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Experimental Study on Coconut Shell as Partial Replacement of Coarse Aggregate in Concrete

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Abstract

Depletion of natural resources is a common phenomenon in developing nations like India due to rapid urbanization and Industrialization involving construction of Infrastructure and other conveniences. In prospect of this, people have begun researching for suitable other viable alternative materials for concrete so that the existing natural resources could be preserved to the possible extent, for the future generation. Lately, on the environmental issues, restrictions on local & natural access or sources and dispose of waste material are gaining great importance. Aggregate is a major ingredient for making concrete, occupy almost 70-80% part of concrete. The roles of structural grade lightweight concrete reduce considerably the self-load of a structure and permit larger precast units to be managed. Coconut Shell is a waste from the agrarian sector and is used in large quantities in the tropical areas. The waste coconut shell may be utilized to replace natural coarse aggregate. In this study, M 20 grade of concrete was produced by replacing natural coarse aggregates at 0%, 10%, 20% and 30% by weight with waste coconut shell. In all total Sixty Three (36) cubes were casted and their compressive strength was evaluated at 7, 14 and 28 days. The compressive strength of concrete was reduced as the percentage replacement increased. Concrete mixtures were tested and compared in terms of compressive strength of the conventional concrete at 28 days. The results showed that Coconut Shell Concrete (CSC) can be used in light weight concrete construction. Utilization of Coconut Shell will not only be cost effective and Eco friendly, but also resolve the issues related to shortage of conventional material and problem of disposal of waste material.

Keywords: Coconut shell, workability, Compressive strength, Conventional Concrete.

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. In addition, Concrete is the 2nd most consumed substance in the world-behind water. About 7.23 billion tons of concrete is produced every year. Annual production represents one ton for every individual on the planet. Production of concrete is increasing due to high growth of infrastructure development and construction activities in 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 form the concrete less expensive and to lead

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sustainable development. This environmental reason has generated a lot of concern in the construction world. The role of sugarcane bagasse, wood
]chips, plastic waste, fabric waste, polyethylene, rice husk ash, rubber tires, vegetable fibres, paper and pulp industry waste, vegetable fibres, paper and pulp industry waste, peanut shell, waste glass, broken bricks are some cases of replacing aggregates in concrete.
Concrete is the best material of choice where strength, durability, impermeability, fire resistance & absorption resistance are required. Concrete production demands its constituents like aggregates, cement, water and mixtures. Sources of conventional aggregates occupy the major part of the concrete. The large-scale production of concrete in construction activities using conventional coarse aggregate such as granite immoderately reduces the natural stone deposits and affecting the environment hence causing ecology imbalance. Increasing demand of natural aggregates shows that crushed stone demand will be 2050 million metric tonnes in 2020.
This huge demand of natural aggregate raises a serious question about the preservation of natural aggregate sources for sustainable development. Extraction and processing of aggregates are also a major concern for the environment. Hence consumption of alternative waste material in lieu of natural aggregate in concrete production not only protects the environment, but also makes concrete a sustainable and environment friendly construction material.

2 Materials

I. Cement

Ordinary Portland cement (RAMCO) of 53 grade from a single batch was used for the entire work and care has been taken to store it in air tight containers to keep it from being influenced by the air and storm dampness and moistness.

Ii. Fine Aggregate

Fine aggregate is the essential ingredient in concrete that consists of natural sand or crushed stone. The quality and fine aggregate density strongly influence the hardened properties of the concrete. The concrete or mortar mixture can be made more durable, stronger and cheaper if you made the selection of fine aggregate on basis of grading zone, particle shape and surface texture, abrasion and skid resistance and absorption.

Iii. Coarse Aggregate

Throughout the investigations, a crushed coarse aggregate of 20 mm downsize procured from the local crushing plant was used. The aggregate was tried for its physical prerequisites, for example, Gradation, Fineness modulus, Specific Gravity and Bulk thickness and so forth as per IS: 2386-1963 and IS: 383-1970.

Iv. Water

Fresh potable water with pH value less than 7 free from organic matter and oil which is available in the college campus is used in mixing the concrete. Quantity of water required for current study. The remainder of the materials for readiness of the solid blend were taken by weigh clumping.

V. Coconut Shell

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Coconut shell particles are used as reinforcing material for investigation. Shell particles of size between 20 mm – 600 μ are prepared in grinding machine. Coconut shell has high strength and modulus properties. Coconut shells were collected from local shop to analyze its properties as shown in Table 1

Figure 1: Crushed Coconut Shell

Table 1 Physical Properties of Coconut Shell

Sl. No:	**Parameters**	**Results**
1.	Specific Gravity	1.33
2.	Water Absorption (%)	25
3.	Bulk Density (Kg/m^3) Compacted Loose	 800 590
4.	Shell Thickness(mm)	2-7

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3 Nominal Proportions

The concrete mix is designed as per IS: 10262-1982 [21], IS: 456-2000 [22] for the normal concrete. The grade of concrete, which we adopted, is M20. The concrete mix proportion (cement: fine aggregate: coarse aggregate) is 1:1.5: 3 by volume and a water cement ratio of 0.50.

Figure 2: Mix Proportion

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4 Experimental Methodology

The study is conducted to analyse the compressive strength of concrete when the natural coarse aggregate is partially replaced with waste coconut shell respectively. Compressive strength tests were done on compression testing machine using cube samples. Three samples per batch were tested with the average strength values reported in this paper. The natural coarse aggregates were replaced as 0%, 10%, 20% and 30% by weight of M-20 grade concrete. In all total 63 cubes of OPC (150mm × 150mm × 150mm) were examined and results were analyzed after curing of 7days, 14days and 28 days. Due to high water absorption of coconut shell, they were pre-soaked in water for 24 hours, prior to mixing. Results obtained from the replacement are compared with data from a Conventional concrete.

Figure 3: Cube Preparation

5 Results and Discussions

i. Compressive Strength of Concrete

Table 2 Waste Concrete Shell Replacement Compressive strength of concrete (M 20)

Sl. No:	Specimen	Compressive Strength at 7 days (N/mm²)	Compressive Strength at 14 days (N/mm²)	Compressive Strength at 28 days (N/mm²)
1.	Conventional Concrete	15.12	18.63	23.25
2.	10%	13.83	17.78	20.75
3.	20%	12.11	16.77	19.63
4.	30%	11.65	15.9	18.67

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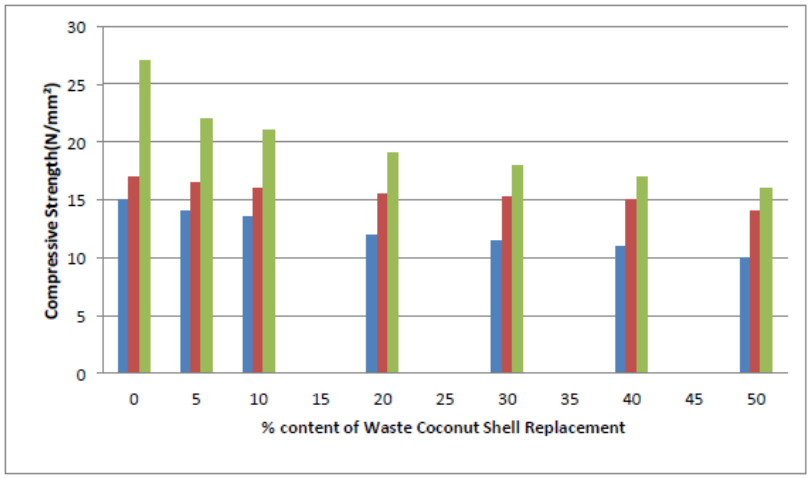

. Figure 3 (BAR GRAPH) Percentage Replacement of Waste Coconut Shell vs Compressive Strength (N/mm2) of Concrete for M 20 at 7, 14 and 28 days

Experimental investigation is performed to determine the Compressive Strength of Coconut Shell Concrete on partial replacement of natural coarse aggregate and also to compare the behavior of concrete for more fruitful outcome. At different proportions, varying strength of concrete was observed, which are measured in N/mm2. The results obtained for 28-day compressive strength confirms the optimal percentage requirement for substitute of natural coarse aggregate with Waste Coconut Shell as shown in Figure 3 (Bar Graph).

6 Conclusions

Based on experimental investigations concerning the compressive strength of concrete, the following observations are drawn

1. Concrete on 10% partial replacement of natural coarse aggregate with Waste Coconut Shell, Compressive Strength obtained is 20.75 N/mm2 at 28 days. Thus, making the replacement both technically and economically feasible and viable (Table 8). On further replacement, decrease in the compressive strength of Coconut Shell Concrete has been observed. (Fig.6 and Fig.7).

2. Coconut shell can be grouped under lightweight aggregate because 28-day air-dry densities of coconut shell aggregate concrete are less than 2000 kg/m3. Actual Density of coconut shell is in the range of 550 - 650kg/m3.

3. From the above experimental results and discussions of researches on coconut shell, the coconut shell has potential as lightweight aggregate in concrete. Also, using the coconut shell as aggregate in concrete can reduce the material cost in construction because of the low cost and its abundant agricultural waste.

4. The specific gravity of coconut shell is low as compared to the coarse aggregate and the water absorption is higher for coconut shell than coarse aggregate and hence the strength decreased in comparison with the conventional concrete.

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5. 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.

6. Coconut shell concrete is also classified as structural lightweight concrete. It is concluded that the Coconut Shells are more suitable as low strength-giving lightweight aggregate when used to replace common coarse aggregate in concrete production.

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