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A Review on "Experimental analysis of deep beam by using BFRP and Bamboo as reinforcement"

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Abstract - *This Review paper covers the study of deep beam and proposed to carry out the experimental work to check the feasibility and possibility of BFRP (Basalt fibre reinforced polymer) and bamboo to be used as reinforcement in a deep beam. In this paper objective of work and their methodology is suggested. The outcomes may lead to change a practice of material as reinforcement other than steel in RCC deep beam.*

Key Words: Deep beam, Baslat fibre Reinforced polymer, BFRP , Bamboo as reinforcement, cost effective construction, corrosion free structural element

1.INTRODUCTION

1.1 Deep beam

Deep beams are often used as structural members in Civil Engineering works. Because of the geometric proportions of deep beams, their strength is usually controlled by shear rather than flexure, if normal amounts of reinforcements are provided. Reinforced concrete (RC) deep beams are generally used as load-transferring elements, such as transfer girders folded plates, and foundation walls. In buildings, a deep beam or transfer girder is used when a lower column on the exterior façade is removed for architectural purposes. In construction, deep beams are widely used in water tanks, underground bunkers, silos, nuclear reactors, etc., where walls act as vertical beams spanning between column supports. Sometimes pile caps are also designed as deep beams. Indian Standard Code IS:456-2000 (page no.51 , clause no.29.1) the beams with span to depth ratios less than 2.5 for continuous span and less than 2.0 for simply supported span are considered as deep beams.

1.2 Bamboo

Bamboo is available everywhere around the world; some regions in the world continue to use bamboo structures to this day. It was found that for steel it is necessary to spend 50 times more energy than for bamboo. In the production of one tone steel two tons of CO2 is produced. In contrast bamboo plant absorbs CO2 besides producing oxygen. The tensile strength of bamboo is relatively high and can reach 200-300 MPa; this turns the use of bamboo attractive as substitute of steel, especially when considering the relation between tensile resistance and specific weight of bamboo which is six times greater than for the steel. Tensile strength of bamboo reinforcement is almost the same with steel reinforcement, but bamboo material is not as ductile as steel material. In the recent years, due to an increase in the cost has led to the use of naturally available material for the reinforcement of concrete beams in the rural constructions. In the developing countries like India, have more than 80 percent of the population living in rural area. Bamboo is one of the widely used construction materials since ancient times due to its low cost, high strength, feasibility, low weight, earthquake resistance, etc. It has started appearing recently in designer homes as flooring, walling and paneling material. Bamboo is especially preferred by poor and for rural construction. It is unpopular in conventional construction due to low durability, lack of structural design data, exclusion from building codes etc. The world timber demand is increasing at a rapid rate but the timber supply is depleting. It's been found through research that bamboo can suitably replace timber and other materials in construction and other works. Industrially treated bamboo has shown great potential for production of composite materials and components which are cost-effective and can be successfully utilized for structural and non-structural applications in construction. Bamboo is one of the oldest traditional building materials used by mankind. Bamboo is. quite common for bridges, scaffolding and housing, but it is usually used as a temporary exterior structural material. In many overly populated regions of the tropics, certain bamboos supply the one suitable material that is sufficiently cheap and plentiful to meet the extensive need for economical housing. With the advancement of science and technology and the tight supply of timber, new methods are needed for the processing of bamboo to make it more durable and more usable in terms of building materials. Studies have been carried out on the basic properties and on processing of bamboo into various kinds of composite products. Bamboo has several unique advantages like ability to grow fast with a high yield and also it matures quickly. Additionally bamboo can be grown abundantly and that too at a lower cost which makes it more economical. Bamboo mainly grows in tropical and sub-tropical regions of Asia, Latin America and Africa. Bamboo is versatile resource characterized by high strength to weight ratio and ease in working with simple tools. Bamboo is the fastest growing, renewable natural resource known to us. It

is a small wonder, therefore, that this material was used for building extensively by our ancestors. It has a long and well established tradition as a building material throughout the tropical and sub-tropical regions. It is used in many forms of construction, particularly for housing in rural areas. But, enough attention had not been paid towards research and development in Bamboo as had been in the case with other materials of construction including timber Due to the advantageous characteristics of Bamboo, in the last few years, studies have been made on Bamboo as structural material and reinforcement in concrete.

1.2 BFRP

Concrete is the world's most used man-made construction material today. It is relatively cheap and easy to form when cast in India. The most common reinforcing material for Reinforced Concrete (RC) used until now and is still used today is steel. Using steel as reinforcement has numerous advantages; it is strong in tension and has a high modulus of elasticity. The thermal expansion is similar to concrete and it works well with concrete under loading. The production process for steel is very stable and thus the material properties are also very stable, then steel is easy to form and work with. But using steel as reinforcement has also some disadvantages; it can corrode with time and has low fire resistance. The price of steel has also been rising over the last few years. The main challenge for civil & structural engineers is to provide sustainable, environmental friendly and financially feasible structures to the society. Finding new materials that can fulfill these requirements is a must. The relatively new development of an FRP composed of fibers of melted basalt rock (BFRP). Basalt fibers are environmentally friendly and nonhazardous materials as they are produced from volcanic rocks by using single component raw material and drawing fibers from the molten rocks. Basalt is naturally occurring and is one of the most abundant materials on

2. RELEVANCE

The rapid development of economic construction, people are increasingly looking for more and more new materials for building construction. This is an essential part of human life; it cannot be limited to the use of wood and stone. In the past engineering structures, the common concrete structure and steel structure, followed by masonry structure, wood structure and glass curtain wall structure, especially in urban and rural buildings. Reinforced concrete is widely used in modern engineering structures as a kind of excellent traditional building material. This is because first of all, the steel bar is protected by concrete and has the characteristics of durability and fire resistance. Secondly, its integrity is better. Can be modeled, can be local materials, steel and reduce cost and other characteristics. However, the use of reinforced concrete in the process there are many problems, such as self-important, in corrosive and other adverse environmental durability. Based on these factors, domestic and foreign scholars have carried out research on new materials. Reinforced concrete deep beams have many useful applications, particularly in tall buildings, foundations and offshore structures. However, their design is not covered adequately by national codes of practice. As a present scenario, research carried out on RC deep beam by using BFRP and bamboo yet not found. It can be used to study the tensile and bending experiments of concrete deep beams. This study will therefore focus on concrete deep beams reinforced with BFRP and bamboo.

3. LITERATURE REVIEW

Vengatachalapathy.V, Ilangovan R. (2010): Paper on "A study on steel Fibre reinforced concrete deep beams with and without openings". This experimental study deals with the behavior and ultimate strength of steel fiber reinforced concrete (SFRC)deep beams with and without openings in web subjected to two point loading, nine concrete deep beams of dimensions 750mm×350mm×75mm thickness were tested to destruction by applying gradually increased load. Simply supported conditions were maintained for all the concrete deep beams. The percentage of steel fiber was varied from 0 to 1.0.The influence of fiber content in the concrete deep beams has been studied by measuring the deflection of the deep beams and by observing the crack patterns. The investigation also includes the study of steel fiber reinforced concrete deep beams with web reinforcement with and without openings. The ultimate loads obtained by applying the modified Kong and Sharp's formula of deep beams are compared with the experimental values. The above study indicates that the location of openings and the amount of web reinforcement, either in the form of discrete fibers or as continuous reinforcement are the principal parameters that affect the behavior and strength of deep beams. The conclusions can be drawn from the experimental results are obtained. Web openings may be provided in the compression zone of the beams and fiber content of 0.75%by volume may be added to improve the strength of the structure. The openings in the tension zone weaken the beam. Fiber content of 0.75%by volume of the beam improves the ultimate load and the first crack load of the beam. Additional of steel fibers increase the tensile strength of concrete matrix and also increase in the flexural rigidity of the beam.

Anurag Nayak, Arehant S Bajaj, Abhishek Jain, Apoorv Khandelwal, Hirdesh Tiwari, (2011): Carried out study on "Replacement of steel by bamboo Reinforcement" The present paper deals with cost-wise comparison of steel reinforcement with bamboo reinforcement. The utilization of bamboo reinforcement as replacement of steel reinforcement is gaining immense importance today, mainly on account of the improvement in the economical aspect combined with ecological benefits. To study the effect of replacement of steel reinforcement by bamboo reinforcement, designs have been conducted on one way slab of size 3000 x 7000 sq-mm with providing beam of 7000

mm length and 250 x 250 sq-mm. In this paper the designs are done on the basis of shearing and bending. Based on this study of cost vs strength provided results have been discussed in the paper. In this project we have opted advanced bamboo reinforcement technique instead of traditional steel reinforcement. This is a good idea for low cost economical structure. Bamboo reinforcement technique is used for both main and distribution reinforcement as it was same earlier done for steel reinforcement. It is three times cheaper than steel reinforcement technique. It is clear from results that this bamboo reinforcement technique is absolutely cheaper than steel reinforcement technique especially for single story structure.

Rahman M.M, Rashid M.M, Hossain M.A, Hasan M.T and Hasan M.K (2011): Carried out study on "Performance evaluation of bamboo reinforced concrete beam" Traditionally steel is used as reinforcement in concrete. But because of cost and availability, replacement of steel with some other suitable materials as reinforcement is now a major concern. Though bamboo has been used as a construction material, especially in developing country, until today its use as reinforcement in concrete is very limited due to various uncertainties. Since bamboo is a natural, cheap and also readily available material, it can be a substitute of steel in reinforcing of concrete. In this paper, aptness of bamboo as reinforcement in concrete will be evaluated. To assess this, tensile strength test of bamboo having three and five nodes are performed. 1 m bamboo sticks of varying cross sections are used in this test. Also flexural strength test of bamboo reinforced beam is done to characterize the performance of bamboo as reinforcement. Singly and double bamboo reinforced beams of 750 mm length having 150 mm width and depth are compared with plain concrete beam to carry out in this test.

Dipti R.Sahoo, Carlos A. Flores and Shih-Ho Chao (2012): Paper on "Behavior of Steel fiber reinforced concrete deep beams with large opening" Large openings in reinforced concrete (RC) deep beams generally interrupts the load transfer by concrete struts and causes a sharp decrease in strength and serviceability. The reinforcement detailing of these deep beams based on strut-and-tie models (STMs) can be complex and, very often, these models may not predict the failure mechanism of deep beams due to localized damages. This study investigates the performance of two RC and two steel fiber-reinforced concrete (SFRC) deep beams with large openings under monotonically increased concentrated loads. The boundary regions near the supports of two specimens were strengthened with steel cages formed by steel reinforcement bars. The RC specimen with strengthened boundaries exhibited a ductile mode of failure and had significantly higher ultimate strength than predicted by STMs. Although the complex reinforcement detailing as per STMs was not used, the SFRC specimens with 1.5% volume fraction of fibers reached much higher strength than the design load and exhibited significant post peak residual strength and a ductile mode of failure.

Jigar K.Sevalia, Nirav B. Siddhpura, Chetan S. Agrwal, Deep B. Shah, Jai V. Kapadia, (2013): Carried out work on paper "Study on bamboo as reinforcement in cement concrete" The early times Bamboo is used as a construction material. The Bamboo is used in both technical as well as non-technical ways. Our ancestors used Bamboo in the construction of the houses. The Bamboo was used as the struts, posts, roofs etc. in the construction of the houses. The concrete is good in compression but weak in the tensile strength. So steel is used as reinforcement in the concrete to achieve the tensile strength. Problems encountered with the commonly used construction material like steel are high in cost, corrosion, etc. Due to the advantageous characteristics of Bamboo, in the last few years, studies have been made on the use of Bamboo as structural material and reinforcement in concrete. The main obstacle for the application of Bamboo as a reinforcement is the lack of sufficient information about its interaction with concrete, strength and durability. This study presents 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.

Prem Kumar.V, Vasugi.V (2014): Carried out work on "Study on mechanical strength of bamboo reinforced Concrete beams" Recently, considering global warming, lack of resources and ecofriendly issues, the use of natural materials has become active in the construction industry. Bamboo has been in wide usage as a vital material for construction due to its low cost, high strength, flexibility, light weight, earthquake resistance, etc. This study explores the feasibility of usage of bamboo as reinforcement in concrete beams for rural construction. The untreated and treated bamboo reinforced concrete beams are casted with different stirrup materials. The shear link materials used were bamboo and Thermo Mechanically Treated (TMT) rods. Bamboo has been treated with a thin layer of epoxy to the surface followed by a coating of fine sand. Conventional steel reinforced concrete beam is tested for its flexural strength, modulus of elasticity, deflection and crack pattern. Same tests were carried out for the treated and untreated bamboo reinforced beams with TMT rod stirrups and bamboo stirrups. Sand has been replaced by quarry dust as a fine aggregate in concrete due to its inadequacy. Finally the comparison and analysis is carried out for the conventional steel reinforced concrete beam over the treated and untreated bamboo reinforced concrete beams with the help of experimental values obtained.

Rathi V.R, Ghogare A.V, Nawale S.R (2014): Paper on "Experimental study on glass fiber reinforced concrete moderate deep beam" The result of glass fiber reinforced moderate deep beam with and without stirrups have been presented. Six tee beams of constant overall span and depth 150mm, 200mm, 250mm, 300mm with span to depth (L/D) ratios of 4,3,2.4, &2 and glass fibers of 12mm cut length and diameter 0.0125mm added at volume fraction of 0%, 0.25%, 0.50%, 0.75% & 1 %.The beams wear tested under two point

loads at mid span. The results showed that the addition of glass fiber significantly improved the compressive strength, split tensile strength, flexural strength, shear stress and ductility of reinforced moderate deep beam without stirrups.

Satya M Saad, Indrajit Patel, Nandish Pethani (2014): Carried out study on "Basalt fibre reinforced polymer (BFRP):Effective replacement of steel in reinforced concrete" They come to know that concrete structures are usually reinforced because plain concrete has strong limitations to resist tension. One of the familiar reinforcing material is steel; it suits well as reinforcement but has quite well known pros and cons. Fibre Reinforced Polymer (FRP) have over the past years became an interesting choice as a reinforcement for concrete. There are widely researched range and types of FRP namely: Aramid FRP (AFRP), Carbon FRP (CFRP) and Glass FRP (GFRP). FRP shows various advantages out of which few are: high tensile strength, high strength-weight ratio, no corrosion and also light in weight. These many of such benefits suggest the structural designers to research & implement on a large scale the replacement of steel with different FRPs as a choice of reinforcing material for concrete. One of the choices that we have made is Basalt Fibres Reinforced Polymer (BFRP) which is rather a new material to structural design, although it has been known for several decades. They are made from basalt rock, are very light and have tensile strength, over twice as high as steel. Tensile strength of BFRP tendon is about twice the tensile strength of steel reinforcement and elongation of BFRP tendons is much more than of steel. To utilize the high tensile strength of BFRP and prevent cracking of concrete, the tendons could be prestressed. This paper focuses on the various performance based study of BFRP on reinforced concrete properties where we replaced reinforcing steel with BFRP and extended it as a prestress reinforcement to achieve few specialties in reinforced concrete elements. .

Swami P.S, Patil S.S, Kore P.N (2015): Carried out study on "Behavior of concrete deep beams with high strength reinforcement" They state that the high performance reinforcement continues to gain wider acceptance in industry practice, due to improved mechanical properties of new materials. For decades, methods of design and analysis of concrete members reinforced with normal strength steel have been developed. Recently, reinforcing steel (550 & 550) with strength higher than conventional steel has become commercially available. The introduction of high strength reinforcing steel can be useful to reduce the quantity of reinforcement required, thereby lessening reinforcement congestion and improving constructability. This paper presents construction and testing of several high strength reinforced concrete deep beams which includes three beams, designed for three different country codes, for each shear span to depth ratio as described and the test data is presented. The beam consists of simple span subjected to two point loading, each span being 0.7 m in length. The shear span to depth ratios ranged from 0.62 to 0.77. From the data revealed by the analysis, design and experimental work following conclusions are summarized Failure of deep beams was mainly due to diagonal cracking and it was along the lines joining the loading points and supports. The cracks pattern and failure mechanisms for deep beams reinforced with high strength reinforcement were similar to those deep beams with normal strength reinforcing steel. The strength of beams with 250 mm shear span is less than that of 200 mm shear span which means the strength of deep beam is inversely proportional to the shear span for the constant depth of the beam. It is assumed that the arching action of the main tension steel & the web steel together with concrete will carry the shear. All deep beams had low deflection at failure as there was no flexural failure. As reported by F. K. Kong the shear strength of deep beams is 2 to 3 times greater than that given by usual equations. But in this case due to use of high strength reinforcement the shear strength of deep beam is found 6 times greater than design loads.

Rahul padagannavar, K Arjun (2016): Paper on "Experimental study on bamboo reinforced beam" In the present era, Concrete is the most absorbed construction material in the whole world. Concrete is found to have finest compressive strength however poor in tensile. The aimless infrastructural development is effecting the environment. Steel which is costly, un economical and increase in CO2 emission is being used in construction, replacing with bamboo can reduce the effect on environment by using eco-friendly material. This project deals with the value of bamboo as a structural element in flexure. The fresh green bambusa bamboo is treated by broucherie technique making bamboo dry and moisture free, reinforcement crate has been created using steel and bamboo stirrups. The flexure test was carried out on the beams and MOE (modulus of elasticity) has been determined.

Sanjeev Gill, Dr. Rajeev Kumar (2016): Carried out study on "To Experimental study and use of bamboo in civil structure as reinforced concrete" They said that the construction industry is the main consumer of energy and materials in most countries. Though bamboo has been used as a construction material, especially in developing country, until today its use as reinforcement in concrete structure is very limited due to various uncertainties. Since bamboo is a natural, cheap and also readily available material. The utilization of bamboo reinforcement as replacement of steel reinforcement is gaining immense importance today, mainly on account of the improvement in the economical aspect combined with ecological benefits. The industrialization of the material bamboo was supposed to solve the problem of utilizing bamboo in the industrial context, which has been considered an important strategy for local economic development in many developing countries where bamboo sources are abundant. Through industrialization bamboo is processed and fabricated into different standard industrial products which are mainly used as a cheap substitute for hardwood because bamboo grows much faster than timber and is a renewable source after5-6 years. But in this process

of industrialization bamboo loses its structural advantages and at the same time also loses the connection to its traditional bamboo culture. The physical and mechanical properties like compressive strength, tensile strength, Flexural test, Bonding strength, water absorption, density etc. of the selected bamboo species in material testing laboratory. Purpose of the experiments on bamboo strips is for validation and justification of these results confirm the application of bamboo as reinforcement element. The study also indicated that different species of solid bamboo is available in India. The research revealed out that solid and hollow bamboo can equally be utilized for both furniture products and construction works. The researcher used observations, interviews and experiments for collecting data. The utilization of bamboo as a complementary resource material for furniture and construction works.

Sri Murni Dewi, Devi Nuralinah (2017): Paper on "The recent research on bamboo reinforced concrete" The last research on bamboo reinforced concrete in Brawijaya University Indonesia. Three kinds of structures studied in recent year, the mounting of pegs on reinforcement, the use of lightweight brick to reduce the weight of the beams, and the use the light weight aggregate for bamboo concrete composite frame. All that experiments overcome some problems exist in using bamboo as environmental acceptance structures.

Xiao-Chu WANG, Tian-Shi RONG, Liu XIAO (2017): Paper on "Theoretical study on composite bars of basalt fiber" This paper introduces the current development of basalt fiber, this paper expounds the made of basalt fiber composite reinforced by basalt fiber, used to advantage in the field of civil engineering, and process and the main use of present domestic and foreign research. Basalt fiber tensile strength generally can reach 2000Mpa, elastic modulus can reach about 90Gpa, basalt fiber softening point of 960 degrees Celsius, and its strength at high temperature can maintain strength for a long time. Basalt fiber has a high alkali resistance to acid, in cement can maintain a high degree of stability; alkali resistance is much better than glass fiber.

4. OBJECTIVES

- The main aim of this investigation is to examine the possibility and feasibility of BFRP and bamboo as reinforcement for deep beam.
- To evaluate the ultimate load carrying capacity of deep beams reinforced with BFRP and bamboo as reinforcement.
- To study the cracking characteristics and shear behavior of RC deep beams.
- To study the effectiveness of BFRP and bamboo as reinforcement in resisting shear failure.
- To compare the experimental results of BFRP,bamboo and steel reinforced deep beams.

4. METHODOLOGY

In order to accomplish the objectives, the project work has been divided into five major parts. They are:

- Collection of required data to carry out the analysis from the journals,techinal magzines,reference books and web source.
- Casting of deep beam with two different sizes for analysis of paprameters.
- Preparation of deep beams with three number of specimen of each material.
- Comparison to be made between this analysis to know the possibility and feasibility.
- From the results of analysis the final conclusions will drawn.

5. CONCLUSIONS

It is expected that study gives such an analytical data which helps for determination of Possibility and feasibility of BFRP and bamboo as reinforcement in Deep beam.

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BIOGRAPHIES

He is an excellent academic person and PG student with intend in Reasearch work. Working on number of projects which is related with strucutral engineering.

He is Research scholor having more than 31 years teaching experience. Published number of reasearch paper, guided number of research project ang PG,UG student.