Experimental Investigation on Partial Replacement of Coarse Aggregate by Coconut Shell in M20 grade Concrete

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Abstract: **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. Here we make use of coconut shell as a partial substitute to coarse aggregate. In this study, M 20 grade of concrete was produced by partially replacing Coarse Aggregate by coconut shell. Cubes and cylinder are cast and their compressive strength and Split tensile strength were evaluated at 7, 28 and 56 days by replacing coarse aggregate by coconut shell at 10%, 20%, and 30%. The compressive strength of concrete reduced as the percentage replacement increased. It can be replaced up to 20%. With the increase in the replacement of coconut shell the slump value increases, which lead to increase in workability. Its utilization is cost effective and ecofriendly.**

***KEYWORDS*- Coconut shell, Compressive strength, Split tensile strength, cement and aggregates.**

I. 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. The use of aggregates for construction is one of the most important parts of construction for it well added strength to the concrete. Finding a substitute for the aggregates used today is a task that is worth studying because the quarrying of aggregates from rivers and mountains harms the environment. If a substitute for aggregate can be obtained naturally and the source is abundant and can be regenerated, obtaining the aggregate would deplete its source. The use of coconut by products has been a long time source of income for some people in the country. The use of coconut shell could be a valuable substitute in the formation of composite material that can be used as a housing construction, such as concrete cubes, beams and cylinders. Coconut is famous as multi-function plant that all parts of its plant can be used for various activities. The use of this agricultural waste due to an assumption is that it can replace the existing material used in commercial product in order to reduce cost or improve mechanical properties of the composite material. Industrialists in most of the coconut producing countries hail the economic, environmental and technological benefits of utilizing coconut farm wastes. On the farmers' side, agricultural residues can be a source of extra income. Studies have shown that burning of agricultural wastes causes air pollution, soil erosion and even a decrease in soil biological activity that can eventually lead to decreased soil fertility. Using agricultural and forest residues for industrial purposes is a much more environment safe and friendly more than any other method of wastes disposal being commonly adopted nowadays. Considered the most useful tree in the world, the coconut palm provides food, drink, clothing, shelter and financial security. Hardly an inch of the coconut palm goes to waste in countries such as the Philip-pines where families rely on the coconut palm for survival and refer to it as the "tree of life".

Building materials from agricultural and forest wastes are ideal for socialized or low-cost housing since these are generally cheaper than conventional materials. The availability of suitable materials is intimately linked to the development of a new product, such as producing a concrete cubes using coconut shells. Generating this product using agricultural waste will introduce alternative construction materials with a low production cost and lessen the social and environmental problems. Modern construction technologies being developed, respond to ecological and social issues of excessive use of raw materials from nature. The main objective of this study will give partial replacement for the aggregates and will determined the ability and benefits to the concrete cubes when substitutes.

The 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, split tensile 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. Tests are as per the specified procedure of Indian Standard Codes.

II.OBJECTIVES:

These are some of the objectives obtained from the study

- Preparation of M20 Grade concrete mix.
- To obtain compressive strength and split tensile strength.

III. METHODOLOGY

➢ **MATERIALS USED:**

- Cement
- Fine Aggregate
- Coarse Aggregate
- Coconut Shell

1. **CEMENT:**

In the most general sense of the word, cement is a binder, a substance which sets and hardens independently, and can bind other materials together. The most important use of cement is the production of mortar and concrete- the bonding of natural use of aggregates to from a strong building material which is the face of normal environmental effects.OPC is the most common type of cement in general use around the world, because it is a basic ingredient of concrete, mortar, stucco and most non-specialty grout. It is a fine powder produced by grinding Portland cement clinker (more than 90%), a limited amount of calcium sulphate which controls the set time, and up to 55 minor constituents (as allowed by various standards).

- The cement used for our experimental work is ultratech cement (OPC 53-Grade). Conformed to the quality provisions of Indian standard specification.
- The specific gravity of the cement was 3.15

2. **FINE AGGREGATE**:

Locally available sand passed through 4.75mm IS sieve is used. The specific gravity of 2.75 and fineness modulus of 3.338 are used as fine aggregate. The loose and compacted bulk density values of sand are 1094and 1162 kg/m3 respectively, the water absorption of 1.538%.

3. **COARSEAGGREGATE:**

20MSA:-Crushed aggregate available from local sources has been used. The coarse aggregates with a maximum size of 20mm having the specific gravity value of 2.885and fineness modulus of 7.386 are used as coarse aggregate. The water absorption of 0.504%. 10MSA:-Crushed aggregate available from local sources has been used. The coarse aggregates with a maximum size of 10mm having the specific gravity value of 2.895and fineness modulus of 5.953 are used as coarse aggregate. The water absorption of 1.425%. The loose and compacted bulk density values of coarse aggregates are 1463 and 1696kg/m3 respectively.

4. **WATER:**

This is the least expensive but most important ingredient of concrete. Water, which is used for making concrete, should be clean and free from harmful impurities such as oil, alkali, acid, etc. In general, water which is fit for drinking should be used for making concrete and shall conform to the requirements of IS: 456-1978.

5. **COCONUT SHELL:**

Coconut shells which were already broken into two pieces were collected from hostels hotels ; air dried for five days approximately at the temperature of 25 to 100C; removed fiber and husk on dried shells; further broken the shells into small chips manually using hammer and sieved through 20mm sieve. The material passed through 20mm sieve and retained in 4.75mm sieve was used to replace coarse aggregate with Coconut Shell. The material retained on 20mm sieve was discarded.

➢ **APPLICATIONS OF COCONUT SHELL**

- It is used in low cost building and marine structures
- Used as concrete blocks
- Eco friendly

➢ **ADVANTAGES OF COCONUT SHELL**

- Coconut shell can be replaced as coarse aggregate.
- It is used as lightweight concrete for construction of footpath pavements

Figure: 1.1 Coconut Shell as aggregates

➢ **PREPARATION OF MOULDS: (AS PER IS: 516-1959)**

- **PREPARATION OF MATERIALS**

All materials shall be brought to room temperature, preferably 27^{o}+_ 3^{0} c before commencing the experiments. The cement samples, on arrival at the laboratory, shall be thoroughly mixed dry either by hand or in a suitable mixer in such a manner as to ensure the greatest possible blending and uniformity in the material, care is being taken to avoid the intrusion of foreign matter. The cement shall taken be stored in a dry place, preferably in air tight metal containers. Samples of aggregates for each batch of concrete shall be of the desired grading and shall be in an air-dried condition.

- **PROPORTIONING**

The proportions of the materials, including water, in Concrete mixes for determining the suitability of the materials available, shall be similar in all respects to those to be employed in the work. Where the proportions of the ingredients of the mortar as used on the site are to be specified by volume, they shall be calculated from the proportions by weight used in the test cubes and the unit weights of the materials.

- **WEIGHING**

The quantities of cement, each size of aggregate, some %age of coconut shell and water for each batch shall be determined by weight, to an accuracy of 0.1 percent of the total weight of the batch.

- **MIXING CONCRETE**

The concrete shall be mixed by hand or preferably in a laboratory batch mixer, in such a manner as to avoid loss of water or other materials. Each batch of concrete shall be of such a size as to leave about 10 percent excess after moldings the desired number of test specimens.

- **HAND MIXING**

The concrete batch shall be mixed on a water-tight, non absorbent platform with a shovel, trowel or similar suitable implement, using the fallowing procedure:

❖ The cement and fine aggregate and coarse aggregate shall be mixed dry until the mixture is thoroughly blended and is uniform in colour.

❖ The aggregates shall then be added and mixed with the cement until it is uniformly distributed throughout the batch.

❖ The water shall then be added and the entire batch mixed added to the coconut shell until the concrete appears to be homogenous and has the desired consistency. If repeated mixing is necessary, because of the addition of water increments while adjusting the consistency, the batch shall be discarded and a fresh batch made without interrupting the mixing to make trial consistency tests.

- **PLACING**

The test specimen shall be made as soon as practicable after mixing, and in such a way as to produce full compaction of the mortar with neither segregation nor excessive laitance. The mortar shall be filled into the mould in layers approximately 2 cm deep. In placing each scoopful of mortar, the scoop shall be moved around the top edge of the mould as the mortar slides from it, in order to ensure a symmetrical distribution of the mortar within the mould. Each layer shall be compacted either by hand or by vibration as described below. After the top layer has been compacted, the surface of the concrete shall be finished level with the top of the mould, using a trowel, and covered with a glass or metal plate to prevent evaporation.

- **COMPACTION BY HAND**

When compacting by hand, the standard tamping bar shall be used and the strokes of the bar shall be distributed in a uniform manner over the cross section of the mould. The number of strokes per layer required is 12. The strokes shall penetrate into the underlying layer and the bottom layer shall be tamped throughout its depth. Where voids are left by tamping bar, the sides of the mould shall be tapped to close the voids.

- **COMPACTION BY VIBRATION**

The compacting by vibration, each layer shall be vibrated by means of an electric or pneumatic hammer or vibrator or by means of a suitable vibrating table until the specified condition is attained.+

- **CURING OF TEST SPECIMENS: (AS PER IS: 516-1959:**

The test specimens shall be stored on the site at a place free from vibration, under damp matting, sacks or other similar material for 24 hours +1/2 hour from the time of adding the water to the other ingredients. The temperature of the place of storage shall be within the range of 22^0 to 32^0C. After period of 24 hours, they shall be marked for later identification, removed from the moulds and, unless required for testing within 24 hours, stored in clean water at a temperature of 24^0 to 30^0C until they are transported to the testing laboratory. They shall be sent to the testing laboratory well packed in damp sand, damp sacks, or other suitable material so as to arrive there in a damp condition not less than 24 hours before the time of test. On arrival at the testing laboratory, the specimens shall be stored in water at a temperature of $27^0 + 2^0$C until the time of test. Records of the daily maximum and minimum temperature shall be kept both during the period of the specimens remain on the site and in the laboratory.

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Fig, 1.2 shows the preparation of coconut shell concrete

IV. EXPERIMENTAL METHODOLOGY

1. COMPRESSIVE STRENGTH:

Fig. 1.3 "Testing of compressive strength test specimen"

Table 1 compressive strength of the M20 grade concrete

No. of days	Normal Concrete (0%)	Concrete with partially replacement Coconut shell N/mm^2		
		10%	20%	30%
7	15	11.1	12.15	11.58
28	18.25	14.81	13.77	12.5
56	26.6	18.22	17.03	15.55

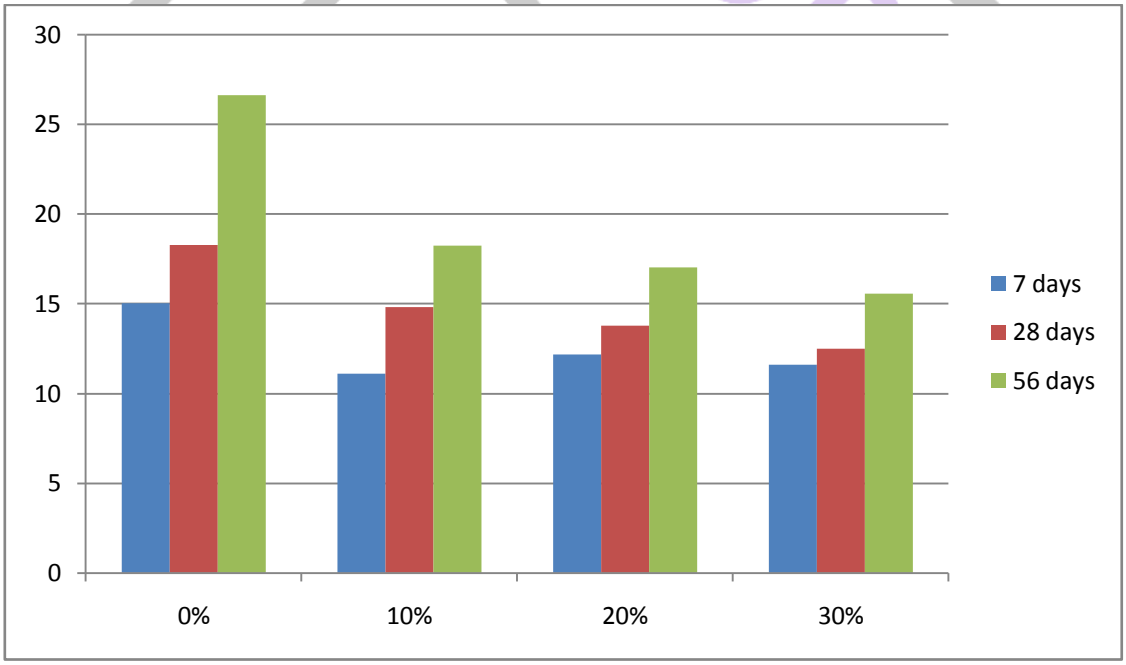

Fig. 1.4 shows compressive strength

2. SPLIT TENSILE STRENGTH:

Fig. 1.5 "Testing of Split tensile strength test specimen"

Table 2 Split tensile strength of the M20 grade concrete

No. of days	Normal Concrete (0%)	Concrete with partially replacement Coconut shell N/mm^2		
		10%	20%	30%
7	1.56	1.49	1.50	1.42
28	2.26	2.21	2.25	2.12
56	3.12	2.95	3.10	2.85

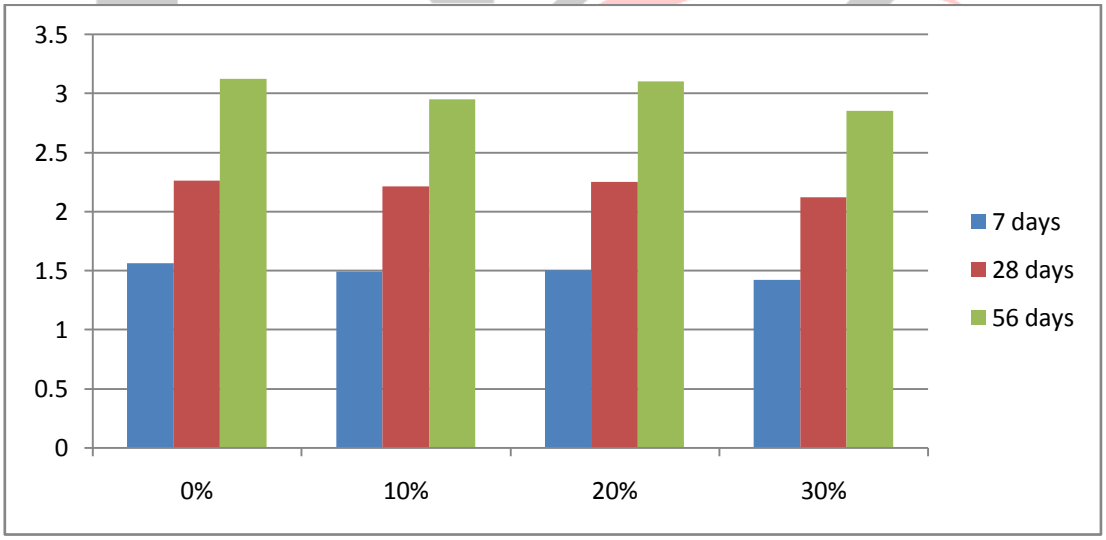

Fig. 1.6 shows split tensile strength

V. CONCLUSIONS

The following conclusions could be drawn from the present investigation

- By studying the results obtained we conclude that Coconut shell can be replaced upto 10-12.5% as a coarse aggregate.
- It is concluded that Increase in percentage replacement by coconut shell reduces compressive strength of concrete.
- Similar to compressive strength, the split tensile strength also decreased with increase in Coconut Shell replacement.
- Increase in percentage replacement by coconut shell increases workability of concrete.

➢ Use of coconut shells in cement concrete can help in waste reduction and pollution reduction. The need of this project is to encourage the use of the waste product as construction materials in low-cost housing.

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