International Journal of Engineering Research-Online
A Peer Reviewed International Journal
Articles available online http://www.ijoer.in

Vol.3., Issue.3, 2015

RESEARCH ARTICLE

ISSN: 2321-7758

APPLICATION OF COCONUT SHELL IN CEMENT CONCRETE

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Article Received: 30/04/2015 | Article Revised on:06/05/2015 | Article Accepted on:10/05/2015

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ABSTRACT

The rising cost of construction materials in developing countries has necessitated research into the use of alternative materials for civil engineering construction. Coconut shells a waste material is available in large quantities in India. In this study, a concrete mix of M-25 concrete was used as control mix; coconut shells were used to replace aggregate. The main objective is to encourage the use of these 'seemingly' waste products as construction materials in low-cost housing. It is also expected to serve the purpose of encouraging housing developers in adopting these materials in house construction. The paper aims at analyzing compressive strength and other characteristics of concrete produced using crushed, granular coconut as substitutes for conventional coarse aggregate with partial replacement. 30 no. of cubes were produced and the densities and compressive strengths were evaluated at 7 days and 28 days. A potential exists for the use of coconut shells as replacement of conventional aggregate in both conventional reinforced concrete and lightweight reinforced concrete construction as well.

Keywords - Compressive strength, Concrete mix, Coconut Shell, Concrete cube specimens

INTRODUCTION:

Concrete is the world's most used construction material. The consumption of concrete has been increasing at a higher rate due to the demand placed by the development of infrastructure in both developing and developed countries. The negative consequences of increasing demand for concrete include depletion of aggregate deposits; environmental degradation and ecological imbalance. The possibility of a complete depletion of aggregate resources has rendered continued use of aggregates for construction unsustainable. The amount and type of waste materials have increased manifold due to population growth, industrialization and all round development of society. Non-decaying materials remain in the environment for many years which not only cause the disposable problem but also contribute to the environmental hazards. The environmental impact can be reduced by making proper sustainable use of waste. In view of this challenge, researchers throughout the world have been investigating ways of replacing aggregates to make construction sustainable and less expensive. Research addressing environmental and sustainability issues in construction has generated lot of interest in the world. The non-decaying waste

materials cause a waste disposal crisis, thereby contributing to the environmental problems. However, the environmental impact can be reduced by making more sustainable use of this waste. While wastes generated by industrial and agricultural processes have created disposal and management problems which pose serious challenges to efforts towards environmental conservation, their use contributes to resource conservation, environmental protection and the reduction of construction costs, since waste materials can be obtained at little or no cost, also it will make significant contribution to the conservation of natural resources and maintenance of ecological balance. This is known as the Waste Hierarchy. Its aim is to reduce, reuse, or recycle waste, the latter being the preferred option of waste disposal {Kambli Parag S., Mathapati Sandhya R., (2014)}.

The objectives of the study are:-

Investigation of partial use of coconut shells in place of coarse aggregate in concrete mixes for various construction purposes, ensuring that the resulting concrete has the proper compressive strength.

To prepare mixes containing various percentages of the coconut shell.

To determine basic characteristics of the concrete such as compressive strength, density and slump.

Comparison of result of various characteristics with control mix.

To minimize the cost of production of concrete by replacing conventional Coarse Aggregate with coconut shell.

Cement AND AGGREGATES:

Ordinary Portland cement (Grade-43) meeting the requirement of IS -10262:2009 was used in this research. River sand and crushed stone with 4.75 mm and 20 mm maximum size respectively were used in this research. Physical properties of sand and gravel are as per IS code.

Coconut Shell:

The coconut shell used in this study was collected from different temples in Bhopal city of Madhya Pradesh State, India. Coconut shell particles are used as coarse aggregate, partially replacing the stone aggregate, for investigation. Shell particles of size between 20 mm – 600 µ are prepared in grinding machine. Coconut shell aggregates are potential candidates for the development of new composites because of their high strength and modulus properties. An approximate value of coconut shell density is 1.60 g/cm3{Kambli Parag S., Mathapati Sandhya R., (2014)}.

Figure.1 Coconut Shell sample

SPECIMEN PREPARATION:

Dry mix of concrete was prepared by mixing all the ingredients in a mixer. The mix proportions for all mixes were based on weight proportions of M-25 concrete (cement: sand: gravel).

The quantity of Coconut Shell was increased in four trials as T-1, T-2, T-3, T-4 & T-5 corresponding to 0%, 10%, 20%, 30% & 40% replacement of Coconut Shell. The properties of freshly mixed concrete were determined and test specimens were cast for the evaluation of strength of concrete.

For each percentage increment of Coconut Shell, three cube specimens were tested for compression and water absorption test each at 7days and 28 days of curing period. A total of 30 specimens were made for the experimentation of this study.

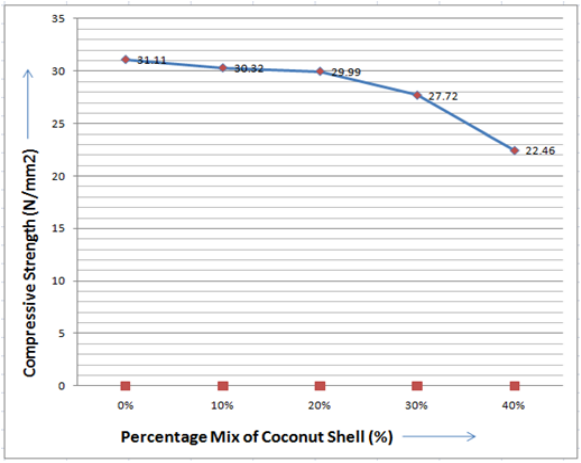
Compressive Strength:

Compressive strength decreases continuously on addition of the coconut shell. As it can be seen from graph 1, 7 days compressive strength decreases from 31.11 N/mm^2 to 22.46 N/mm^2. A similar trend was observed in compressive strength for 28 days (graph 2). The results of compressive strength of different trials are summarized in table1.

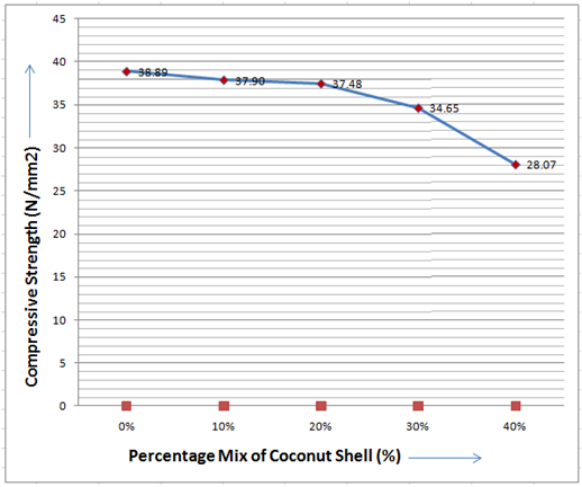
Density: Density decreases continuously on addition of the coconut shell, as it can be seen from the graph 3 and table 2, density measured after 7 days curing period decrease from 2387 N/mm^3 to 2335 N/mm^3. A similar trend in compressive strength was observed after 28 days curing period. The results of density of different trials are summarized in table 2, graph 3 and graph 4.

Table.1 Compressive Strength for Different Proportions of Coconut Shell

Trial	Compressive Strength After 7 Day (N/mm²)			Compressive Strength After 28 Day (N/mm²)		
T-1	27.11	35.56	30.67	33.89	44.45	38.34
(0%)	31.11			38.89		
T-2	26.42	34.65	29.89	33.02	43.31	37.36
(10%)	30.32			37.90		
T-3	26.13	34.27	29.56	32.66	42.84	36.95
(20%)	29.99			37.48		
T-4	24.15	31.68	27.33	30.19	36.60	34.16
(30%)	27.72			34.65		
T-5	19.57	25.67	22.14	24.46	32.09	27.67
(40%)	22.46			28.07		



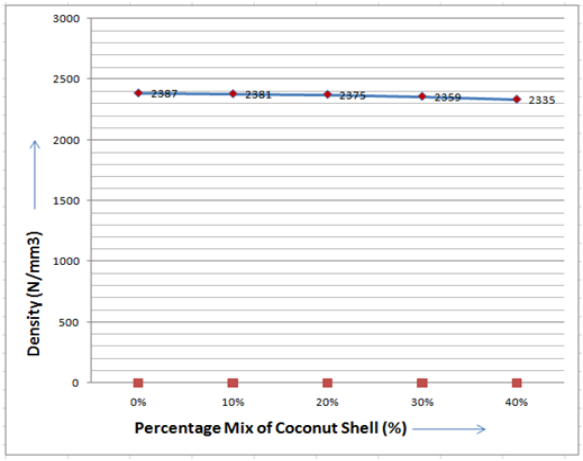
Graph 1: Variation in 7 days Compressive Strength of Concrete with Different Proportions of Coconut Shell.



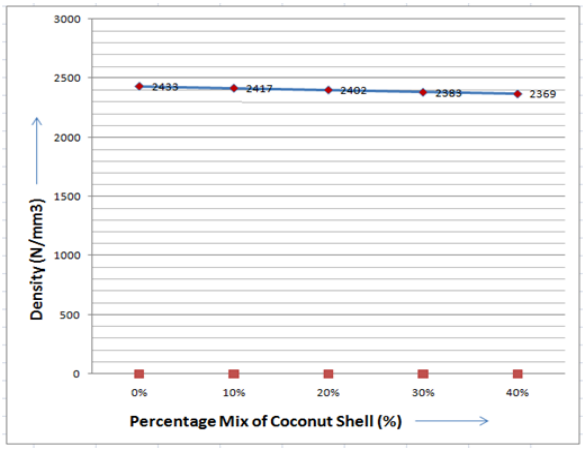
Graph 2: Variation in 28 days Compressive Strength of Concrete with Different Proportions of Coconut Shell.

Table.2 Density for Different Proportions of Coconut Shell

Trial	Density After 7 Days (N/mm³)	Density After 28 Days (N/mm³)
T-1 (0%)	2387	2433
T-2 (10%)	2381	2417
T-3 (20%)	2375	2402
T-4 (30%)	2359	2383
T-5 (40%)	2335	2369



Graph 3: Variation in Density of Concrete with Different Proportions of Coconut Shell after 7days.



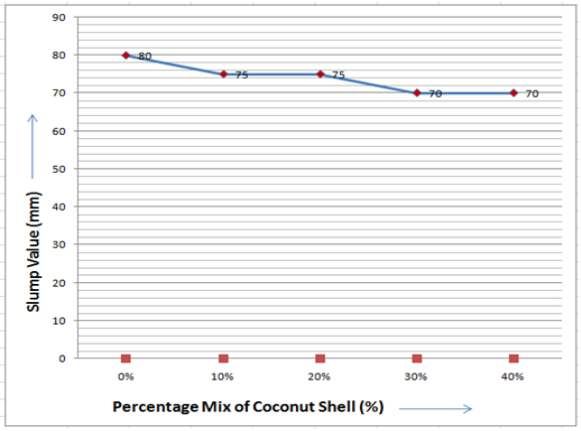
Graph 4: Variation in Density of Concrete with Different Proportions of Coconut Shell after 28 days.

Workability (Slump Test):

It is clear from table3 and Graph 5, that the slump value of concrete decreases, as the amount of coconut shell increases. The slump value was measured between 80 mm to 70 mm.

Table 3 Variation in Slump Value with Different Proportions of Coconut Shell

Trial	Slump Value (mm)
T-1 (0%)	80 mm
T-2 (10%)	75 mm
T-3 (20%)	75 mm
T-4 (30%)	70 mm
T-5 (40%)	70 mm



Graph 5: Variation in Slump Value of Concrete with Different Proportions of Coconut Shell.

COST Analysis:

The cost of concrete mix with 10%, 20%, 30% and 40% replacement of coarse aggregate by coconut shell was estimated at Rs 4971/- , Rs 4942/-, Rs 4912/- and 4885/- respectively as against Rs 5000/- , the cost of M25 concrete without coconut shell, the control mix.

CONCLUSION:

Based on the results of study the following conclusions are drawn:

- Compressive Strength of Concrete mix with 10%, 20%, 30% and 40% Coconut Shell replacing coarse aggregate, decreased continuously by 2.5%, 3.6%, 10.5% and 27.8% respectively compared to control mix.
- Density of Concrete mix with 10%, 20%, 30%, and 40% Coconut Shell replacement of coarse aggregate decreased continuously by 0.6%, 1.3%, 2.0% and 2.6% respectively compared to control mix.
- Slump value of concrete mix decreased by 6.25% with 10% coconut shell addition while it remained constant at 6.25% decrease on 20% addition of coconut shell compared to control mix but it decreased by 12.50% with 30% and 40% addition of coconut shell.
- Using the coconut shell as an aggregate in concrete reduces the material cost, as it is cheap and an abundant agricultural waste.
- Coconut Shell Concrete can be used in rural areas and places where coconut is abundant and may also be used where the conventional aggregates are costly.

It is concluded that the Coconut Shells are more suitable as low strength-giving lightweight aggregate when used to replace commonly used stone coarse aggregate in concrete production.

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