Experimental Study of Partial Replacement of Coarse Aggregate Byusing Coconut Shell

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***Abstract*—In this experimental study, an eco-friendly and sustainable alternative is proposed by partially replacing conventional coarse aggregate with coconut shell an agricultural waste material abundantly available in tropical regions. Concrete specimens were prepared and tested for compressive strength workability (slump test), and density. Additionally, it allows for intricate designs and complex shapes, expanding its usability in construction and design industries. This paper explores the composition, manufacturing process, benefits, and potential applications of CS, highlighting its innovative role in modern construction. The industrial wastes produced by industries create serious problems. Although the concrete is the most popular construction material, it has some limited properties, low tensile strength, low ductility, low energy absorption, and shrinkage, cracking associated with hardening and curing. The coconut shell included in concrete was subjected compressive strength tested for 7, 14and 28 days**

***Index Terms*—Fine Aggregate, Concrete, coconut shell& Compressive Strength**

I INTRODUCTION

1.1General

The three basic needs of human are food, clothing, and shelter. Civil Engineer has relevance with all basic needs of man directly or indirectly.

Man has progressed a lot in developing the method of constructing shelter. Initially man used to stay in huts and time passed it developed into house that is load bearing.

In this constructed environment, the rising cost of building construction materials is the factor of great concern. The cost of building materials are raising day by day.

Concrete is a composite material which composed of aggregates, cement and water. Concrete is used more than any other man-made material in the world.

The possibility of a complete depletion of aggregates for construction unsustainable. Now time has come to think of some alternative materials for sustainable use in concrete mix. In this study we are going to partially replace coarse aggregate with coconut shell with myrobalan powder as admixture. 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 1.78 million hectares.

Coconut shell is one of the waste materials can be used as a aggregate in concrete due to some reasons like large scale cultivation of coconut in coastal region of India including Kerala, Andhra Pradesh, Goa, etc. due to tough made tissue, shell is not decomposed easily and remain as solid waste for years.

Coconut shell being a hard and not easily degrade material. At present, coconut shell has also been burnt to produce charcoal and activated carbon for food and carbonated drink and filtering mineral water use.

However, the coconut shell is still under utilized in some places. The chemical composition of the coconut shell is similar to wood. It contains 33.61% cellulose, 36.51% lignin, 29.27% and ash at 0.61%. Until now, industrial by products and domestic wastes has been utilized in concrete, but the use of agricultural waste in concrete is in its infancy stage. Coconut shell is an agricultural waste.

The materials are proportioned by their weights. The water cement ratio is obtained by conducting various workability tests. The obtained results are compared with that of conventional mix. Tests are as per the specified procedure of Indian standard codes.

2.2 Materials

- CEMENT
- FINE AGGREGATE
- COARSE AGGREGATE
- COCONUT SHELL

3.1 CEMENT

Ordinary Portland cement grade 43, conforming to I.S.12269-1987 was used. The physical property of cement is shown as per table 1.

Table – 1 Basic Result Of Ordinary Portland Cement (OPC)

TEST	RESULT
Initial setting time	45
Final setting time	430
Standard consistency	29
Specific gravity	3

B. Coarse Aggregate:

As coarse aggregate in concrete consist 35 to 70% of volume of the concrete. An aggregate with specific gravity more than 2.55. The physical properties of coarse aggregate are shown in table 2.

Table – 2

Sieve Analysis of Coarse Aggregate (20mm)

Sl. No.	I.S sieve design ation	Wt. retained(gms)	Cumulative percentage of wt. retained	percentage of passing
1	20mm	1070	21.4	78.6
2	10mm	3772	96.84	3.16
3	4.75mm	152	99.88	0.12

C. Coconut Shell:

Table – 4

Physical Properties of Coconut Shell

TEST	RESULT
Specific gravity	1.13
Water absorption	24.03%

D. Fine aggregate

The fractions from 4.75 mm to 150 microns are termed as fine aggregate. Locally available natural river sand conforming to grading of IS: 383 1970 with specific gravity 2.77 was used as fine aggregate.

Table – 6Sieve Analysis of Fine Aggregate

Sl. No.	I.S sieve sizes	Weight Retained(gms)	Cumulative percentage of wt. retained	Percentage of passing
1	4.75mm	0	0	0
2	2.36mm	14	1.4	98.6
3	1.18mm	288	30.2	69.8
4	600µ	299	60.1	39.9
5	300µ	281	88.2	11.8
6	150µ	90	97.2	2.8
7	Pan	24	99.6	0.4

Table – 7 Test Value Result of Fine Aggregate

NO	PROPERTIES	VALUES
1	Size of Aggregates	Passing through 4.75mm sieve
2	Fineness Modulus	2.77
3	Specific Gravity	2.63
4	Zone	II

III. WORKABILITY TESTS

Slump test is the most commonly used method of measuring workability of concrete which can be employed either in laboratory or at site of work. It is not a suitable method for very wet or very dry concrete. It does not measure all factors contributing to workability, nor is it always representative of the playability of the concrete. However, it is used conveniently as a control test and gives an indication of the uniformity of concrete from batch to batch. Repeated batches of the same mix, brought to the same slump, will have the same water content and water cement ratio; provided the weights of aggregate, cement and admixtures are uniform and aggregate grading is within acceptable limits. Additional information on workability and quality of concrete can be obtained by observing the manner in which concrete slumps. Quality of concrete can also be further assessed by giving a few tamping or blows by tamping rod to the base plate. The deformation shows the characteristics of concrete with respect to tendency for segregation. The size of slump cone mould is Bottom diameter: 20 cm, Top diameter: 10 cm and Height: 30 cm In slump test of fresh concrete, each layer of concrete was compacted 25 times with the help of steel rod 0.6m long and 16mm in diameter. The slump cone is removed carefully in the vertical direction without affecting the shape of concrete slump

IV. TESTS FOR CONCRETE

A. Test for Compressive Strength of Concrete Cubes:

Compression test is the most common test conducted on hardened concrete, partly because it is an easy test to perform, and partly because most of the desirable characteristic properties of concrete are qualitatively related to its compressive strength. The cube specimen is the sizes 100x100x100 mm are used for compression test. These specimens are tested by compression testing machine after 7 days and 28 days curing. The compressive strength test on hardened concrete will be performed on a 2000 KN capacity compression testing machine. Compressive strength=maximum load/area =P/A

V. RESULTS

The mix proportion for M 25 is and W/C ratio of 0.45 was casted. Slump test was tested when the concrete in fresh concrete. The cubes, beams and cylinders were tested for compressive strength, split tensile strength, Impact strength and flexural strength. These tested were carried out at age of 7 days and 28 days.

A. Workability Test Results:

1) Slump Test:

Slump (mm)	
0% coconut shells	120 mm
10% coconut shells	112 mm
20% coconut shells	103mm
30% coconut shells	92 mm
40% coconut shells	81 mm

Table – 8 Slump test

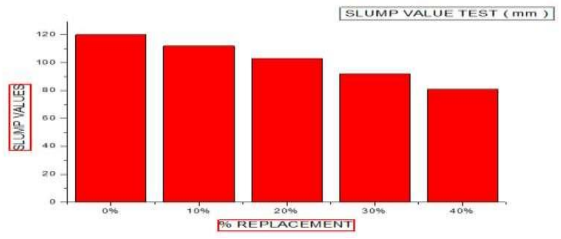
B. Strength Results:

2) Compressive Strength Test Results:

Table – 9

Compressive Strength Test Results

% REPLACEMENT	CUBE STRENGTH AT 7 DAYS (N/mm2)	% DECREASE IN STRENGTH AT 7 DAYS	CUBE STRENGTH AT 28 DAYS (N/mm2)	% DECREASE IN STRENGTH AT 28 DAYS
0	21.7	-	34.5	-
10	18.25	16	31.5	9
20	15.56	28	29.4	15
30	13.27	39	27.5	20
40	11.5	47	25.3	26



Graph 1: Slump Test Results for Conventional And % CS

VI. CONCLUSIONS

In this study the strength characteristics of concrete produced by volume replacement of 10%, 20%, 30%, and 40% replacement of crushed aggregate with coconut shells were investigated:

- It was observed that compressive strength was found to be descending for replacements, the compressive strength decreased by 47% for 7 days and 27% for 28 days.
- It was observed that split tensile strength was found to be descending for replacements, the split tensile strength decreased by 39% for 40% replacement.
- It was observed that flexural strength was found to be descending for replacements, the flexural strength decreased by 50% for 40% replacement.
- As the % of coconut shell increases the number of blows for normal and ultimate crack decreases.
- For increase in the percentage of coconut shells, the difference in number of blows between initial and ultimate crack reduces.
- It was observed that shear strength was found to be descending for replacements, the shear strength decreased by 48% for 40% replacement.
- It was observed that all three parameters i.e. Compressive strength, split tensile strength and flexural strength decreased with increasing the coconut shell content in aggregates.

VI. FUTURE SCOPE

- Durability tests on CS which may take around a year to complete can be conducted as a future work.
- Experiments on impact value and crushing value etc can be done in order to analyse strength properties of coconut shells.
- Action of coconut shell aggregates in cement matrix is also an area requiring future research.
- We can also study about the use of coconut shell aggregates along with other non-conventional aggregates like palm kernal shells, volcanic debris etc

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