacturing using natural materials has become actively. In the developing countries expected to contribute significantly to earthquake-resistant construction and seismic retrofit technology because bamboo is low cost, fast growing, and broad distribution of growth. In this project bamboo as used facing and reinforcement in retaining wall. This project investigates the load – deflection behavior of with and without reinforcement in retaining wall with different spacing.

Key words: Bamboo Reinforcement, Retaining Wall

I. INTRODUCTION

Retaining walls are used to provide lateral resistance for a mass of earth or other materials. These walls are used in a variety of applications including right-of-way restrictions, protection of existing structures that must remain in place, grade separations, new highway embankment construction, roadway widening, etc. The loading condition of retaining wall depends on the backfill soil. For better performance granular cohesionless backfill material are provided. Under certain condition a conventional retaining wall with reinforced backfill more safe. Bamboo strips/ sheets/geogrids/geotextiles etc are used as reinforced backfill in retaining wall, laid horizontally may cause an appreciable decrease in the lateral thrust on the retaining wall which can be designed for the reduced sliding and overturning forces. There is less danger of strips breaking away due to differential settlement between the fill and the wall. Bamboo is a natural resource; it is easily available material in rural and farming areas. Bamboo is commonly used for construction and housing. Bamboo has been used in variety of application such as musical instrument home decoration; dolls, toys, jewelry and it make a furniture. The main applications of bamboo in construction field are foundation, roofing, walls, scaffolding, flooring, and trusses. Deformation problem in soft clay embankment can be solved by using bamboo grid reinforcement. Bamboo is good compressive strength and is light in weight. Advantageous of bamboo as construction material cheap rate and availability in rural and urban areas. The other main advantageous of bamboo is better flexibility and maneuverability.

II. OBJECTIVES

1) Laboratory tests which were performed to determine the engineering properties of sand and bamboo.
2) The design of retaining walls using sand and
3) Bamboo reinforcement.
4) Model wall behavior in terms of load – deflection behavior of with and without reinforcement in retaining wall with different spacing.

III. LITERATURE REVIEW

Ghavami (1995) studied bonding and bending with bamboo in lightweight concrete. Most developing countries have several problems, and one of the main problems is housing. The values of the test of compression and shear are dependent on the type of bamboo. The tensile strength is higher than the compression strength with the compressive range 12 to 53 MPa. In several tests, Bambusa vulgaris schard and Dendrocalamus were researched the highest value two types of bamboo, treatment and untreated. The treated specimens were wrapped with 1.5mm steel wire on embedded 40m spacing and cared Negrolin-sand. In this test, treated bamboo, 0.97N/mm2,was more effective than untreated bamboo, 0.52 N/mm2, with up to 90% improved bond stress.

Talwar (1981) developed theoretical analysis for computing earth pressure distribution, total pressure and its point of application behind a retaining wall with a vertical back and retaining cohesionless reinforced backfill. The investigator supported his theoretical findings with model test results. Experiments were conducted on a 46.5 cm high and 62.7 cm long rigid model retaining wall supporting reinforced backfill with no surcharge load. Garg, 1988 extended the work of Talwar, 1981 considering the uniformly distributed surcharge load on the backfill. He also developed a concept of economical placement of reinforcement. Theoretical findings were supported by laboratory model tests.

Swami Saran(1992) focus Stability of an element of the failure wedge. This study investigate that optimum length of reinforcing strips is found to be around 0.6 times the height of wall. The Pressures due to both backfill and surcharge loading are reduced about 50% for all practical values of the spacing coefficient Dp.

IV. MATERIALS

A. SAND

Locally available cohesionless dry sand used in the model tests. Sand has collected from vamanapuram. The properties of sand have shown in table 1and figure 1shows grading curve of sand.

Parameter	Value
Specific gravity	2.60
Coefficient of curvature, Cc	1.10
Uniformity coefficient, Cu	2.09
Gravel	0.1%
Sand	7.9%
Silt	92%
emin	0.67

emax	0.74
Angle of internal friction, φ	38°
Cohesion(c)	0

Table 1:Properties of sand

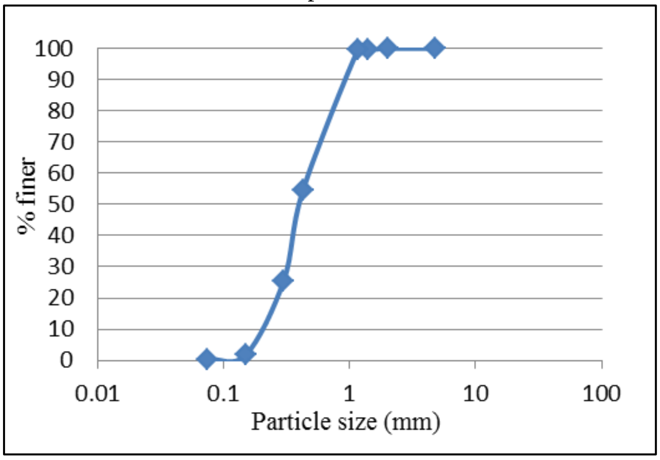

Fig 1: Grading curve for sand

B. BAMBOO

The bamboo used for carrying out this experiment is Ochalandra Travancorica reedi or simply reeds is a rare species of bamboo found abundantly in the forests of Kerala Since the plant propagates rapidly and the collection method is by select felling, the ecological balance is not disturbed even if reeds are cut in large numbers. Bamboo has 0.8 mm width. The reinforcements used were strips of bamboo. Table 2 shown in details of bamboo.

Local name	Etta, Oda (Kerala)
Culm length	2-6m
Culm diameter	2.5-5cm
Thickness	Thicker at lower parts and thinner at upper parts
Distribution	Species seen widely in Kerala and parts of Tamil Nadu and Karnataka

Table 2: Details of bamboo

Mechanical Property	Value (Kg/cm^2)
Ultimate compressive strength	562.4
Ultimate tensile strength	1265.4

Table 3: Mechanical Properties

V. METHODOLOGY

A. Design criteria

A gravity retaining wall was selected for this project. Designing the retaining wall dimensions. The wall satisfies the external stability requirements (overturning, sliding and bearing capacity).

- The following assumptions were made in order to proceed with the analysis of a wall retaining reinforced fill:
- The backfill is homogeneous, isotropic, and cohesionless.
- The backfill carries surcharge loading.
- The coefficient of friction between the soil and the reinforcement is independent of the overburden pressure and the dimensions of the reinforcement.
- The failure surface is a plane passing through the heel of the retaining wall.
- The frictional resistance offered by each reinforcing strip to the lateral movement of the wedge is uniformly distributed over a fill height equal to the vertical spacing of the reinforcement encompassing that fill layer.
- No water pressures develop within the reinforced backfill.

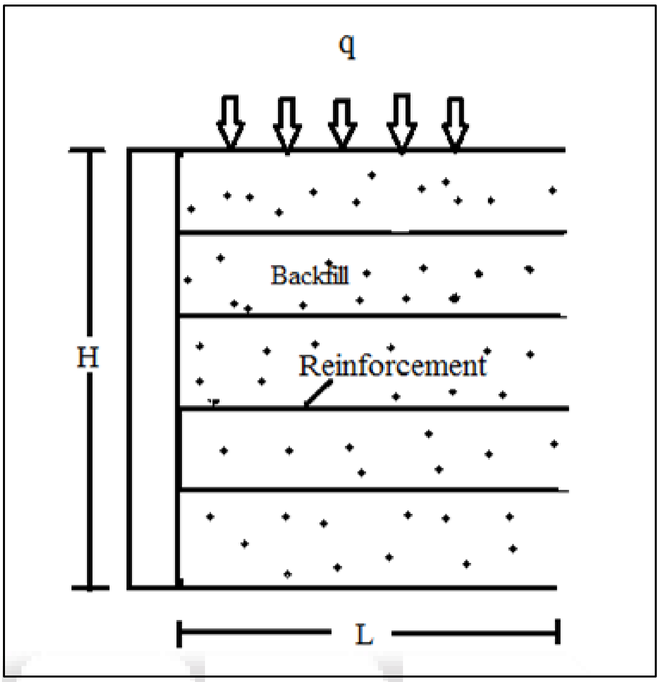

Fig. 2: Retaining wall with reinforced backfill

This analysis for a retaining wall of height H if with a vertical back face. The wall retains a cohesionless backfill that has a dry density γ and an angle of internal friction (φ).The backfill carries a surcharge of intensity q. The properties for sand used for the design were: cohesion= 0; frictional angle = 38°; unit weight = 15.57 KN/cm^3. Using the above assumptions, the design of the retaining wall was performed to ensure safety against overturning, sliding and bearing capacity. The factor of safety against sliding and overturning applying to the wall with sand backfill were 2.53 and 1.99.

B. Experimental Setup

The test facility can accommodate approximately 0.25 m3 of backfill. The model were 500 mm high by 500mm wide by 1000mm long and were constructed with a uniform sand backfill. Facing of retaining wall as a bamboo. Sand was filled five layers, in between two layers providing bamboo reinforcement. The first trial without reinforcement providing in between two layers of sand. Reinforcement was arranged in lengthwise at different spacing in each trial 78.33mm, 67.14mm, 58.75mm, 52.2mm and 47mm. After backfilling was done in stage wise by free falling technique (placing the calculated amount of backfill material based on layer thickness and target density) and compacting manually to achieve the target density. A solid wooden platform has been placed on the surface of backfill. Model wall configuration with concrete cubes used as surcharge load. To monitor the lateral deformation of the wall, linear variable magnetic dial gauge were positioned on the front face of the wall and to measure horizontal displacement against the facing

Fig. 3: Arrangement of reinforcement

Fig. 4: Experimental setup

VI. RESULTS & DISCUSSIONS

A. Load – Deflection Behavior

This experimental study was performed for gravity retaining wall with uniform backfill and bamboo reinforcement. The deflection behavior of the facing wall under surcharge load is illustrated by typical load- deflection curve as shown. Figure 5 shows the behavior of load - deflection curves at without reinforcement, the load up to 2710.7N corresponding deflection at 0.4mm.

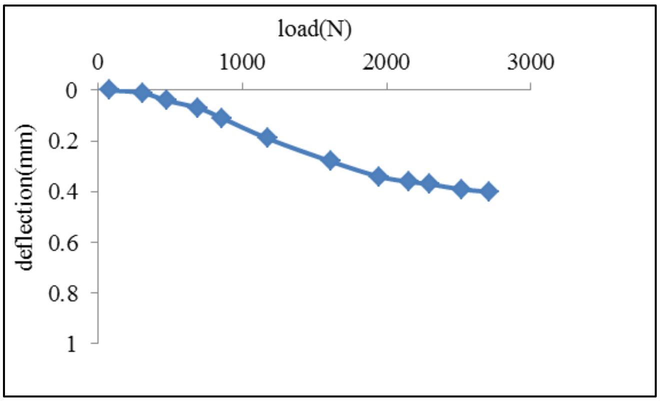

Fig 5: Load - deflection curves at without reinforcement

In this experimental study model was constructed. Sand was filled five layers, each layers providing bamboo reinforcement. Reinforcement was arranged in lengthwise and different spacing in each trial. In the first trial without reinforcement has placed, the load have applied up to 2710.7N corresponding deflection at 0.4mm. Next each trial the reinforcement was placed at different spacing.

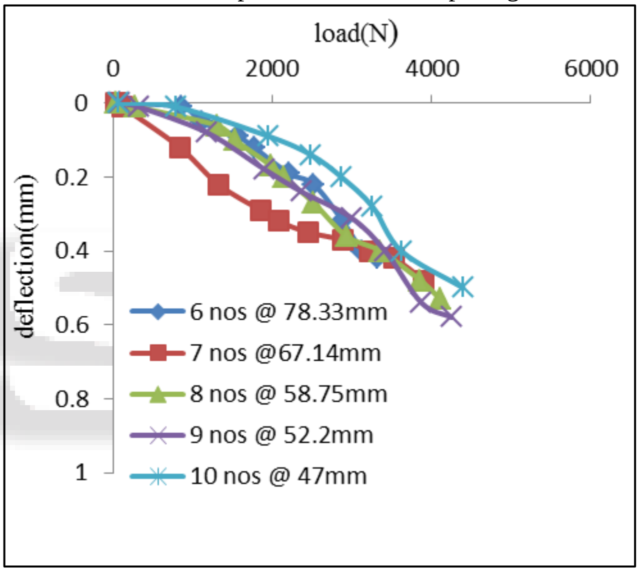

Fig. 6: Combined load-deflection curves at different spacing

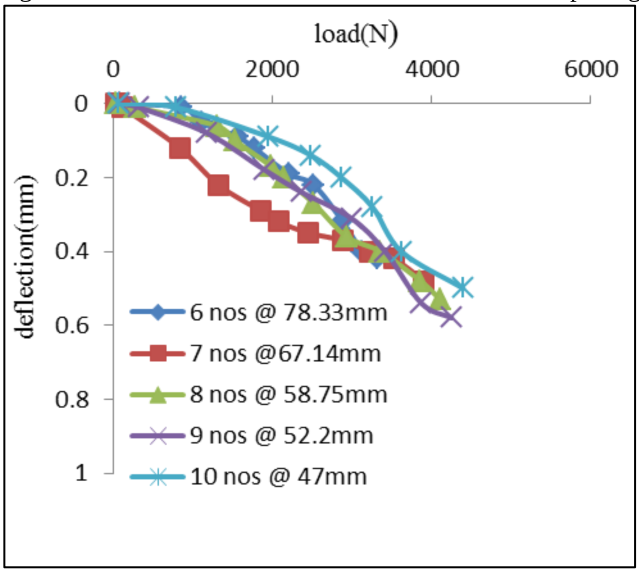

Fig. 7: Combined load-deflection curves at with and without reinforcement

Trial No	Number of bars	Spacing(mm)	Deflection (mm)	Load(N)
1	0	0	0.4	2710.7
2	6	78.33	0.4	3128.79
3	7	67.14	0.4	3224.49
4	8	58.75	0.4	3357.29
5	9	52.2	0.4	3416.19
6	10	47	0.4	3619.40

Table 4: Experimental results

A substantial increment in load was observed due to bamboo reinforcement as compared with without reinforcement in retaining wall. The deflection has increased by increasing surcharge load. In the first case without reinforcement in retaining wall has 0.4mm deflection corresponding load noted as 2710.7N. In the second case bamboo reinforcement in retaining wall load has increased 15.42% corresponding 0.4mm deflection at 78.33mm spacing. Corresponding 0.4mm deflection and at 67.14mm, 58.75mm, 52.2mm, 47mm spacing a substantial increment in load obtained is 18.95%, 23.85%, 26.02%, 33.52% respectively. The spacing of reinforcement decreased with increasing load carrying capacity of backfill it shows figure 5.9.

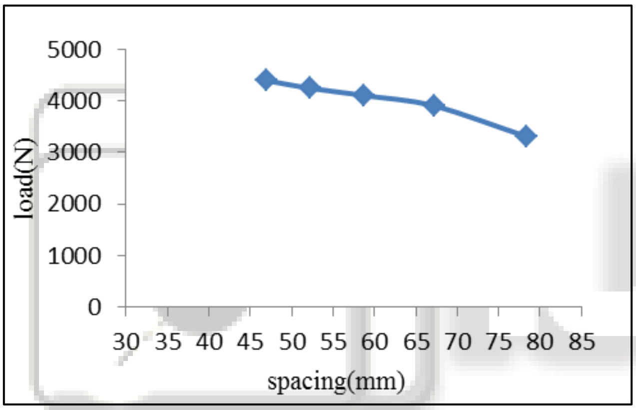

Fig. 8: Load-spacing curve

VII. Conclusions

These experimental studies on responses of laboratory scale retaining wall models with backfill materials and bamboo reinforcement. This project addresses one potential use of bamboos within the civil engineering field. Using bamboo as reinforcement for retaining wall has been investigated.

- A substantial increment in load was observed with bamboo reinforcement other than without reinforcement in retaining wall. The deflection has increased by increasing surcharge load.
- In the first case without reinforcement in retaining wall corresponding to 0.4mm deflection the load noted as 2710.7N.
- In the second case with bamboo reinforcement in retaining wall load has increased 15.42% corresponding to 0.4mm deflection at 78.33mm spacing. Corresponding 0.4mm deflection and at 67.14mm, 58.75mm, 52.2mm, 47mm spacing a substantial increment in load obtained is 18.95%, 23.85%, 26.02%, 33.52% respectively.
- The maximum load corresponding 0.4mm deflection without reinforcement is 2710.7N. By providing 6,7,8,9 and 10 numbers of reinforcements in retaining wall progressively there obtained substantial increment in load.
- The maximum load retaining wall can withstand at 0.4mm deflection is noted while providing 10 number of reinforcements corresponding load obtained is 3619.40N. This value 33.5% greater than without reinforcement.
- The load carrying capacity of backfill increased with decreasing spacing of reinforcement.
- In construction field bamboo has used as a reinforcement material because of it availability, economical benefit and cost saving. However, there is still ample scope for research on the subject.

There is more future scope in the topic by analyzing different factors such as varying width of bamboo, L/D ratio, and different height of retaining wall.

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