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Fiber Reinforced Concrete Using Coconut Shell

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Abstract: ***Coconut shell as aggregate in concrete production not only solves the problem of disposing this solid waste but also helps conserve natural resources. In this paper, the physical properties of crushed coconut shell aggregate were presented. The fresh concrete properties such as density and 28-days compressive strength of a lightweight concrete made with coconut shell as coarse aggregate also presented. The findings indicated that water absorption of the coconut shell aggregate was high about 24 % but the crushing value and impact value was comparable to that of other lightweight aggregates. The average fresh concrete density and 28-day cube compressive strength of the concrete using coconut shell aggregate were 1975 kg/m3 and 19.1 N/mm2 respectively. It is concluded that crushed coconut shells are suitable when it is used as substitute for conventional aggregates in lightweight concrete production.***
Keywords: Lightweight aggregate, Agriculture waste, Coconut shell, Physical properties, Compressive strength.

I. INTRODUCTION

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 light weight aggregates or by entraining air into a concrete mixture. Some of the lightweight aggregates used for lightweight concrete productions are pumice, perlite, expanded clay or vermiculite, coal slag, sintered fly ash, rice husk, straw, sawdust, cork granules, wheat husk, oil palm shell, and coconut shell. Following a rapid growth in population, the amount and type of waste materials have increased accordingly creating environmental problems. Different alternative waste materials and industrial by products such as fly ash, bottom ash, recycled aggregates, foundry sand, china clay sand, crumb rubber etc were replaced with natural aggregates.

A. *Problem Statement*

1) Large scale cultivation of coconut in coastal regions of India including Kerala, Andhra Pradesh, Goa, Tamil Nadu, Odisha etc.
2) After the kernel is consumed, the shell is thrown away here and there causing environmental pollution.
3) Due to its tough made tissue, the shell is not decomposed easily and remains as solid waste for years. Hence utilizing it in a proper manner reduces environmental problems.

II. LITERATURE REVIEW

Kulkarni P. Vishwas and Gaikwad Sanjay kumar B. (2013) have made a comparative study on coconut shell aggregate with conventional concrete and concluded that coconut shell aggregate concrete has a low modulus of elasticity.

Shelke et al; (2014) have reviewed coconut shell as partial replacement for coarse aggregate and they made the following inference that the increase in percentage of coconut shell decreased with density of concrete. With the increase in the percentage of coconut shell, the strength of 7 days curing increased with the corresponding 28 days curing strength.

Coconut shell is most suitable and compatible with the cement. The 28 days air dry density of coconut shell aggregates is less than 2000 kg/m3 and this is within the structural light weight concrete. Coconut shell aggregates satisfies the requirements of ASTM C 330.

Kambli Parag S. and Mathapati Sandhya R. (2014) have studied the application of coconut shell in concrete and arrived at the following conclusions i.e. coconut shell has potential as light weight aggregate in concrete. It can be used where conventional aggregates are costly.

Rao et al; (2015) have studied the strength properties of coconut shell concrete and arrived at the following conclusions that addition of coconut shell aggregate alone decreases the workability of concrete. Increase in coconut shell percentage decreased densities of concrete.

Presently in India, about 960 million tones of solid wastes are being generated annually as by-products during industrial, mining, municipal, agricultural and other processes. Of this 350 million tonnes are organic wastes from agricultural sources; 290 million tones are inorganic waste of industrial and mining sectors. However, it is reported that about 600 MT of wastes have been generated in India from agricultural sources alone.

III. SCOPE OF WORK

The scope of this work is limited to the following:

1) To determine the optimum percentage replacement of the coconut shell in concrete without compromising the strength.
2) The mechanical properties of coconut shell.
3) Test of the compressive strength of coconut shell concrete.
4) The engineering properties of other aggregates used in the concrete (stone and fine aggregate)
5) The chemical properties of the binder used (ordinary Portland Test of compressive strength of cubes with partial replacement of normal
6) Stone aggregate with coconut shell.

IV. AIM AND OBJECTIVE OF THE STUDY

The aim of this research is to investigate the use of coconut shell as coarse aggregate in concrete, through:

1) Characterization of the materials used for the works.
2) Experimental determination of the mechanical properties of the concrete.

V. MATERIALS USED

A. *Coconut Shell*

Coconut shell is one of the by-products from the processing of coconut, it is organic in nature and similar to hard woods in chemical composition though lign in content is higher and cellulose content is lower

Table 5.1 . COCONUT SHELL COMPOUND

COCONUT SHELL COMPOUND	
COMPOUND	PERCENT (%)
CELLULOSE	33.61
LIGNIN	36.51
PENTOSANS	29.27
ASH	0.61

VI. EXPERIMENTS AND RESULTS

A. *Soundness of Cement Test*

The soundness test for the brand of ordinary Portland cement used was conducted using the „Le Chatelier" method of measuring expansion in accordance to NIS 447(2003) and BS 4550 (1978). The results of the soundness tests are presented in table.

Table 3.1: Soundness test results of ordinary Portland cement used.

OPC samples	Average Expansion (mm)	Total average Expansion
Specimen A	4.80	
Specimen B	4.75	
Specimen C	4.80	4.78

B. Fineness Test of the OPC used

The test was carried out in accordance with BS 12 (1991) and NIS 448, (2003). The test results are presented in table

Table 6.2. The test was performed using the Blaine air permeability

OPC Samples	Specific surface area	Average Specific surface
Sample A	658	
Sample B	659	658
Sample C	657	

C. Initial and Final setting time for the OPC used

Samples Of OPC	Average initial setting time	Overall average initial setting time (mins)	Average final setting time	Overall average initial setting time (mins)
Sample	1hr. 42mins		3hrs. 02mins	
Sample	1hr. 45mins		3hrs. 08mins	
Sample	1hr. 48 mins	1hr.45mins	3hrs.05mins	3hrs.05mins

D. Chemical Composition test of the OPC used.

Table 6.4. Composition of cement

Sl/no	Oxide composition	Percentage of oxide composition
1.	CaO	65.22
2.	SiO_2	21.55
3.	Al_2O_3	5.28
4.	Fe_2O_3	3.95
5.	MgO	1.85
6.	SO_3	1.50
7.	Loss of Ignition	1.44
8.	Insoluble residue	0.65
	TOTAL	100.00

Fig 6. Machine crushed Coconut shell aggregate.

E. Coconut shell Aggregate Impact Value

Table 6.5. impact value test

Samples	Aggregate impact value %	Average aggregate impact value %
A1	1.32	
A2	1.31	
A3	1.33	1.33
B1	1.29	
B2	1.30	
B3	1.29	1.29
C1	1.31	
C2	1.30	1.30
C3	1.29	

Table 6.6: Coconut shell aggregate crushing value

Samples	Single aggregate size (mm)	Aggregate crushing value	Average aggregate crushing value %
A1	10mm	1.159	
A2	10mm	1.158	
A3	10mm	1.153	1.156
B1	10mm	1.169	
B2	10mm	1.158	
B3	10mm	1.160	1.162
C1	10mm	1.158	
C2	10mm	1.154	
C3	10mm	1.159	1.157

VII.MATERIAL PROPORTIONING AND PREPARATION OF MIX

Table 7.1. Material proportion for the various mix ratios (coconut shell concrete)

sl/no	mix ratio	w/c ratio	agg/c ratio	Cement kg/m^3	Fine Agg kg/m^3	Coconut Shell aggregate kg/m^3
1.	1:1:1	0.5	2.0	425	425	425
2.	1:2:2	0.5	2.0	424	849	849

A. Compressive Strength Result

Table 7.1. Compressive strength of specimens

Replacement %	Average compressive strength N/mm2 at the different age of test				
	3 day	7 day	14 day	21day	28 day
0%	8.10	17.00	21.00	24.00	27.00
25%	6.90	14.00	18.00	20.00	23.00
50%	6.00	12.00	14.00	16.00	20.00
75%	5.10	11.00	12.00	15.00	17.00
100%	4.50	10.00	11.00	14.00	15.00

VIII. RESULTS AND DISCUSSION

1) The average moisture content and water absorption of the crushed coconut shell was found to be 4.20 % and 24.00 % respectively.

2) The slump obtained for the trial mix was 55 mm, which has showed that CS concrete has a medium degree of workability. The fresh concrete density and 28-day hardened concrete density (under SSD condition) using coconut shell were found to be in the range between 1975 - 2110 kg/m3 and 1880 - 1930 kg/m3 respectively.

3) The 28-day compressive strength of the concrete using coconut shell aggregate was found to be 19.1 N/mm2 under full water curing. The compressive strength of concrete using coconut shell coarse aggregate was more than 17.2 N/ mm2, which is a requirement for structural lightweight concrete.

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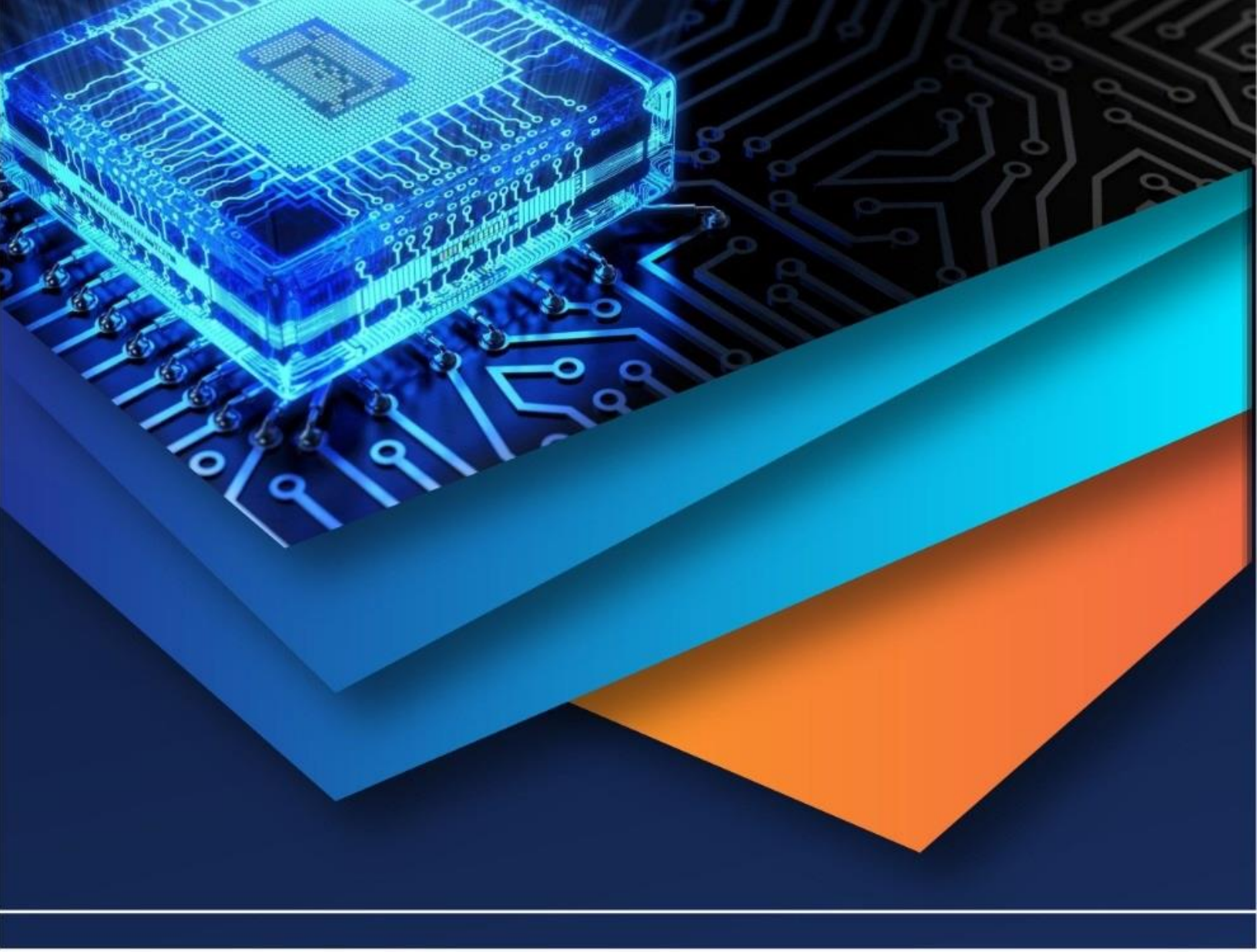

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