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FLEXURAL BEHAVIOR OF BAMBOO REINFORCED FERROCEMENT PANELS

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Abstract

Ferrocement is an emerging technology that differs from conventional reinforced concrete by the manner in which the reinforcing elements are dispersed and arranged. It consist of closely spaced, multiple layers of wire mesh embedded in cement mortar. Traditionally steel is used as reinforcement in concrete structures; but because of cost and availability, replacement of steel with some other suitable material as reinforcement is now a major concern. The construction industry is the main consumer of energy and materials in most of the countries. Since Bamboo is a natural, ecologically friendly, cheap and also readily available material; it can be use as a substitute of wire meshes in reinforcing of Ferrocement structures. This study describes the results of testing of Ferrocement beams reinforced with different number of Bamboo mesh layers and variation in spacing of bamboo reinforcement. The main objective of these experimental tests is to study the effect of using different numbers of Bamboo mesh layers and spacing variation on the Flexural strength of Ferrocement beams.

Keywords: Ferrocement, Bamboo reinforcement, Construction material, wire mesh, Flexural strength.

I. INTRODUCTION

A new material named “Ferrocement” is born and along-with it a new technology in construction Industry is developed. It has converted the heterogeneous brittle material like RCC into a homogeneous, ductile composite. This is due to a small change of replacing steel bars by continuous meshes of fine steel wires. With Ferrocement it is possible to fabricate a variety of components, may be walls, floors, roofs, shells etc. They are thin walled, lightweight and durable. In addition it needs no formwork or shuttering for casting. Ferrocement has applications in all fields of civil construction, including water and soil retaining structures, building components, bridges, domes, dams, boats etc. Ferrocement is ideally suited for thin wall structures as the uniform distribution and dispersion of reinforcement provide better cracking resistance, higher tensile strength to weight ratio, ductility and impact resistance. The only limitation of Ferrocement structures is the total cost of structure; wire mesh material imparts major part of cost in conventional ferrocement. Bamboo is fast growing and ecologically friendly natural material for structural applications. The tensile strength of

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Bamboo is quite high and can reach up to 125 Mpa. This makes Bamboo an alternative to wire mesh in Ferrocement structures.

II. LITERATURE REVIEW

Darshan G. Gaidhankar et.al [1] carried out an experimental work on forty eight ferrocement slab panels for studying their flexural behavior. The panels tested for flexure are of size550mm X 200mm with 20mm, 30mm and 40mm thickness. Expanded metal mesh of size 15mm X 30mm opening was used with water cement ratio of 0.4 and 1:1 cement sand proportion. Form experimental work, authors concluded that, the flexural load at first crack and ultimate loads depends on number of reinforcing mesh layers used in ferrocement panels. As number of layers of wire mesh increases from 2 to 4; ductility and capability to absorb the energy of panels increases.

T.Gutu[2] has carried out the tests to detect the mechanical strength properties of bamboo including physical, mechanical using different types of bamboo thus wet bamboo, dry, solid and hollow bamboo specimens were tested for strength properties. Author has found that, bamboo strength properties are suitable for use as an additional material. Author noted that, most of developed countries use bamboo for most of their big projects e.g. Construction of bridges, construction of bamboo corridors in Europe.

Dr. Patel Pratima et.al[3] carried out an experimental work on 138 slab panels with M20 grade of concrete in which bamboo mesh was embedded as reinforcement. The panels tested for flexure were of size 900mm X 250mm X 75mm. Authors concluded that the load carrying capacity of bamboo strips with concrete is justifying the steel reinforcement. Replacement of steel reinforcement can be possible by using, bamboo as bonding element in concrete.

Vincent Prabakar Rajaiah[4] hascarried out an experimental investigation to observe flexural behavior of folded ferrocement panels. For panels with single wire mesh, the wire mesh was placed at mid depth of panel; and the panels with double wire mesh, the wire meshes were placed on two sides of the skeletal steel. 1:1 cement sand proportion used for mortar with 0.3 water to cement ratio for mixing. Author concluded that cracking load was not significantly affected by the number of wire mesh layers particularly for folded panels.

James Kariuki[5] have casted laminated bamboo beams by using high strength polyvinyl acetate as an adhesive for lamination of bamboo strips. The intention was to study the behavior of laminate bamboo beams under two point flexure loading and compare it with cypress beams. Total six laminated beams of dimension 45mm X 95mm X 600mm were tested; these beams were compared with three beams made with cypress timber. From experimental tests, Authors concluded that, laminated bamboo beams exhibits better load carrying capacity than cypress beams.

Jigar K. Sivalia et.al.[6] has presented the evaluation of the feasibility of the use of bamboo as reinforcement in concrete members .In this study the bamboo was used as a reinforcing material without any treatment and stirrups. In the recent era, concrete is the most consumed construction material in the entire world. Concrete is found to have excellent compressive strength but poor tensile strength. This study reflects about the usefulness of bamboo as a structural member in flexural elements.

This paper presents efficiency of Bamboo mesh in Ferrocement panels under the flexural loading.comparision of same is done with conventional wire mesh ferrocement panels according to the layers of mesh, opening size and flexural load.

III. MATERIAL AND SPECIFICATIONS

In this present study following materials are used for casting the specimen.

1. Cement: PPC, 53 grade cement was used having fineness of 4 %.
2. Fine aggregate: River sand used as fine aggregate in mortar mix. The river sand passing through 4.75mm sieve having specific gravity 2.42 and water absorption 1.9 %.
3. Wire mesh: Steel wire mesh having 1.45mm diameter i.e. 15 gauge and 15mm X 15mm opening and 25mm X 25mm opening area respectively for conventional ferrocement panels casting.
4. Bamboo strips: Seasoned Bamboo strips of 740mm length were used as a reinforcement mesh in panels.
5. Water: used potable water which satisfies requirements of IS 456-2000.
6. Sample mould: Sample mould for specimen casting was prepared having dimensions 750mm X 125mm with 35mm thickness.Sample mould is shown in figure no.1.
7.

Figure No. 1. Sample Mould For Casting

IV. Experimental Programme And Results

The program was conducted for understanding the behavior of bamboo mesh as reinforcement in ferrocement panels under flexural loading. The testing carried out on panels of size 750mm X 125mm with 35mm thickness with single layer and double layer bamboo mesh with variation in spacing as 15mm X 15mm opening and 25mm X 25mm opening area. The cement sand proportion for casting used was 1:3 with water cement ratio of 0.4. For this experimental program 24 numbers of panels were casted using conventional wire mesh as reinforcement. And 48 panels were casted using bamboo mesh as reinforcement. The specimens were cured for 7 days and 28 days in potable water.

A. Flexural strength test- IS 516(1959):

The panels were tested under flexural testing machine with loading cell of 100 KN capacity. The specimen was placed for uniform loading. The load was applied to uppermost part of specimen along with two loading points. for applying loads two steel rollers were used in the assembly.

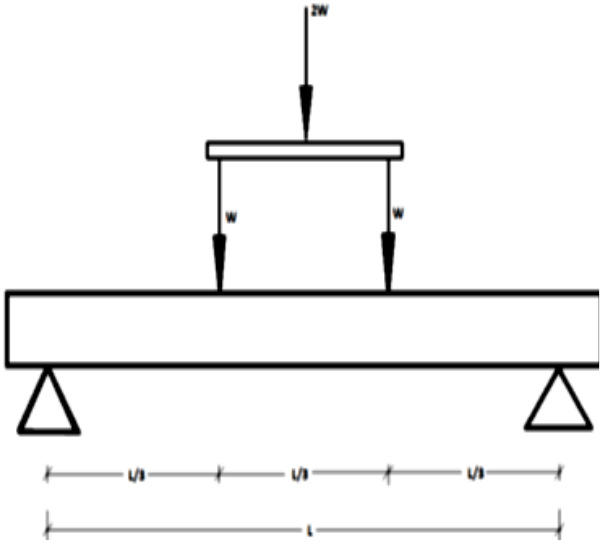


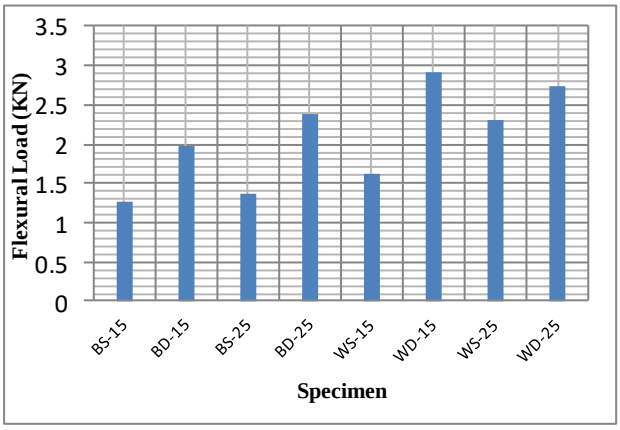
Figure No. 2.Typical Two Point Loading Arrangement.

Load was increased until the specimen fails, and the maximum load applied to the specimen during the test was recorded. Results are shown in following table I and table II.

Where BS means bamboo mesh with single layer and BD means bamboo mesh with double layer. WS means wire mesh single layer and WD means wire mesh double layer. Number infront indicates opening size provided.

TABLE NO. I 7 DAYS CURING FLEXURAL LOAD CARRYING CAPACITY

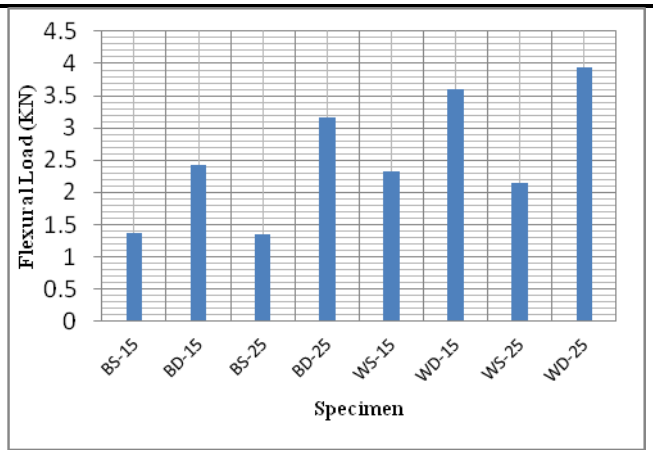
Sr.No.	Specimen	Mesh Type	Opening Size (mmxmm)	No. of Specimen	Flexural Load (KN)
1	BS-15	Bamboo	15 X 15	6	1.26
2	BD-15	Bamboo	15 X 15	6	1.97
3	BS-25	Bamboo	25 X 25	6	1.37
4	BD-25	Bamboo	25 X 25	6	2.39
5	WS-15	Wire Mesh	15 X 15	3	1.63
6	WD-15	Wire Mesh	15 X 15	3	2.92
7	WS-25	Wire Mesh	25 X 25	3	2.30
8	WD-25	Wire Mesh	25 X 25	3	2.74



Graph No.1. 7 Days Curing Flexural Load Carrying Capacity

TABLE NO. II 28 DAYS CURING FLEXURAL LOAD CARRYING CAPACITY

Sr. No.	Specimen	Mesh Type	Opening Size(mm xmm)	No. of Specimen	Flexural Load (KN)
1	BS-15	Bamboo	15 X 15	6	1.36
2	BD-15	Bamboo	15 X 15	6	2.42
3	BS-25	Bamboo	25 X 25	6	1.35
4	BD-25	Bamboo	25 X 25	6	3.16
5	WS-15	Wire Mesh	15 X 15	3	2.32
6	WD-15	Wire Mesh	15 X 15	3	3.61
7	WS-25	Wire Mesh	25 X 25	3	2.15
8	WD-25	Wire Mesh	25 X 25	3	3.94



Graph No.2.28 Days Curing Flexural Load Carrying Capacity

V. CONCLUSION

The following conclusions were drawn from the experimental study carried on bamboo reinforced ferrocement laminates.

Flexural strength of panel after 07 days of curing with double layer bamboo mesh is 56% higher than panel with single layer and 20 % higher than panels with single layer conventional wire mesh for 15mm X 15mm opening.

Flexural strength of panles after 07 days of curing with double layer bamboo mesh is almost twice than with single layer and almost same with single layer conventional wire mesh panels with 25mm X 25mm opening.

Flexural strength of panel after 28 days of curing with double layer bamboo mesh is 77% higher than panel with single layer and almost same for panels with single layer conventional wire mesh for 15mm X 15mm opening.

Flexural strength of panles after 28 days of curing with double layer bamboo mesh is almost 2.5 times higher than with single layer and 47% higher than single layer conventional wire mesh panels with 25mm X 25mm opening.

Bamboo reinforced ferrocement panels are economical as compared to conventional wire mesh reinforced ferrocement panels. Though the flexural load carrying capacity is lesser than conventional it is acceptable and can be used for light weight structures as a wall panels.

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