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EXPERIMENTAL INVESTIGATION ON REPLACEMENT OF COARSE AGGREGATE BY COCONUT SHELL AND BAMBOO IN CONCRETE

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Abstract - *In the present paper, this experiment describes the behavioral study of coconut shell incorporated with bamboo fibre sticks in concrete structure. The addition of fibers in concrete improves various engineering properties of concrete. Coconut shell has received attribute as a result of its lower density and advanced thermal properties Cement is a binder material with various composition of Concrete but instantly it possesses low tensile strength. In this study partially replaced natural fiber's material of coconut shell and bamboo is improved then tensile strength of the concrete. The accumulation of fibres arbitrarily dispersed in the composition increases the resistance to cracking, deflection and other serviceability conditions substantially. Coconut shell is the one among the waste product which can be used as a coarse aggregate in concrete resulting in low-cost light weight concrete and bamboo are also low cost and easily available materials. In this material are eco-friendly. In this study coconut shell is added from 10% and 20% simultaneously bamboo sticks are added from 10% and 20 % and both materials are combined from 20% and 40% for replacing coarse aggregate in the M25 grade concrete. The compressive strength & flexural strength of cured concrete is evaluated for 7, 14 & 28days.*

Key Words: Coconut shell, Bamboo Sticks, Epoxy, Concrete, Compressive strength, Flexural strength, etc…

1. INTRODUCTION

Utilization of concrete is increasing at a very high rate due to infrastructural development activities in the world. Concrete is one of the world's most widely used construction material. In addition, Concrete is the second most consumed substance in the world after water. Approximately ten billion tons of concrete is produced every year. Annual production represents one ton for every individual on the planet There are some negative impacts of more production of concrete like continuous extensive extraction of aggregate from natural resources will lead to its depletion and ecological imbalance. So many researchers are in search of replacing coarse aggregate to make the concrete economical and to extend sustainable development. The role of sugarcane bagasse, wood waste, plastic waste, fabric waste, polyethylene, rubber tires, vegetable fibers, paper and pulp industry waste, rice husk ash, natural fiber waste, peanut shell, waste glass, broken bricks are some cases of replacing aggregates in concrete. Therefore, there is a need to explore and to find out suitable replacement material to substitute the natural stone. Coconut shell has high strength and modulus properties. Bamboo has the fibrous content so it has the tensile strength. Coconuts and bamboo are being naturally available in nature and since its shells are non-biodegradable; they can be used readily in concrete, which may fulfill almost all the qualities of the original form of concrete. The countries with the highest volumes of coconut production in 2018 were Indonesia (19M tonnes), the Philippines (14M tonnes) and India (12M tonnes), together accounting for 73% of global production. More than 50% of the bamboo species occur in Eastern India- Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim, Tripura and West Bengal. In this type of concrete, the crushed stone aggregate is replaced different present with crushed coconut shell and bamboo Sticks.

1.1 AIM AND OBJECTIVE

The aim of study is to evaluate the performance and suitability of coconut shell and bamboo in concrete with as alternative for coarse aggregate.

To evaluate the compressive strength, and flexural strength of concrete with replacement of coarse aggregate with coconut shell and bamboo

The objectives of experimental study are:

- Study on strength characteristics of M25 grade concrete with replacement of 10%, 20% in coconut shell simultaneously in bamboo and then combined 10% of coconut shell +10% of bamboo sticks totally 20% of replacement of coarse aggregate and combined 40% of coarse aggregate by 20% of coconut shell + 20% of bamboo sticks.
- To determine the %, strength of concrete at 7, 14, 28 days.

- coconut shells and bamboo fibers are used to increase the flexural and compression strength of concrete.

2.0 MATERIALS USED

2.1 CEMENT

Cement is a binder, a substance used for construction that sets, hardens and adhere to other material. Locally available 53 grades ordinary Portland cement (OPC) of Dalmia brand has been used in the present investigation for all concrete mixes. The cement used was fresh and without any lumps. In other words, the hydration process and consequently, the release of heat is moderate and therefore, occurrence of micro cracking is much less and can be easily controlled by proper curing of the concrete

2.2 FINE AGGREGATE

Fine aggregate should be hard, durable and clean and be free from organic matter etc. Locally available river sand is used as fine aggregate in the concrete mixes. A test for fine aggregates has been conducted as per provisions of IS: 383-1970 and IS: 2386-1963.In the experiment which is passing through 4.75mm IS sieve and retained on 75 microns IS sieve.

2.3 COARSE AGGREGATE

Coarse aggregate can be defined as inert granular materials obtained after crushing a stone. Coarse aggregate was used of size 20mm conforming to IS 383 is used. Coarse aggregates passing through 20 mm and retained on 12.5mm sieve are used in the experiment. Good-quality of aggregate which is clean, hard, strong, have durable particles, and be free of absorbed harmful chemicals, coatings of clay, or other contaminates that can affect hydration of cement or reduce the paste-aggregate bond.

2.4 COCONUT SHELL

Coconut shell is an abundantly available waste material which can be used as potential or replacement material in the construction. Coconut shell passing through 20mm IS sieve and retaining on 12.5mm IS sieve. Coconut shell are soaked in water for 24hours and then used in concrete as coconut shells have more water absorption than coarse aggregate.

Fig -1: coconut shells

2.5 BAMBOO STICKS

Bamboo, as species of plant in the grass family possessing good strength and flexibility and can be used as building material. Bamboo fibres with size of varying length from 2 to 3 cm, breadth from 1 to 2 cm, and thickness of 1 to 1.5 cm is also used as replacement of coarse aggregate at the replacement precent of 10% and 20%. The physical properties of all these materials were tested as per IS 383-1970.

Fig -2: Bamboo pieces

2.6 EPOXY RESIGN

Epoxy resin is protecting the surface from absorbing water its change the properties of aggregate, the coat over with epoxy resign. Because of its high adhesive properties, epoxy resin is used as a binder for high-friction aggregate and as an adhesive to bond it to the pavement. Epoxy resin is coated with natural fibers of coconut, bamboo sticks to strengthen the aggregate. The flexural results from coconut shell and bamboo concrete is increased.

Fig -3: Epoxy Resin

3.0 MIX DESIGN

Concrete mix of M25 grade was designed by conforming to IS 10262-1982 method. The coarse aggregate was replaced with coconut shell 10% and 20% simultaneously bamboo sticks 10% and 20% and combination of 10% CS + 10% BS simultaneously 20% CS + 20% BS. 0.45 water cement ratio was kept constant

Table -1: Mix proportion

Description	Cement	Fine aggregate	Coarse aggregate	Water cement ratio
Ratio	1	1.70	2.65	0.45
Mass Kg/m^3	420	717.60	1117.60	190

MIXES:

C0 - Normal concrete

C1 - 10% Of CS

C2 - 20% Of CS

C3 - 10% Of BS

C4 - 20% Of BS

C5 - Combination Of 10% CS + 10% BS

C6 - Combination Of 20% CS + 20% BS

Where,

CS=Coconut shell

BS=Bamboo sticks

4.0 CASTING, CURING AND TESTING OF SPECIMEN

Using final mix proportion to mix the cement, coarse aggregate, fine aggregate, and water for different concrete mixes. Batching of materials as per mix design is done by weigh batching. All ingredients are first dried mixed then water added. Machine mix is done to get homogenous mixture and or used hand mixing. Then the mixture is poured into specimens. Vibrators are used for compaction. After vibration the surface of specimen is leveled using trowel. Specimens are kept for drying for 24 hours and then specimen were demolded. Specimens are then kept for curing. Curing is done 7, 14, 28 days.

It is planned to cast 42 cubes of size 150mm x 150mm x 150mm for the compressive strength test and 42 prism of size 100mm x 100mm x 500mm for the flexural strength are to be used as per IS provisions. Average result specimens for all above parameters are to be considering in main results. In this study we replace of 20 mm coarse aggregate with pieces of coconut shells and bamboo.it will cast in given correct percentages. At last, the curing period is completed the cubes and prisms will be testing and take a result.

Fig -4: Mixing the concrete

Fig -5: casting

Fig -6: cubes and prisms Ready for testing

5.0 COMPRESSIVE STRENGTH TESTS

Specimens of size 150 × 150 × 150 mm were casted for all the proportions and tested in compression testing machine. Capacity of machine is 2000KN.Compressive strength calculated by using equation,

$$F=P/A$$

Where, F= compressive strength in N/mm2

P= maximum load in Newton

A= cross sectional area in mm2

Fig -7: Test Setup to check Compressive Strength

Table-2: Shows the average compressive strength at various proportions

S.I NO	MIX CODE	COMPRESSIVE STRENGTH IN (N/mm²)		
		7 DAYS	14 DAYS	28 DAYS
1	C0	16.27	21.79	25.5
2	C1	16.8	23.01	25.92
3	C2	14.72	21.49	24.26
4	C3	13.36	19.07	22.79
5	C4	10.8	14.76	19.64
6	C5	13.72	19.43	23.06
7	C6	8.83	13.31	17.37

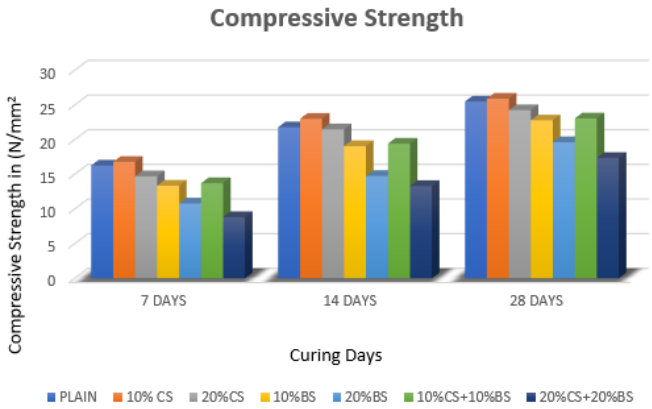

Fig -8: Average compressive strength for various proportions

6.0 FLEXURAL STRENGTH TESTS

Concrete as we know is relatively strong in compression and weak in tension. Beams tests are found to be dependable to measure flexural strength property of concrete. The system of loading used in finding out the flexural tension is two points loading. The specimen placed in flexural testing machine in such a manner that the load to be applied to uppermost surface as cast in the mould. The flexural strength was found by using equation,

$$F = PL/bd2$$

Where, F=Flexural strength in N/mm²
P = Maximum load applied
L = Length of specimen
b = breadth of specimen
d = depth of specimen

Fig -9: Test Setup to check Flexural Strength

Table -3: shows the average flexural strength at various proportions

S.I NO	MIX CODE	FLEXURAL STRENGTH IN (N/mm²)		
		7 DAYS	14 DAYS	28 DAYS
1	C0	6.1	6.75	7.73
2	C1	5.38	6.27	6.96
3	C2	4.97	5.67	6.18
4	C3	5.74	6.46	7.24
5	C4	5.12	5.85	6.32
6	C5	5.28	6.25	6.82
7	C6	4.12	4.75	5.23

Fig -10: specimen loading to cracks formed

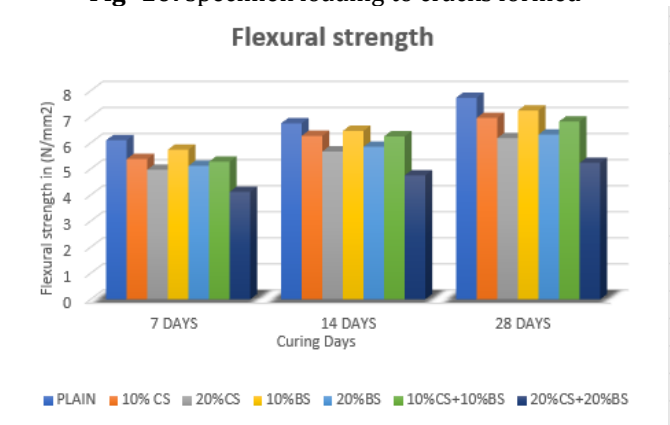

Fig -11: Average Flexural strength for various proportions

7.0 RESULTS AND DISCUSSION

In the above experimental investigation, the use of coconut shell and bamboo sticks in the concrete to reduce the waste reduction, eco-friendly and low-cost materials. This study is based on the comparison of compressive strength and flexural strength of the coconut shell and bamboo stick concrete to the conventional concrete of M25 grade mix. From the partial replacement of coarse aggregate by using the coconut shell and bamboo is 10% and 20%, and combination of 10% CS+10% BS and 20%CS + 20%BS replacement. The results obtained for 7 days ,14 days, 28 days of compressive strength and flexural strength confirms the optimal percentage requirement for substitute of natural coarse aggregate with coconut shell and bamboo are shown in the graph. The experimental result obtained from the research work the following conclusion can be made:

[1] On 10% replacement of natural coarse aggregate with Waste Coconut Shell and bamboo, Compressive Strength of coconut shell concrete has obtained 25.92 N/mm2 at 28 days. Thus, making the replacement both technically and economically feasible and viable. On further replacement, decrease in the compressive strength of Coconut Shell Concrete has been observed.

[2] In the investigation coconut and bamboo replaced separately and combined the analysis of replaced 10% of coconut shell is increased compressive strength and flexural with comparatively conventional concrete and other percentages. More than 20%CS, 10%BS, 20%BS replacement decreases in strength in seen. And the combinations of 10%CS + 10%BS replacement coconut and bamboo is good

[3] For the optimum result 10% replacement of coconut shell and bamboo sticks is good.

[4] Experimental results and discussions of researches on coconut shell and bamboo confirm that the coconut shell has potential as lightweight aggregate and bamboo as increasing the tensile strength of the concrete. Also, using the coconut shell and bamboo sticks as aggregate in concrete can reduce the material cost in construction because of the low cost and its abundant agricultural waste.

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IS CODES

- IS CODE 10262:2009 for Concrete Mix Proportion
- I.S 383-1970: "Specifications for coarse and fine aggregates"
- Indian Standard (IS 12269-1987) Specification for 53 grade ordinary Portland cement
- I.S (456-2000) "Code of practice for Plain and Reinforced Concrete", Bureau of Indian Standards, New Delhi.

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