International Research Journal of Emerging Trends in Multidisciplinary
ISSN xxxx-xxxx
Volume 1, Issue 1 March 2015
www.irjetm.com

STUDY ON BEHAVIOUR OF COCONUT SHELL AGGREGATE CONCRETE WITH BAMBOO REINFORCEMENT INCOMPRESSION MEMBER

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ABSTRACT:

The use of waste materials is one of the options for sustainable construction. In this paper the coconut shell waste is considered as coarse aggregate (after the same has been crushed) for preparing light weight concrete. The natural material like bamboo which is having considerable tensile strength is considered for reinforcement along with coconut shell concrete. Since the bamboo may absorb moisture from the concrete, to find its effect the bamboo is treated with water repellent substance like epoxy adhesive is considered. Two types of short columns are being tested with untreated bamboo and with treated bamboo along with coconut shell concrete of M_{20} grade. The results will be reported along with conventional concrete short column with steel reinforcements.

Key words: Coconut shell aggregate concrete, Bamboo reinforcement, Epoxy adhesive.

INTRODUCTION

BAMBOO

Bamboo is natural, cheap, widely available material. It is strong both in tension and compression. The tensile strength of bamboo is relatively high. Bamboo is a composite material with long and parallel cellulose fibers in its structure. Also, it exhibits good flexibility and toughness characteristics. The most surprising thing is its growing speed as most growth occurs during the first year and almost all growth ceases by the fifth year. The strength of bamboo does increase with its age, but the maximum strength occurs at 2.5-4 years. Bamboo nodes are spread along the giant grass, and their function is to prevent buckling. In fact, bamboo can bend as much as touching the ground without breaking.

COCONUT SHELL CONCRETE

Concrete is the widely used number one structural material in the world today. The demand to make this material lighter has been the subject of study that has challenged scientists and engineers alike. The challenge in making a lightweight concrete is decreasing the density while maintaining strength and without adversely affecting cost. Introducing new aggregates into the mix design is a common way to lower a concrete's density. Normal concrete contains four components, cement, crushed stone, river sand and water. The crushed stone and sand are the components that are usually replaced with lightweight aggregates. Lightweight concrete is typically made by incorporating natural or synthetic lightweight aggregates or by entraining air into a concrete mixture.

Coconut is grown in more than 93 countries. South East Asia is regarded as the origin of coconut. India is the third largest, having cultivation on an area of about 1.78million hectare. Annual production is about 7562 million nuts with an average of 5295 nuts per hectare. The coconut industry in India accounts for over a quarter of the world's total coconut oil output and is set to grow further with the global increase in demand. However, it is also the main contributor to the nation's pollution problem as a solid waste in the form of shells, which involves an annual production of approximately 3.18 million tonnes. Coconut shell represents more than 60% of the domestic waste volume. Coconut Shell, which presents serious disposal problems for local environment, is an abundantly available as an agricultural waste from local coconut industries. In developing countries where abundant agricultural and industrial wastes are discharged, these wastes can be used as potential material or replacement material in the construction industry. This will have the double advantage of reduction in the cost of construction material and also as a means of disposal of wastes.

Coconut shell concrete with bamboo as reinforcement in a column.

CONCRETE MIX

The design of mix (normal concrete of grade M-20) in the laboratory is carried out by IS method following IS 10262-2009.The ratio for 1: 1.8: 2.84

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/0.5.The cube strength achieved for this mix at 28 days 35.16 N/mm².

For coconut shell concrete mix design particulars are taken from **GUNASEKARAN** et.al (2011) [3].The ratio for the mix M20 is 1:1.47:0.65/0.42In the above mix the CSC aggregate are to be in saturated surface dry condition (SSD).The Coconut shells are be soaked in water for 24 hour before it is used. The strength achieved at the end of 28 days using this proportion is 26.7 N/mm².

Material used

The materials used in bamboo reinforced concrete are,

i) Cement - OPC 53
ii) Fine aggregate - River sand
iii) Coarse aggregate -20mm size (Granite)
iv) Water
v) Coconut shell aggregate -12.5mm size
vi) Epoxy adhesive

Table .1.Mechanical Properties Conventional concrete And Coconut shell concrete

Mechanical Properties	Conventional concrete	Coconut shell concrete(CSC)
Compressive strength inN/mm² at 7 days 14 days 28 days	15.3 26.3 35.16	11.3 12.46 26.7
Spilt tensile strength in N/mm² at 7 days 14 days 28 days	2.9 3.12 3.35	1.4 1.5 2.7
Flexural strength in N/mm² at 7 days 14 days 28 days	3.5 4 4.5	2.13 3.12 4.68

TEST ON BAMBOO

The compressive strength test is conducted on the bamboodimensions ofspecimen 300mm length and various cross section, by using CTM with capacity of 2000 KN.

Table.1.shows various types of Bamboo and their compressive strength. From the results bamboo1compressive strength (51.06N/mm^2) is high compared to the other type of bamboo. It was suitable for carrying more load compared to other one. The experiment was conducted based on the Albermani.F [2].

Sample type	No.of. specimen	Load in KN	Area in mm^2	Compressive stress in N/mm^2	Average Compressive stress in N/mm^2
Bamboo1	Trial 1	65	1570	41.40	51.06
	Trial 2	67	1306	51.30	
	Trial 3	95	1570	60.5	
Bamboo2	Trial 1	61	1256.6	48.5	43.4
	Trial 2	54	1256.6	42.97	
	Trial 3	48	1256.6	38.19	

Table.2. Compressive strength test on full bamboo

Direct tension test

The direct tension is conducted on the bamboo dimensions of specimen 300mm length and 20 mm diameter by using UTM with capacity of 40 tonnes. The experiment was conducted based on the Md Ahsan Sabbir [2].The Modulus of elasticity E=55468.7 N/mm^2**.**

Tensile Stress = 121.2N/mm^2

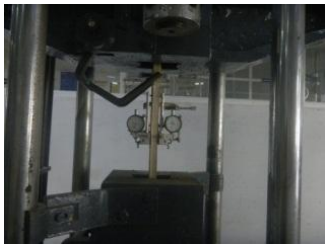

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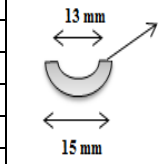
Fig.2.Tension test on bamboo

Table.3. Tension test on bamboo

Load in kg	Dimension of specimen in mm	Area in mm^2	Stress in N/mm^2	Stra in $\times 10^{-4}$
0	 b_1=150 mm b_2=130 mm t= 10 mm $(b_1 + b_2)t/2$	140	0	0
100			7.1	1.1
200			14.2	2.4
300			21.3	3.3
400			28.4	4.6
500			35.5	6.1
600			42.6	9
700			49	11
800			56.8	14
900			63	18
1000			70	22
110			77	26

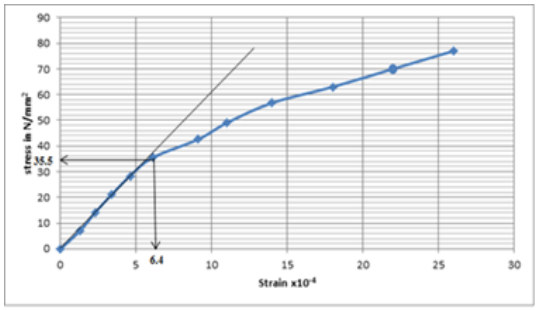


Fig.3. Stress-strain curve of bamboo

Epoxy adhesive

Epoxies are most commonly used structural adhesive because of their strength and their ability to resist weather, chemicals and solvents and extreme temperature. Epoxy adhesive have incredible strength are water proof and have high bond strength.

Mechanical properties

High resistance to stress
Low elongation to fracture

Chemical properties

High resistance to chemical and physical agents.
High resistance to temperature.
Good adhesion to aluminium, steel, wood and many plastics.

SURFACE TREATMENT FOR BAMBOO

Epoxy adhesive consist of two parts of resin and one part of hardener that must be thoroughly mixed just before use. Epoxy adhesive is applied over bamboo surface. When the epoxy is wet fine sand for sprinkled on the surface it was dried for 24 Hrs.

This process will increase the bamboo surface friction and also increase bonding strength between bamboo, avoiding bamboo slipping from concrete element and epoxy coating reduce the water absorption characteristic of bamboo.

Specimen preparation

This paper intends to compare strength of short concrete columns conventional concrete with conventional steel and coconut shell concrete with bamboo as reinforced by bamboo and short coconut shell concrete columns reinforced by conventional steel reinforcement. Twelve square short columns with different types of reinforcement. A three is conventional concrete with steel-reinforced, three coconut shell concrete with steel reinforced, three coconut shell concrete with untreated bamboo and three coconut shell concrete with treated bamboo. Details of reinforcement are shown in Table.4.were tested under uniaxial compression by a Universal Testing Machine with a maximum capacity of 2000 kN. All specimens have the same cross-section of 120 mm x 120 mm and are 1000 mm in height. Details of reinforcement are shown in Table.4.Longitudinal reinforcements were prepared separately for steel reinforcement a bamboo. Steel reinforcement, 10mm in diameter, could be easily cut and bent to required length, while reinforcing bamboos obtained from the culms of Bamboo about five years of age were split with a wedged knife and shaped into sections 20mm width and 10 mm in thickness. Some reinforced bamboos were treated with epoxy adhesive one day before the reinforcements were built up. Figure.2 shows

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Cross section in mm	Length in mm	Reinforcement	Concrete	Number of specimen
120 x 120	1000	Steel 10 mm ϕ 4 nos of bar	Conventional concrete M_{20} grade	3
120 x 120	1000	Steel 10 mm ϕ 4 nos of bar	Coconut shell concrete M_{20} grade	3
120 x 120	1000	Split bamboo 20mmx10mm 4 nos of bar (Treated bamboo)	Coconut shell concrete M20 grade	3
120 x 120	1000	Split bamboo 20mmx10 mm 4 nos of bar (Untreatedbamboo) 6mm ϕ ties were provided at 100 mm c/c for all specimens	Coconut shell concrete M_{20} grade	3
			total	12

specimens of reinforcement ratio of treated bamboo. All columns have the same transverse reinforcements 6 mm in diameter. Longitudinal and transverse reinforcements were built up depending on the type and the number of longitudinal reinforcements. Two steel formworks were used to cast these concrete specimens. They were cast horizontally with an open surface on the top. Three standard concrete cubes were cast at the same time to determine the compressive strength of the mix. After the concrete had set the next day, formworks were taken off and all specimens were continuously cured with water for 28 days, under wet gunning bags.

Table.4.Details of Columns for test

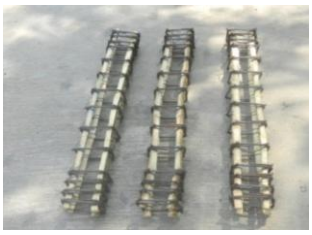

Fig.4. Treated bamboo reinforcement

CONCLUSION

In this project,casting of conventional concrete with steel reinforcement, ,coconut shell concrete with steel reinforcement and coconut shell concrete with bamboo reinforcement is completed and now curing is going on, further testing should be done.

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