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Utilization of Coconut shell As Coarse Aggregate in Concrete

Krishkumar Patel[1], Jaimin Patel[2], Bhargav Kanthariya[3], Zenith Mehta[4], Nirmal Patel[5], Shyam Doshi[6]

[1,2,3,4,5]*Student of B.E. Civil at Bhagwan Mahavir College of Engg. & Tech.*
[6]*Assistant Professor at Civil Department of Bhagwan Mahavir College of Engg. & Tech., Surat, Gujarat*

Abstract - *Disposal of agriculture waste material is a great problem and it becomes challenging to find natural resources due to their extreme exploitation. Use of waste materials as construction materials has several benefits such as decrease in cost, saving in energy, and protection of environment.*

Coconut shell is one of the main contributors of pollution problem as an agricultural waste. Coconut shell used as coarse aggregate in concrete encouraged sustainable and environmentally helpful material in the construction field. The main concern of this research is the environment, and the construction and building technology to improve natural world and building materials. This paper presents an investigation of strength characteristics of concrete produced using crushed granular coconut shells as substitutes for conventional coarse aggregate. The tested parameters include physical properties and mechanical properties of coconut shell concrete. The test results illustrated that coconut shell can be used as a replacement of coarse aggregate for the production of lightweight structural concrete. Some of the interesting insights of the study are:

Coconut shells are applicable as partial substitute as coarse aggregates for concrete.

The good indicators of coconut shell quality as aggregate of concrete are particles, shape and texture, resistance to crushing, absorption and surface moisture, and light-weight.

***Key Words*: Coconut shell, to reduce construction cost, light weight concrete, Use waste materials**

1. INTRODUCTION

Concrete is world's most widely used construction material. The utilization of concrete is increasing at a higher rate due to development in infrastructure and construction activities all around the world. However 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. Researchers are in search of replacing coarse aggregate to make concrete less expensive and to lead sustainable development. This environmental reason has generated a lot of concern in the construction world. The use of sugarcane bagasse, wooden chips, plastic waste, textile waste, polyethylene, rice husk ash, rubber tyres, vegetable fibers, paper and pulp industry waste, groundnut shell, waste glass, broken bricks are some examples of replacing aggregates in concrete. Coconut shell is categorized as light weight aggregate. The coconut shell when dried contains cellulose, lignin, pentosans and ash in varying percentage. In Asia, the construction industry is yet to realize the advantages of light weight concrete in high rise buildings. Coconut shells are not commonly used in construction industry and are often dumped as agricultural waste. The aim of this research is to spread awareness of using coconut shell as partial replacement of coarse aggregate in concrete and determining its compressive strength and density. 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 standards codes.

2. LITERETURE REVIEW

Quarry dust was used as an alternate material for river sand both in conventional and also in coconut shell concrete. For any materials in concrete to be used in realistic situations, its strength and durability need to be examined. Therefore, this study examines durability performance of quarry dust as fine aggregate and coconut shell as coarse aggregate in concrete. Durability properties investigated include the absorption, volume of permeable voids, sorptivity, rapid chloride penetration test and salt ponding test. Tests were conducted at an age of 3, 7, 28, 56, 90, 180 days and one-year period of curing. The test results showed that the durability properties of quarry dust used concrete performed as a traditional one and coconut shell concrete are comparable to that of other conventional lightweight concretes. [5]

The rising cost of construction material is a matter of concern. The reason for increase in cost is high demand of concrete and scarcity of raw material. Hence the concrete technologists must search for some economical alternative to the coarse aggregate. In this study, M 20 grade of concrete was produced by replacing granite by coconut shell. Forty five cubes were casted and their compressive strength and workability were evaluated at 7, 14 and 28 days. The compressive strength of concrete reduced as the percentage replacement increased. Concrete produced by 2.5%, 5%, 7.5%, 10% replacement attained 28 days compressive

strength of 19.71,19.53,19.08,18.91 respectively. These results showed that Coconut shell concrete can be used in reinforced concrete construction. Its utilization is cost effective and eco friendly. [6]

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3. MATERIAL

3.1 Coconut

Coconuts are referred to as "man's most useful trees", "king of the tropical flora" and "tree of life". Coconuts or its scientific name cocosnucifera are the most important of cultivated palms and the most widely distributed of all palms. Coconut is a tall cylindrical-stalked palm tree, reaching 30 m in height and 60-70 Cm in diameter. It is a tropical plant.

For low altitudes. It needs sunshine and a soil rich in calcium and phosphorus, and is thus generally suitable for cultivation in sandy seashore.

The most important part of the tree is its fruit, which is egg-shaped, about 30 cm long, and 25 cm in diameter. The more external layer of the fruit is thin and smooth; its fibrous mesocarp is 3-5 cm thick, and the endocarp is very hard. The fruit has a large central cavity, which contains a sweet liquid (coconut water). The number of fruits per trees varies, depending entirely on soil conditions. It is possible to get from 20 up to 600 fruits per year. The leaf stalk encircles the trunk and supports the weight of the bunch of nuts. The cluster of nuts weights 30-50 Ib when green and the 20-ft long leaf weight 20-25 lb. The fruit is oval in shape, and in the husk is about the six of a football. The fruit consists of 4 parts: about 35% husk, 12% shell, 28% meat and 25%water.

World Coconut Production

Country	Production (tons)2016
Indonesia	17,722,429
Philippines	13,825,080
India	11,127,898
Sri Lanka	2,520,095
Brazil	2,649,246
Thailand	815,406
Vietnam	1,469,960
Mexico	1,004,710
Papua New Guinea	1,191,430
Malaysia	504,773
WORLD	61,708,358

Properties of coconut shell :-

- Coconut shell has high strength and modulus properties.
- It has added advantage of high lignin content. High lignin content makes the composites more weather resistant.
- It has low cellulose content due to which it absorb less moisture as compare to other agriculture waste.
- Coconuts being naturally available in nature and since its shells are non-biodegradable; they can be used readily in concrete which may fulfill almost all.

Sr. no	Physical Property	Test Results
01	Specific Gravity	1.3 to 1.5
02	Water Absorption (%)	13 to 24
03	Bulk Density(kg/m^3)	800
04	Shell Thickness	(2-7)mm

3.2 Cement

PPC 53 grade was used conforming to IS 269-2015 and physical property was given below:

Physical Properties of Cement –

Portland cements are commonly characterized by their physical properties for quality control purposes. Their physical properties can be used to classify and compare Portland cements. The challenge in physical property characterization is to develop physical tests that can satisfactorily characterize key parameters- Setting Time, Soundness, Fineness and Strength.

3.3 Fine aggregate

Sand conforming to Zone-I(White Boreli) was used as the fine aggregate, as per I.S 383-1970. The sand was air dried and free from any foreign material, earlier than mixing. The sand which was locally available and passing through 4.75mm IS sieve is used. The specific gravity of fine aggregate was 2.60. Locally available river sand conforming

to Grading zone 1of IS: 383 –1970.Clean and dry river sand available locally will be used. Sand passing through IS 4.75mm Sieve will be used for casting all the specimens. Fine aggregate is defined as material that will pass a No. 4 sieve and will, for the most part, be retained on a No. 200 sieve. For increased workability and for economy as reflected by use of less cement, the fine aggregate should have a rounded shape. The purpose of the fine aggregate is to fill the voids in the coarse aggregate and to act as a workability agent.

3.4 Coarse aggregate

Aggregates generally occupy 70 to 80 percent of the volume of concrete and can therefore be expected to have an important influence on its properties. They are granular materials, derived for the most part from natural rock (crushed stone or natural gravels) and sands, although synthetic materials such as slag and expanded clay or shale are used to some extent, mostly in lightweight concretes. In addition to their use as economical filler, aggregates generally provide concrete with better dimensional stability and wear resistance. Aggregate classifications are made principally for the purpose of easier identification of particular aggregate lots, or to become familiar with the different types of aggregates. There are numerous ways of classifying aggregates.

3.5 Water

Water to be used in the concrete work should have following properties: It should be free from injurious amount of oil, acids, alkalis or other organic or inorganic impurities. It should be free from iron, vegetable matter or other any type of substances, which are likely to have adverse affect on concrete or reinforcement. It should be quite satisfactory for drinking purpose which is used in mixing of concrete.

4. MATERIAL ANALYSIS

4.1 Cement

Properties of cement

Sr.no	Particular	Value
1	Fineness of grinding (Residue on I.S. sieve no.9)	1%
2	Normal Consistency (%) water consistency	31%
3	Setting time Initial setting time (min) Final setting time (min)	85 min 290min
4	Compressive strength (average of three cubes)	26.35/mm^2

4.2 Fine aggregate

Sieve analysis of F.A

I.S. SIEVE	CUMLAATIVE % PASSING		AVERAGE
	Sample 1	Sample 2	
4.75	95.75	97.53	97
2.36	85.94	91.01	88
1.18	55.14	59.93	58
0.600	26.81	27.09	27
0.300	7.09	8.62	8
0.150	1.16	1.22	7
0.075	0.43	0.51	0.47
PAN	0.03	0.04	00

4.3 Coarse aggregate

Sieve analysis of coarse aggregate 20mm

I.S. SIEVE	CUMULATIVE % PASSING		AVE
	Sample 1	Sample 2	
31.5	100	100	100
25	100	100	100
20	98.06	97.16	98
16	79.09	79.86	79
12.5	44.31	41.93	43
10	5.14	5.29	5
6.3	00	00	0

Sieve analysis of aggregate 10mm

SIEVE	CUMULATIVE % PASSING		AVERAGE
	Sample 1	Sample 2	
12.5	00	00	00
10	92.4	92.19	92.30
6.3	31.73	29.52	60.92
4.75	10.94	7.13	9.03
2.36	1.29	0.55	1.85
1.18	0.63	0.43	1.06
PAN	00	00	00

4.4 Coconut shell

Sieve analysis of coconut shell

Sr. No.	Sieve size	Weight retained (Kg)	Cumulative %retained	% passing
1	40 mm	Nil	0	Nil
2	20 mm	0	0	100
3	16 mm	1920	38.32	61.68
4	12.5 mm	1420	66.66	33.34
5	2.36 mm	890	84.42	15.58
6	10 mm	780	99.99	0.01
7	6.3 mm	10	0.01	0
8	Pan	0	-	-
	Total	5010	5010	-

5. TEST PROGRAMME

Test Conducted On Hardened Concrete: Confirming to IS 516-1959

In present study cube compression test, split tensile test on cylinders on conventional concrete and coconut shell concrete are carried out. The experimental results and discussion results for various tests are described below.

5.1 Compressive strength test

A cube compression test is performed on standard cubes of conventional concrete and coconut shell concrete with partial replacement of 5% 10% 15% of size 150mm x 150mm after 7 days and 28 days of immersion in water for curing.

5.2 Split tensile test

The split tensile test is well known indirect test used to determine the tensile strength of concrete. Due to difficulties involved in conducting the direct tension test, a number of indirect methods have been developed to determine the tensile strength of the concrete. In these tests, in general a compressive force is applied to a concrete specimen in such a way that the specimen fails due tensile stresses induced in the specimen.

The tensile strength at which failure occurs is the tensile strength of concrete. In this investigation the test is carried out on cylinder by splitting along it's middle plane parallel to edges by applying the compressive load to opposite edges. The arrangement for the test is as shown in fig. The split tensile strength of cylinder is calculated by the following formula.

$Ft = 2P/\pi LD$

6. RESULT

In the present work coarse aggregate is replaced with the coconut shell, by volume. Specimens were casted by replacing 0%, 5%, 10% and 15% of coarse aggregate with coconut shell. Tests were conducted on the cast specimens after 7 and 28 days as mentioned in the IS code. There is no need to treat the coconut shell before use as an aggregate except for water absorption. Tests for Tension and compression were conducted and results were obtained. Coconut shell concrete has better workability because of the smooth surface on one side of the shell and the smaller size of coconut shell.

Comparison of strength at 28 days

	Strength in N/mm²
Without replacement	51.80
5% CS replacement	47.83
10% CS replacement	47.54
15% CS replacement	43.82

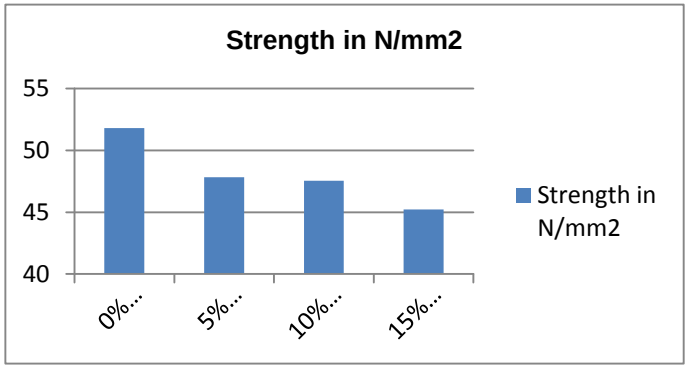

Chart-1: Strength comparison

Difference of mass in 15cm x 15cm x 15cm cube

Ave. mass of normal conventional concrete – 8.745 kg
Ave. mass of 5% CS replacement concrete – 8.558 kg
Ave. mass of 10% CS replacement concrete – 8.388 kg
Ave. mass of 15% CS replacement concrete – 8.271 kg

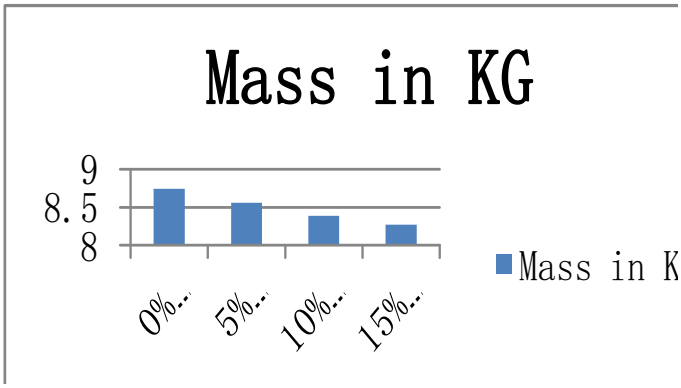

Chart-2. Mass comparison

7. CONCLUSIONS

Use of coconut shell in cement concrete can help in waste reduction and reduction in pollution. The need of the hour is to encourage such a use of the wastes as construction material in low cost housing.

As per our test and research we were conclude that the strength of the concrete is decrease when the amount of coconut shell is increase, but we were also conclude that the when we add 5% and 10% coconut shell in concrete, there was minor difference in strength. When we add 15% coconut shell in concrete the strength was getting low.

So that's why there is ending of replacement of coconut shell in concrete, we conclude that the 10% replacement of coconut shell is better for reduce the weight of concrete structure.

We also conclude that the, there is difference in weight when we replace 10% coconut shell in concrete and the difference between conventional concrete and coconut shell concrete is 357 gram in 15cm x 15cm x 15cm cube. And 364 gram difference in 15cm x 30cm cylinder.

8. REFERENCES

1) Dr. B. Damodhar Reddy, "Experimental Analysis of the Use of Coconut Shell as Coarse Aggregate", published in IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE), volume 10, Issue 6, January, 2014

2) Daniel Yaw Osei, "Experimental investigation on recycled plastics as aggreagate in concrete" International Research Journal of Engineering and Tech. Volume: 02 Issue: 04 | July-2015 (IRJET)

3) Shrikant M. Harle, "partial replacement of coarse aggregate with coconut shell in the concrete" JREAS, Vol. 2, Issue 01, Jan. 2017

4) K. Gunasekaran, "Study on reinforced lightweight coconut shell concrete beam behavior under shear", Materials and Design 50 (2013) 293–301

5) S. PrakashChandar, "Study on some durability properties of coconut shell concrete with quarry dust", Article in European Journal of Environmental and Civil Engineering · January 2018 DOI: 10.1080/19648189.2017.1418435

6) DewanshuAhlawat, "coconut shell as partial replacement of coarse aggregate", Article in International Journal of Civil Engineering and Technology 4(6):12-16 · December 2013

7) Dr. Amarnath Yerramala, "Properties of Concrete with Coconut Shells as Aggregate Replacement" Volume 1, Issue 6 (October2012) PP: 21-31

8) Ajay Kumar Sharma, "Effect of Coconut Husk on the Properties of Concrete", Paper ID: IJSRDV4I120564 Published in: Volume : 4, Issue : 12 Publication Date: 01/03/2017

9) Concrete technology (theory and practice) by M L Gambhir fourth edition.