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# Performance of Coconut Shell as Coarse Aggregate in Cement Concrete

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**Abstract -** *A large amount of waste coconut shell is generated in India from temples and industries of coconut product and it's disposal needs to be addressed. Researchers have proposed to utilize it as ingredient of concrete This experimental investigation was aimed to quantify the effects of replacing partially conventional coarse aggregate by coconut shell to produce concrete. The research was aimed to observe the effect of such replacement on compressive strength, tensile strength and density of concrete.*

## 1. INTRODUCTION

In the present scenario, no construction activity can be imagined without concrete. It is one of the most commonly used material in construction industry and is the 2nd most consumed substance in the world after water . More than 10 billion tons of concrete is produced every year. Annual production represents approximately 1.5 ton for every person on the planet. Aggregates are the largest constituent in the concrete. About 70-80% of the volume of structural concrete is occupied by aggregates, in which 25-30 is occupied by fine aggregate and 40-50% is occupied by coarse aggregate.

### 1.1 Scarcity of Aggregates

Quantity and properties of coarse aggregate has considerable impact on various characteristics and properties of Concrete. Conventionally, crushed rocks are used as coarse aggregate and river sand as fine aggregate. Both are naturally avail- able material. Due to rapid growth of construction a conventional aggregate sources are depleting very fast resulted in scarcity of resources.

### 1.2 Sustainable Development

For sustainable development, these materials should be used wisely and at the same time alternative materials need to be searched to replace conventional aggregate. Beside these, crushed aggregate may contain a percentage of irrespirable crystalline silica or free silica which releases during the production and handling, could pose health problems or skin irritation. Further, with increased population and modern living habits. production of waste material is increasing at fast pace and its disposal has become a genuine problem.

To resolve the problem, solution is either (i) to minimize the waste at production level or done (ii) to utilize the waste materials for some positive activity. In view created of these issues, reuse of various types of waste materials for concrete production has been investigated and reported such as fly the ash , industrial slag , waste plastic , over burnt bricks , coconut shell ,waste rubber tires , Waste glass recycled coarse aggregate , papercrete etc. From such studies. it may be believed that innovation in the construction industry will clients mainly focus on use of industrial and agro wastes or by-products that are suitable for partial replacement of conventional ingredients of concrete. Waste coconut shell has potential being was carried as coarse aggregate in concrete. The present study focuses CA and on use of waste coconut shell (CS) as partial replacement of conventional coarse aggregate (CA) for concrete production.

## 2. OBJECTIVES

1. To study the variation of properties between coconut shell concrete structures and conventional concrete structures.
2. To study the effect of coconut shell on compressive strength, concrete density .
3. To enable suitable waste management of coconut shells.
4. To design an economical mix design.

## 3. APPLICATION OF COCONUT SHELL AS COARSE AGGREGATE

Properties of coconut shell which may make it suitable coarse aggregate for concrete are i) it's high strength and modulus properties ii)it's high lignin content that makes the composites more weather resistant iii) it's low cellulose content due to which it absorbs less moisture as compared to other agricultural wastes iv) it's shells are non biodegradable v) can be used readily in concrete which may fulfill almost all the qualities of the original form of concrete vi) sugar in the coconut shell is not in a free sugar form and therefore does not affect the setting and strength of concrete vii) it's surface texture is fairly smooth on concave and rough on convex faces.

### 3.1 Experimental Investigation

The mix design of M20 grade of control concrete (i.e concrete with no coconut shell) was carried out for maximum permissible w/c ratio of .45. Then Coarse Aggregate was replaced by Coconut Shells in proportions i)10% ii)20% iii)30% and iv)40% by volume respectively, keeping w/c ratio and quantity of other ingredients constant.

7 days and 28 days compressive strength and density of concrete was obtained for these concrete mixes.

## 4. MATERIALS USED

In this study the materials used were Ordinary Portland Cement, Potable water, Natural Sand, and crushed coarse aggregates. Waste coconut shell was used as a partial replacement of conventional crushed coarse aggregate. Details of material used are provided in the following section.

### 4.1 Waste Coconut Shell (CS)

Waste coconut shells were collected from various premises in Piravom where coconut shells are used to make oil. The coconut shells were sun dried for 30 days before being crushed manually. Shells were broken into smaller size and these shells were washed and allowed to dry for another 30 days. The range of the particle sizes of coconut shells varies from 5 to 20 mm. The coconut shells were submerged under water for 24 hrs before using as aggregate.

**Table -1:** Quantity of aggregates required for 1 $m^3$ Concrete

| INGREDIENTS | % COCONUT SHELL IN TOTAL COARSE AGGREGATE (BY VOLUME) | | | | |
|---|---|---|---|---|---|
| | 0 % | 10 % | 20 % | 30 % | 40 % |
| WATER (kg) | 186 | 186 | 186 | 186 | 186 |
| W/C RATIO | 0.45 | 0.45 | 0.45 | 0.45 | 0.45 |
| CEMENT (kg) | 413.33 | 413.33 | 413.33 | 413.33 | 413.33 |
| NATURAL SAND (kg) | 678.30 | 678.30 | 678.30 | 678.30 | 678.30 |
| COARSE AGGREGATE (kg) | 1109.22 | 997.50 | 888.44 | 776.72 | 665.00 |
| COCONUT SHELLS (kg) | 0 | 51.66 | 102.09 | 153.75 | 205.41 |

## 5. CONCLUSION

The partial replacement of coarse aggregate by coconut shell gave the cement concrete enough strength to be used for structural construction. From this study we found that there is a need to treat the coconut shell before it's use as an aggregate for water absorption. The water absorbed by the coconut shell during the course of soaking is stored and the pore structure in the coconut shell behaves like a reservoir. Intermittent curing condition produces the highest coconut shell aggregate concrete strength followed by full water curing . Coconut shell concrete have a good quality in its later stage.

There was a considerable reduction in the strength and density of coconut shell concrete by increasing the quantity of coconut shell. For 30% and 40% replacement it was found that density reduced and also the compressive strength decreased. It was concluded that the 10% replacement is better in early and later stage. But for the 20% replacement they have a better performance in later stage and is a better solution for the disposal of waste coconut shell and reduction in natural source depletion.

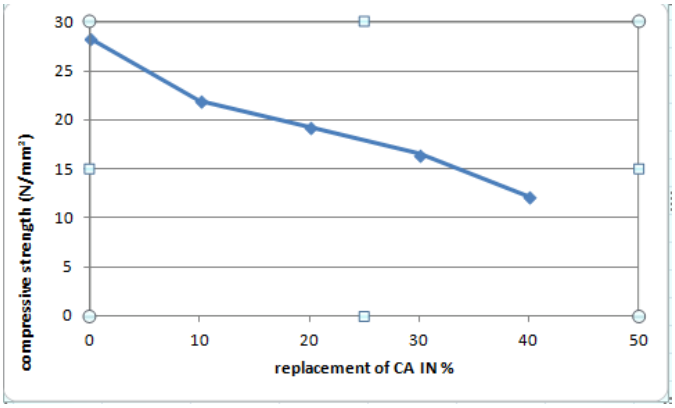


**Chart -1**: Compressive strength vs replacement of CA

**Fig -1**: Breaking of Coconut shell into smaller pieces

**Fig -2:** Cross section of coconut shell concrete

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