Novateur Publications
International Journal of Innovations in Engineering Research and Technology [IJIERT]
ISSN: 2394-3696 Website: ijiert.org
Volume 11, Issue 6, June - 2024

A REVIEW PAPER ON FLEXURAL BEHAVIOR OF BAMBOO REINFORCED FERROCEMENT PANELS

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Article History: Received on: 21/03/2024
Accepted on: 30/05/2024

DOI: https://doi.org/10.26662/ijiert.v11i6.pp1-7

Abstract:
By spreading and organizing the reinforcing elements differently from traditional reinforced concrete, ferrocement is a developing technology. It is made up of numerous layers of closely spaced wire mesh immersed in cement mortar. Steel has historically been utilized as reinforcement in concrete constructions, however due to cost and availability issues, it is becoming increasingly important to replace steel with another appropriate material. In the majority of the world's countries, the building sector is the largest user of resources and energy. Because bamboo is an inexpensive, naturally occurring material that is also widely available, wire meshes for reinforcing Ferrocement buildings can be replaced with bamboo. The testing findings of cement beams reinforced with varying numbers of bamboo mesh layers and bamboo reinforcement spacing are presented in this paper. These experimental experiments' primary goal is to determine how utilizing varying numbers of bamboo mesh layers and spacing variations affects the flexural strength of cement beams.

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

I. INTRODUCTION

Ferrocement has a history of more than 150 years. It remained in background up to 1940. It has boomed as a construction material in the last two to three decades. Though Ferrocement is called as a form of reinforced concrete, it is only in the terms of grouping terms ‘reinforced’ and ‘concrete’. It differs from conventional reinforced concrete by the manner in which the reinforcement is distributed in the matrix and is bonded with it closely spaced and thoroughly distributed continuous fine wire mesh reinforcement in brittle matrix of cement mortar forms Ferrocement. The ingredients of Ferrocement remain strongly bonded together up to yield of steel wires and hence behave more like a homogeneous and ductile material. Structures of thinner sections are possible due to closely tied mesh reinforcement and micro concrete as matrix. Mesh tied tightly over skeletal steel also acts as a formwork. Hence Ferrocement can be cast in any complicated shapes and sizes.

Ferrocement is an environment friendly sound technology and possesses excellent unique properties such as good tensile strength, improved toughness, water tightness, less weight, fire resistance, resistance to cracking and cost, time and material effective construction technology. The following definition was adopted by the ACI Committee: "Ferrocement is a type of thin wall reinforced concrete commonly constructed of hydraulic cement mortar reinforced with closely spaced layers of continuous and relatively small size wire mesh. The mesh may be made of metallic or other suitable materials. According to the ACI Committee, 'durability' is defined as 'ability to resist weathering action, chemical attack, abrasion, or any other process of deterioration', that is, durable concrete will retain its original form, quality and serviceability, when exposed to its environment. The various measures required ensuring 'durability' in conventional reinforced concrete is also applicable to Ferrocement, since, Ferrocement has almost the same type of ingredients/constituents, except, coarse aggregates and the use of smaller fine aggregates, than conventional concrete and a thin cross section.

Foundations-parabolic shaped, multi-bulbed under-reamed piles, RCC columns encased in ferrocement, double walling for compound walls on expansive soils. Walling-single wall, partition wall, double wall with cavity, thermally insulated, soundproof walls, walls resisting rain penetration. Single wall box-like structures, garages, police chowki, site office, stores, wayside shops, latrines, service units, godowns, watchman's cabin, animal sheds, bus shelters, telephone booths, cycle stands etc. Double walled construction with inbuilt columns and beams, precast stiffened plates for cavity walls and hollow floors in construction of multistoried buildings, earthquake resisting structures, beams and columns.

For earthquake resisting structures, the external confinement using ferrocement resulted in enhanced stiffness, ductility, and strength and energy dissipation capacity.Roofing:- flat roof with channel sections, sloping roofs. Shaped roofs like folded plates, cylindrical shells, domes, umbrella, pyramidal, conical, corrugated catenary, gabled and hipped, thermally insulated, hollow floors with grid beams hidden inside, forming box sectioned floors. Flooring-jack arch, precast waffle plates, precast trough sections, ribbed slabs, grid floors, hollow floors. Precast box sectioned large size hollow floors to replace large size prestressed core slabs. Accessories-chajja, lintel, weather-sheds, drop walls, sun-breakers and fins, canopy, lofts, cupboards, boxes for windows, staircase-folded and spiral, drainage chambers and covers, door and window frames, louvered window, precast service units, rainwater gutters, garden pots, flower beds, decorative items for landscaping- ferrocement trees, fountains, waterfalls, decorative compound walls, fence posts, decorative columns, panels and facia, dust bins. Waterproofing: for slabs, roofs, water tanks etc.

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 size 550mm 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] have carried 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] has 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] have carried out 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 in tensile strength. To take care of the tensile strength steel is commonly used reinforcing material. Due to the increasing cost, unavailability and other drawbacks of the steel reinforced to use an alternative material as reinforcement. This case is found common in developing countries. Bamboo is used as a construction material from the earlier times due to its advantageous and versatile properties. As it is good in tension and bending properties it has drawn the attention of researchers to use it as reinforcement in cement concrete. This study reflects about the usefulness of bamboo as a structural member in flexural element. Various surface coatings on the bamboo are given and the reinforcement cage has been prepared using the bamboo stirrups. The flexure test was performed on the beam elements. Modulus of Elasticity has been calculated..

Adom-Asamoah Mark et.al[7] had done comparative study of bamboo reinforced concrete beams with shear links made of different materials. The web materials considered were bamboo, rattan cane and steel. Sixteen (16) beams had tested to failure under four point bend tests. The highest and lowest failure loads had recorded for the cases of steel stirrups and no stirrups respectively. The experimental failure loads averaged 5.05 and 1.72 times the observed first crack and theoretical failure loads respectively. The cheapest and most economical means of providing shear reinforcement for bamboo-reinforced beams was analyzed using a performance model developed in this research. A beam performance index (BPI) in terms of energy absorbed per unit cost of beam, indicated the use of steel stirrups as the most economical. The most expensive means of shear reinforcement provision in bamboo reinforced beams is by rattan cane stirrups irrespective of the grade of concrete. It is therefore recommended that steel stirrups be used to enhance the performance of bamboo reinforced concrete beams.

Nagesh M. Kulkarni et al[8] had described the various experiments conducted on Ferrocement panels in literature review and the conclusions and remarks drawn by the authors. The results obtained are going to help in the project work to investigate the behavior of Ferrocement panels for various parameters and loading. This is useful to find solutions by searching new design techniques and method of constructions.

M.Amala et.al[9] have studied and compared the structural behavior of Ferrocement slabs of different ratios and its mechanical properties. The Ferrocement slabs had made by using cement and copper slag with constant layers of welded meshes. Performance of the tested slabs are presented and discussed in this work. Normally for a Ferrocement slab, 3mm dia. welded wire fabrics are used for construction, in this study very small dia. wires (1mm) and also closely spaced (10 mm) wires are used in order to increase the ductility properties and also durability related properties of Ferrocement.. The flexural properties of these Ferrocement slabs are evaluated and compared under four point static loading system using specific test setups and comparative study of the test results confirm that Ferrocement slabs made of copper slag are more effective in flexural strength.

Randhir Phalke et al [10] had presented results of testing flat ferrocement panels reinforced with different number of wire mesh layers. They had studied the effect of using different no of wire mesh layers on the flexural strength of flat ferrocement panels and to compare the effect of varying the no of wire mesh layers and use of steel fibers on the ultimate strength and ductility of ferrocement slab panels. The no of layers used are two, three and four. Slab panels of size (550*200) with thickness 25 mm are reinforced with welded square mesh with varying no of layers of mesh. Panels had tested under two point loading system in UTM machine after curing period of 28 days. Test concluded that panels with more no of layers exhibits greater flexural strength and less deflection as that compared with panels having less no of layers of mesh.

Yousry B.I. Shaheen et al [11]-have carried out experimental investigations to study the structural behavior of Ferrocement concrete composite channels reinforced with various types of reinforcing materials. The dimensions of the developed Ferrocement and control test specimens were kept constant as100 mm width, 200 mm height and 2000 mm length. The thickness of the two webs and base was kept constant as 25 mm. The test specimens were loaded under four point loadings until failure. The effects of the main parameters were extensively studied. High resistance Ferrocement channels beams were developed with high crack resistance, high deformation characteristics, high strength, high ductility and energy absorption properties could be used with great economic advantages in the same way as steel channels in some of its uses and very useful for developed and developing countries alike.

III OBJECTIVES OF INVESTIGATION

- To study Behavior of ferrocement panels using bamboo mesh strips under flexural loading.
- To investigate the effect of various parameters such as number of mesh layers, different cross-sections of bamboo strips on the flexural strength and bending stress of panels.
- To understand the change in behavior under flexural loading due to opening area of bamboo mesh.
- To investigate Cost comparison between bamboo mesh ferrocement panels and conventional wire mesh ferrocement panels.

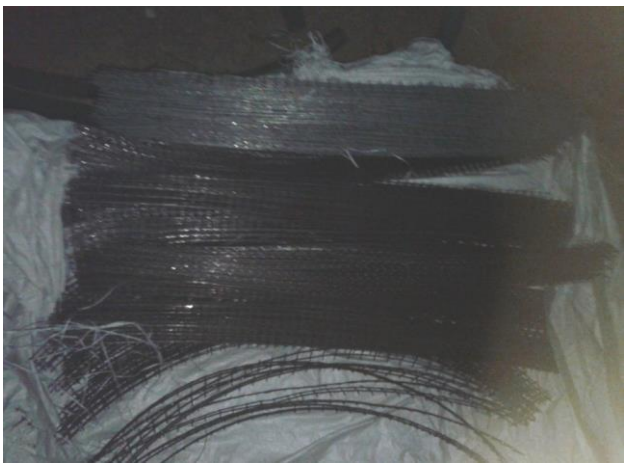
IV METHODOLOGY

Cement: The cement should be fresh, of uniform consistency and free from lumps and foreign matter. It should be stored under dry conditions for as short duration as possible. Types of cement are ordinary Portland cement of various grades, rapid hardening cement, sulphate resisting cement, white and colored

cement and pozzolana cement. The choice of any particular cement depends upon the site conditions. Generally ordinary Portland cement of 43 or 53 grades is used in ferrocement. In coastal areas or for structures exposed to sea water, or acidic industrial wastes sulphate resisting cements are recommended. Pozzolana cement has slow setting and is not recommended for filling in vertical walls of height more than 1200mm at a time.If sulphate-resisting cements or admixtures are not available, rich cement mortar should be used and later the structure should be coated. Cement content in ferrocement is higher than in conventional reinforced concrete. Mineral admixtures like flyash, silica fumes or blast furnace slag may be used to maintain a high volume fraction of fine filler material. In addition to improvement in plasticity of the mix, these minerals are also beneficial in long term strength gain, lower mortar permeability and in some cases resistance to sulphates and chlorides. For Ordinary Portland cement IS-269 of 1976 should be referred.

Meshes:

Reinforcement for ferrocement is commonly in the form of layers of continuous mesh fabricated from single strand filaments. Specific mesh types include woven or interlocking mesh (such as chicken wire cloth), woven cloth mesh in which filaments are interwoven and their intersections are not rigidly connected, welded mesh in which a rectangular pattern is formed by perpendicular intersecting wires welded together at**.** Their intersections and specially woven patterns that may include diagonal filament woven through the rectangular mesh pattern. Examples of welded wire mesh are shown in Fig.3.1 Two other forms of metal reinforcement are in use: expanded metal lath formed by slitting thin gage sheets and expanding them in a direction perpendicular to the slits; and punched, or otherwise perforated, sheet products. Another form of reinforcement consists of continuous filaments that are randomly, or at least irregularly, assembled into a two-dimensional mat form. This particular form of reinforcement has been made with natural organic fibers and glass fibers. It is frequently found in developing countries using indigenous materials.



Bamboo Mesh:

Bamboo mesh of 4X4X3 and 6X6X5 mm in trapezoidal cross-section is used as reinforcement. Bamboo strips of 750mm length are tied together by bending wire to form a mesh opening area provided was 15X15 mm and 25X 25 mm. clear cover of 5mm to 8mm from top and bottom is provided in case of double layer bamboo reinforcement. Whereas in case of single layer reinforced panel, bamboo mesh is placed at the bottom with 5 mm to 8mm cover.

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