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Researchon Flexural Behaviourof Composite Beams

S.Gowtham, R. Mercy Shanthi, M.Jemimahcarmichael

Abstract*—*Concrete is the most used man-made material in the world, with approximately three tons used per annum per individual. Concrete is consumed twice as much as all other construction around the world including wood, steel, plastic, and aluminum. However, the material is used so widely that world cement production now contributes 5 percent of annual global CO2 production. Thus, the idea of reducing the amount of concrete in structures becomes attractive. A new concrete-composite beam with high mechanical performances to weight ratio is developed in this study. By constructing a hollow section in the reinforced concrete elements, a smaller quantity of concrete would be utilized. Hollow concrete sections are commonly used but their construction tends to complicate the setting up stage and increase the cost. In this work, investigation carried out on the strength of hollow reinforced concrete beams produced by the insertion of a bamboo tube, plastic and steel tube during construction is investigated. An experimental investigation is carried out on composite beams under bending loads until failure to evaluate the flexural capacity and the corresponding failure mechanisms. By the experimental method the specimens were tested for flexure and their results are compared.

Index Terms*— *Concrete Composite Beam, Hollow Section, Bamboo Tube, PVC Tube, Steel Tube.

I. INTRODUCTION

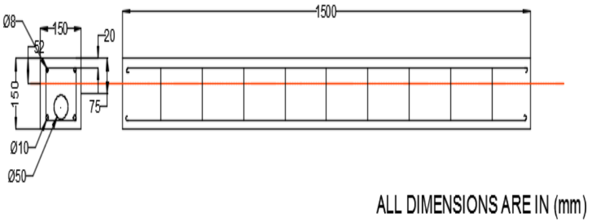
Concrete is a widely used construction material for its various advantages such as low cost, availability, fire resistance etc., but it cannot be used alone everywhere because of its low tensile strength . So generally steel is used to reinforce the concrete. Though steel has a high tensile strength to complement the low tensile strength of concrete, use of steel should be limited since it is very costly and also so much energy consuming in manufacturing process. Most buildings are built using such materials as steel reinforced concrete and structural steel. Specifically, concrete is a high quality and economical material with its ability to support fire and earthquake defence in buildings constructed in developed and developing countries. One of the significant faults of concrete is its low tensile strength. Steel-concrete composite systems for buildings are composed of concrete components that interact with structural steel components within the same system. By their integral behaviour, these components give the required attributes of strength, stiffness and stability to the overall system. Composite members as individual elements of a system have been in use for a considerable number of years. They consist of composite beam, columns, trusses, encased or filled composite elements and steel deck reinforced composite slabs. These members are generally used in steel structures, and their development as composite members is based on utilizing the concrete that would normally be required for encased beam with different composite materials, or that would be required for reducing the concrete quantity. Also to improve the stability of elements present in the structure.

In structural engineering, composite construction exists when two different materials are bound together so strongly that they act together as a single unit from a structural point of view. When this occurs, it is called composite action. One common example involves steel beams supporting concrete floor slabs. If the beam is not connected firmly to the slab, then the slab transfers all of its weight to the beam and the slab contributes nothing to the load carrying capability of the beam. However, if the slab is connected positively to the beam with studs, then a portion of the slab can be assumed to act compositely with the beam. In effect, this composite creates a larger and stronger beam than would be provided by the steel beam alone. The structural engineer may calculate a transformed section as one step in analyzing the load carry capability of the composite beam.

1.1 RESEARCH SIGNIFICANCE

The primary objective of this work is to compare the flexural capacity of composite beam using 1. PVC, 2.Bamboo, 3.Steel.Very few literatures are available comparing encased beam with different materials. Therefore in this paper, experimental investigation on flexural capacity of different type of materials such as bamboo, steel, plastic for encased concrete structures.

Figure 1 details of the beam with composite material



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S.Gowtham, Civil Engineering Department, Karunya Institute Of Technology And Sciences,(Deemed-to-be-University)Karunya Nagar, Coimbatore - 641 114. T.N, INDIA.

R. Mercy Shanthi, Civil Engineering Department, Karunya Institute Of Technology And Sciences, (Deemed-to-be-University) Karunya Nagar, Coimbatore - 641 114. T.N, INDIA.

M.Jemimahcarmichael, Civil Engineering Department, Karunya Institute Of Technology And Sciences, (Deemed-to-be-University) Karunya Nagar, Coimbatore - 641 114. T.N, INDIA.

	(N/mm^2	psi
Modulus of Elasticity(MOE)	16,170	2.3*10^6
Bending Strength, f_b	20.27	2940
Compressive Strength, f_c	7.86	1140
Tensile Strength, f_t	14.96	2170
Longitudinal Shear Strength, f_v	1.41	205

Table 1Properties of bamboo

Property	Value
Technical Name	Polyvinyl Chloride (PVC)
Chemical Formula	(C2H3Cl)n
Melt Temperature	212 - 500 °F (100 - 260°C) ***
Heat Deflection Temperature (HDT)	92 °C (198 °F) **
Tensile Strength	Flexible PVC: 6.9 - 25 MPa (1000 - 3625 PSI)
	Rigid PVC: 34 - 62 MPa (4930 - 9000 PSI) **
Specific Gravity	1.35 - 1.45

Table 2 Properties of pvc

II. EXPERIMENTAL STUDY

Six specimens of composite hollow beam are cast with bamboo tube (2nos), steel tube (2 nos), pvc tube (2nos) steel and concrete and two specimens of reinforced concrete.Table3. Shows the Reinforcement details of the beam and placing of composite material.And details of the beam specimens are shown. The reference beam was normal reinforced concrete with 4 nos of rebar. 2 no's 10mm dia bar at bottom and 2no's of 8mm dia bar at top Table 5 shows details of the composite sections used in the beam.

SI NO	DIA OF THE BAR (mm)		NOS	STIRRUPS	BELOW THE NEUTRAL AXIS	TYPE OF BEAM WITH COMPOSITE MATTERIAL
	TOP	BOTTOM				
1	8	10	2	8 mm @ 150mm c/c	52 mm	PVC HOLLOW PIPE
2	8	10	2	8 mm @ 150mm c/c	52 mm	BAMBOO (WOOD)
3	8	10	2	8 mm @ 150mm c/c	52 mm	STEEL HOLLOW SECTION

Table 3Reinforcement details of the beam & placing of composite material

III. TEST RESULTS AND DISSCUSSION

Based on the result obtained, the load-deflection graphs for the four specimens vary in the load carrying capacity and also it has some difference in deflection. Beam with steel composite material have higher gradient compared with all other specimens. When the load was applied on the specimens, the graph start to show increasing in value for both load and deflection. The deflection of the specimen's increases directly proportional to the load applied. Once reaching the proportional limit, the graph tends to increase with a less steep gradient unit reached the ultimate flexural strength. Besides, the graph differs in the numerical value due to their different dimension and shape.

The flexural strength of the specimens which takes load carrying capacity of reference beam is 30 Mpa, plastic composite beam is 56.66 Mpa bamboo composite beam is 33.33 Mpa steel composite beamis 93.33 Mpa. The load carrying differences are quite large between these four specimens, specimens which encased with the steel have the large load carrying capacity compared to the all three specimens, the plastic encased composite beam carrying high load compared to the reference and bamboo composite beam, comparing the reference and the bamboo encased composite beam load carrying is slightly higher than the reference beam. Also it is found that concrete used is lesser in bamboo encased compared to reference section.

SINO	LENGTH (mm)	BREADTH (mm)	DEPTH (mm)	TYPE OF BEAM	COMPSITE MATERIAL	
1	1500	150	150	Reference Beam(R.C.C)	TK (mm)	DIA of the pipe(mm)
2	1500	150	150	Composite Material With PVC hollow pipe	2	50
3	1500	150	150	Composite Material with Bamboo	2	50
4	1500	150	150	Composite Material with steel hollow section	2	50

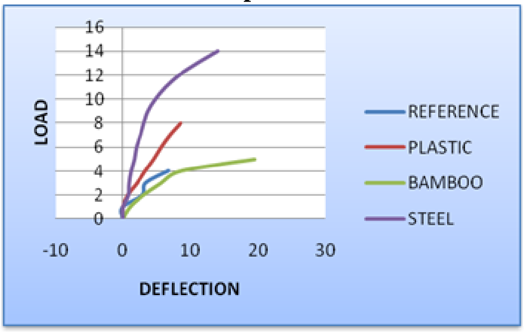
Table 4 Details Of The Beam and Composite Material

	DEFLECTION (MM)			
LOAD (TONNE)	REFERENCE	PLASTIC	BAMBOO	STEEL
0	0	0	0	0
1	0	0	1	0
2	2.9	0.7	3	0.8
3	3.4	2.1	5.6	0.9

4	6.7	3.3	8.4	1.2
5		4.6	19.5	1.7
6		5.7		2
7		7		2.6
8		8.6		3.1
9				3.7
10				4.8
11				6.3
12				8.3
13				11
14				14

Table 5Comparison of Load vsDeflectionfor Different Composite Materials

Figure 2 Deflection In Flexure Strength For Reference And Composite Beams



IV. CONCLUSION

The results of experimental method show that, in addition to the reduction in the weight of the beam and the volume of concrete used, creating a hollow section in a reinforced concrete beam by inserting a Bamboo Tube, PVC, and Steel tube duringconstruction increased the strength of the beamsnoticeably.

Figure 3Failure form of composite beam and load setup

The experimental results showed as increase in strength of 50% in plastic, 20% in bamboo, and 71% in steel when compared to reference beam. A 71 % increase in strength between the reference beam and the steel composite beam failing only in shear was attained using experimental test. It is obtained by comparing Load vs. Displacement graphs, of reference beams with different modes of failure with the corresponding composite beams, that the addition of the Hollow Bamboo Tube, PVC, and Steel Tube causes a considerable decrease in deflection of the beams. This improvement in structural properties achieved suggests that composite reinforced concrete bamboo elements may, in future, be used for improving the strength at an early stage in construction.

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