

Study on Partial Replacement of Coarse Aggregates with Coconut Shells

Darshan M K¹ Moksshitha Shri² Mandanna B P³ Mallesh Bhajantri⁴ Amaresh S K⁵

¹Assistant Professor ^{2,3,4,5}UG Student

^{1,2,3,4,5}Department of Civil Engineering

^{1,2,3,4,5}Dr. Ambedkar Institute of Technology, Bengaluru, Karnataka, India

Abstract— Concrete is made up of cement, fine aggregates, coarse aggregate, water and admixtures if necessary. Aggregate is one of the main ingredients in producing concrete covering up to 75% of total concrete mix. High cost is the dominating factor of conventional construction material which is affecting the housing system. Thus to overcome this drawback, it is necessary to make research on an alternative material which reduces the cost. Thus waste coconut shell may be used to replace conventional coarse aggregate. Coconut shell which is abundantly available as agricultural waste from coconut industries poses a serious disposal problem. Hence using these coconut shells will have the double advantage of reduction in the cost of construction material and also as a means of disposal of wastes. Experimental investigation were carried out by preparing concrete blocks of 150mm*150mm*150mm and compressive strength tests were conducted on these blocks by replacing coarse aggregates in concrete mixes by 0%, 10%, 20% and 30% with coconut shells. From the experimental investigation it was found that coconut shells can be used as an alternative in concrete mixes by adjusting the water cement ratio and admixture contents of the mix.

Key words: Coarse Aggregates, Coconut Shells, Coconut Shell Concrete, Compressive Strength, Waste Utilization

I. INTRODUCTION

Concrete is a composite material composed of coarse aggregate bonded together with fluid cement which hardens over time. 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 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. 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. 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.

II. MATERIALS AND METHODOLOGY

The constituent materials used in this investigation were procured from local sources. The materials are listed below:

- Cement: Ordinary Portland cement of grade 53 conforming to ISN12269-1872 was used. It had the following properties

01	Physical Properties	Test results
02	Specific Gravity	3.10
03	Fineness of Cement (%)	4.5%
04	Standard consistency	33%
05	Initial setting time	30min

- Fine Aggregates: River sand was used as the fine aggregate, conforming to Zone-II as per I.S 383- 1970. It had the following properties

01	Physical Properties	Test results
02	Specific gravity	2.55
03	Sieve analysis	3.57
04	Water content	1.8%
05	Bulking	4%

- Coarse Aggregates: Coarse Aggregates were procured locally and had the following properties:

01	Physical Properties	Test results
02	Specific gravity	2.65
03	Sieve analysis	6.08
04	Water absorption	0.15%
05	Impact value	27.94%

- Coconut shells: Coconut shells were collected from nearby temples and restaurants and upon testing gave the following properties

01	Physical Properties	Test results
02	Fineness Modulus	2.86
03	Crushing Value	3.62

The basic properties of coconut shells such as physical, chemical, mechanical properties, and the compatibility of coconut shells with cement were studied. Numerous trial mixes were conducted by varying cement content, sand, coconut shells and water-cement (w/c) ratio. The acceptable trial mixes were then identified and finally, the workability, strength, density and durability requirements for different applications of Light weight concrete (LWC) were taken into consideration during the selection of the optimum coconut shell aggregate concrete mix





III. MIX DESIGN

The mix design for M20 grade concrete was done as recommended in IS 10262-1982 and according to IS 10262-1982 the following data was required for concrete mix design.

- 1) Grade designation: M₂₀
 - 2) Type of cement: OPC 53 grade conforming to IS 8112
- M20 = 1: 1.5: 3 (CEMENT: FINE AGG : COARSE AGG)
= 0.15*0.15*0.15*2400
= 8.1 KG

FOR NORMAL 0% REPLACEMENT BLOCKS

$$8.1 / 5.5 = 1.5$$

$$1.5 * 1 = 1.5 \text{ KG cement}$$

$$1.5 * 1.5 = 2.25 \text{ KG fine aggregates}$$

$$1.5 * 3 = 4.50 \text{ KG coarse aggregates}$$

$$\text{WATER CEMENT RATIO} = 0.45$$

$$\text{Therefore, water to be added} = 1.5 * 0.45 = 0.675 \text{ L}$$

Following were the quantities of materials required for casting :

01	Percentage of CA replaced	Cement (Kg)	Fine Aggregates (Kg)	Coarse Aggregates (Kg)	Coconut shells (Kg)
02	0%	1.5	2.25	4.5	0
03	10%	1.5	2.25	4.05	0.45
04	20%	1.5	2.25	3.60	0.9
05	30%	1.5	2.25	3.15	1.35

IV. PREPARATION OF SPECIMEN

All materials were brought to room temperature, preferably 27°± 3° 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. Samples of aggregates for each batch of concrete shall be of the desired grading and shall be in an air-dried condition.

A. 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.

B. Weighing

The quantities of cement, size of aggregate, percentage 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.

C. 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.

D. Compaction

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.

E. Demoulding

After placing fresh concrete in moulds, it was allowed to set for 24 hours. It was marked with some permanent identification mark i.e. 71, 72, 73, etc. Concrete cubes are now kept in curing tank for 7, 14 and 28 days. After 7,14,28 days, concrete cubes were removed from curing tank to conduct tests on hardened concrete.



V. RESULTS AND DISCUSSION

A. Compressive Strength

Compressive strength is defined as resistance of concrete to axial loading. Cubes were placed in Universal Testing Machine (U.T.M), and load was applied. The readings on dial gauge were recorded and compressive strength was calculated. Specimens are tested at the ages of 7,14,28 days. 3 specimens are tested for each type of mix at specific age. Dimensions of the specimens are measured with an accuracy of 0.1mm and tabulated. Cubes are placed on the compression testing machine of 100 tons capacity such that the marked face faces the observer and load is applied on the specimen and increased at the rate of 140kg/sq cm/min until the resistance of the specimen to the increasing load breaks down.

$$\text{Compressivestrength} = \frac{P}{B \times D} \text{ (N/mm}^2\text{)}$$

P=load in N.

B=breadth of cube in mm.

D=depth of cube in mm



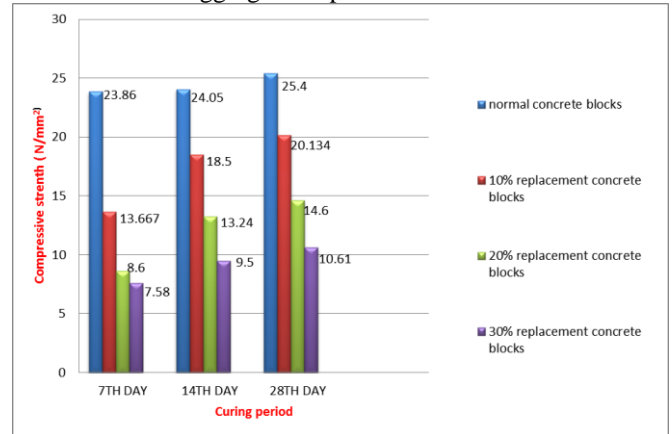
Curing Days	0%	10%	20%	30%
7	23.86	13.67	8.6	7.58
14	24.05	18.50	13.24	9.50
28	25.74	20.34	14.60	10.61

Table 1: Compressive Strength of Coconut Shell Concrete
(N/mm²)

The strength decreased as the percentage replacement increased. As the coconut shell increased, the surface area increased, thus requiring more cement for proper bonding. Since cement content was constant, there was no extra bonding and strength reduced.

B. Bar Graph

The bar charts are drawn for compressive strength results. These are drawn between compressive strength and Days of curing at 7, 14 and 28 days for normal concrete, 10%, 20% and 30% coarse aggregates replaced concrete blocks.



VI. CONCLUSION

The main points of this study are:

- Production of Sustainable Light-weight concrete is attained.
- Overall cost reduction of the construction is observed.
- By using these shells environment can be kept clean.
- Crushing and impact value of shells is very less when compared to coarse aggregates so it cannot be used in heavy works.
- If the strength has to be increased, addition of admixtures and fibers would make it uneconomical.
- Increase in percentage replacement by coconut shell reduces compressive strength of concrete.
- Proper bonding between coconut shell and cement is not possible because of surface area of coconut shell aggregate.

REFERENCES

- [1] Dewanshu Ahlawat and L.G.Kalurkar, "Strength Properties of Coconut Shell Concrete" International Journal of Civil Engineering & Technology (IJCIET), Volume 4, Issue 7, 2012, pp. 20 - 24, ISSN Print: 0976 - 6308, ISSN Online: 0976 - 6316.
- [2] M.R. Kolhe and Dr. P.G. Khot, "Utilization Of Natural Resources With Due Regards To Conservation/Efficiency or Both" International Journal of Management (IJM), Volume 5, Issue 12, 2014, pp. 1 - 11, ISSN Print: 0976-6502, ISSN Online: 0976-6510.
- [3] Alida, A.; Shamsul, B. J.; Mazlee, M. N.; Kamarudin H. (July 2011)., Composite cement reinforced coconut fiber: Physical and mechanical properties and fracture behavior, Australian Journal of Basic and Applied Sciences, July 2011, pp. 1228-1240.

- [4] Cyr M, Aubert JE, Husson B, Clastres P, “Recycling Waste in Cement Based Materials: a Studying Methodology”. In: RILEM Proceedings of the Conference on the Use of Recycled Materials in Building and Structures, Barcelona, Spain, pp. 306-315, 2004.
- [5] Abdulfatah Abubakar and Muhammed Saleh Abubakar, Exploratory Study of Coconut Shell as Coarse Aggregate in Concrete, Journal of Engineering & Applied sciences, vol.3, December 2011.
- [6] J. P. Ries, J. Speck, (2010), “Lightweight Aggregate Optimizes the Sustainability of Concrete”, Concrete Sustainability Conference, National Ready Mixed Concrete Association.
- [7] Gunasekaran K, Kumar PS, (2008), “Developing lightweight concrete using Agricultural and Industrial Solid Wastes”, Proceedings of Innovative World of Concrete’08, 4th International Conference & Exhibition + ICI Silver Jubilee celebration.

