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Experimental investigation of waste coconut shell as a partial replacement of coarse aggregate in concrete

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***Abstract*—In construction industry the rising cost of construction material is the great factor. The prices of building materials are rising day by day. Therefore this is a most priority of all human being to encourage or research on sustainable material which will help to use such waste material as construction material with less cost and safety of structure. The course aggregate is the main constituent of concrete mix, hence in this paper we used coconut shell as a coarse aggregate has been discussed based on the results obtained from test results. The use of coconut shell can also help the prevention of the environment. The paper aims at analyzing compressive strength of concrete (M25) produced using coconut shell as substitute for conventional coarse aggregate with 0%,10%,20%,30%, 40%, 50% partial replacement. The sample cubes are prepared for M25 grade concrete mix for each case another aim of this paper is to spread awareness about use of coconut shell as construction material in civil engineering. Cubes, Cylinders, Prisms are casted, tested and their properties are determined in this paper.**

Index Terms—**Construction material, coconut shell,prevention of environment, compressive strength of coconut shell.**

I. INTRODUCTION

Following a normal growth in population, the amount and type of waste materials have increased accordingly. Many of the non-decaying waste materials will remain in the environment for hundreds, perhaps thousands of years. 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. 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.Now-a-days many engineers and scientists are in process to find various natural as well as modernized ways for the production of construction materials especially concrete. They are also keen in maintaining its quality and strength and therefore various other materials are used as a replacement of a particular material in the making of concrete. One such material is coconut shell which can be used in concrete making by partially replacing coarse aggregate which is a very important component in concrete. Coconuts being naturally available in nature and since its shells are not easily non-biodegradable in they can be used readily in concrete which fulfils almost all the qualities of the original form of concrete.

ADVANTAGES

- By replacing the normal weight aggregate with coconut shell aggregate, the concrete made from it falls under the category of light weight concrete.
- It lacks in compressive strength as compared to conventional concrete but it can be used at places where low strength economical concrete is needed.

SCOPE OF PROJECT

The aim of this study is to assess the utility and efficacy of coconut shells as a coarse aggregate as an alternative to natural aggregate in concrete. Coconut shells have not been tried as aggregate in structural concrete.

II.OBJECTIVES

- To test the feasibility of utilizing coconut shell as a replacement for coarse aggregate in the construction of concrete.

- To find economical solution for high cost construction material.
- To prepare lightweight concrete by using coconut shell as coarse aggregate.
- To make sustainable concrete with more economical for constructions.

III.MATERIALS

CEMENT

Ordinary Portland cement of grade 53 was used. The initial setting time of cement is 30 minutes and the specific gravity of cement is 3.15.

WATER

Clean potable water is used for Mixing and Curing operation for the work. The Water supplied in the campus is of the potable standard of PH value 7 is used.

FINE AGGREGATE

Fine aggregate used was clear sand passing through 4.75mm sieve with a specific gravity of 2.64. The grading zone of aggregate was zone III.

COARSE AGGREGATE

Coarse aggregate used was angular crushed aggregate with a specific gravity of 2.8.

COCONUT SHELL

The coconut shells were sun dried for 5 days before being crushed manually by using hammer. The coconut shells were crushed using hammer to a size such that it passes through a 12mm sieve and retained on 4.75 mm sieve. Crushed shells were washed to remove fibers, mud etc. After washing, these shells were soaked in water for 24 hours and removed from water and then kept for 2 hours at room temperature before using them in preparation of concrete mix.The specific gravity of coconut shell is 1.56.

COCONUT SHELL

COCONUT SHELL AS COARSE AGGREGATE

CONCRETE MIX DESIGN

Mix design is the process of selecting appropriate ingredients of concrete and determining their qualified amounts with the objective of producing a concrete of the compulsory strength, durability and workability as economical as possible.

FACTOR TO BE CONSIDERED FOR MIX DESIGN

1)The grade designation giving the characteristics requirement of concrete.

2)The type of cement influences the rate of development of compressive strength of concrete.

3)Maximum nominal size of aggregate to be used in concrete may be as large as possible within the limit prescribed by IS 456-2000.

4)The cement content is to be limited from shrinkage, creeping and cracking

Concrete mix design: M 25 grade of concrete was designed by IS 10262-1982 method. The natural coarse aggregate were replaced as 0%, 10%, 20%, 30%., 40%, 50%. The test results were analyzed and compared with conventional concrete. Due to high water absorption of coconut shell, they

S.NO	PHYSICAL PROPERTY	TEST RESULT
1.	Maximum Size (mm)	20
2.	Specific Gravity	1.56
3.	Bulk Density(kg/m^3)	580
4.	Water Absorption (%)	23
5.	Aggregate Crushing Value (%)	2.49
6.	Aggregate Impact Value (%)	8.55

were presoaked in water for 24 hours, prior to mixing. Batching and Mixing: weigh Batching was practiced with the help of electronic weigh balance.Batching was done as per mix proportions. Mixing was done by manually. Placing and Compaction cubes are cleaned and oiled to prevent the formation of bond between concrete and moulds. Place the fresh concrete in cubes in three layers, tamping each layer 25 times.Demoulding after placing fresh concrete in moulds, it was allowed to set for 24 hours. It was marked with some permanent identification mark. Concrete cubes are now kept in curing tank for 28 days. After 28 days, concrete cubes were removed from curing tank to conduct tests on hardened concrete.Design concrete mix of 1:1.3:2.3 is adopted to attain25 N/mm2.The water cement ratio of 0.45 is used. After several trails this mix design was finalized.

V.METHODOLOGY

The experimental investigation has been carried out on the test specimens (Cubes, Cylinders, and Beams) to study the strength properties as a result of replacing coarse aggregate by coconut shells in various percentages

namely 10% 20% 30% 40% and 50%. The slump test was conducted on the fresh concrete and compressive strength, split tensile test and Flexural Strength test were conducted on the hardened concrete.

VI. TESTING

The cubes, cylinders and Prism were casted and after completion of 7 and 28 days curing the following tests have been conducted,

- Compressive strength
- Split tensile strength
- Flexural strength

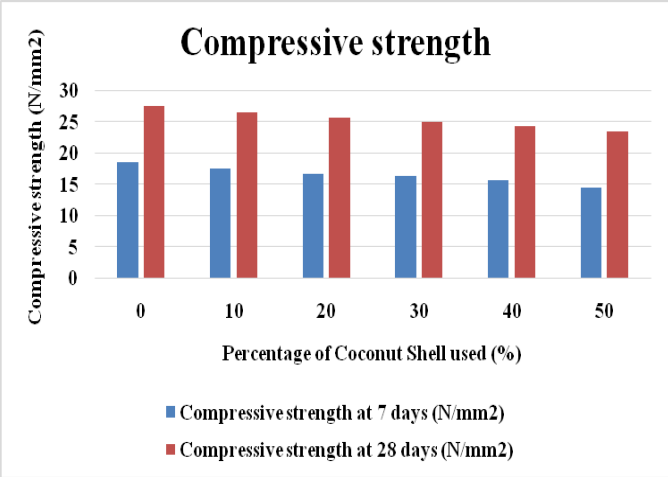
V. RESULT

COMPRESSIVE STRENGTH

For every percentage of replacement 6 cubes have been casted. Among them, 3 cubes were tested on the 7th and the other 3 cubes were tested on the 28th day. Totally 36 cubes were casted and 7th day and 28th day testing has been completed.

Compressive Strength Testing for Cubes

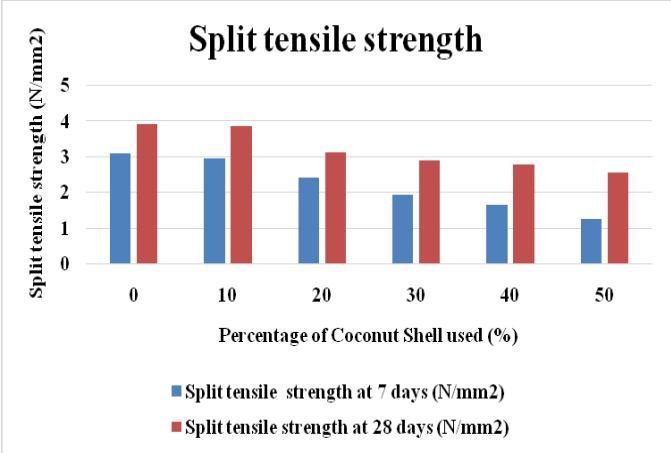
Percentage of Coconut ShelUsed (%)	Compressive strength at 7 days (N/mm^2)	Compressive strength at 28 days (N/mm^2)
0	18.6	27.7
10	17.7	26.6
20	16.8	25.8
30	16.4	25.1
40	15.8	24.4
50	14.6	23.5



SPLIT TENSILE STRENGTH

For every percentage of replacement 6 cylinders have been casted. Among them, 3 cylinders were tested on the 7th and the other 3 cylinders were tested on the 28th day. Totally 48 cylinders were casted and 7th day and 28th day testing has been completed.

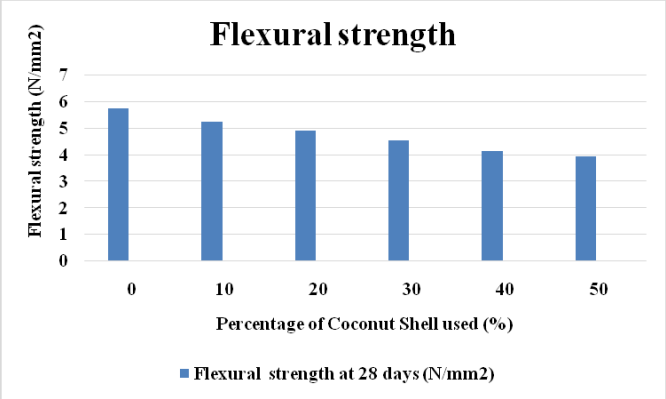
Percentage of Coconut Shell Used (%)	Split tensile strength at 7 days (N/mm2)	Split tensile strength at 28 days (N/mm2)
0	3.10	3.93
10	2.96	3.86
20	2.43	3.14
30	1.96	2.92
40	1.66	2.80
50	1.26	2.56



FLEXURAL STRENGTH

For every percentage of replacement 3 beams have been casted.The 3 beams were tested on the 28th day. Totally 18 beams were casted and 7th day testing has been completed.

Percentage of Coconut Shell Used (%)	Flexural strength at 28 days (N/mm^2)
0	5.75
10	5.26
20	4.94
30	4.56
40	4.16
50	3.96



CONCLUSION

From the review of the above research work undertaken by the various researchers, it can be concluded that coconut shell can be used as coarse aggregates in light weight concrete preparation. Sustainable utilization of this agricultural by-product would preserve the conventional aggregates for future. India is the third highest producer of coconut after Philippines and Sri lanka. Hence this waste should not be dumped here and there; rather it should be utilized in a proper manner so as to eradicate environmental hazards and an effective substitute of concrete aggregate. To opt for green construction, use of coconut shell as coarse aggregates is a right choice, since coconut shell aims to produce light weight concrete and would definitely help in increasing the speed of construction. Till now, only the study regarding coconut shell as aggregate in concrete is studied. But research regarding the use of green coconut (tender coconut) shell and matured coconut husk as fine or coarse aggregates in concrete preparation should be done so as to utilize these vast and under- utilized agricultural wastes in mass construction in infrastructural sector. It is so, because after the consumption of sweet water, the green coconut shells are simply thrown and dumped here and there causing favourable conditions for methane emissions, the most potent green house gases for the atmosphere. Effective utilization these agricultural wastes will not only solve their disposal problem but also protects the local environment. Hence, there is the need to study the feasibility of green coconut shells as the aggregates for concrete preparation in the future research programme.

The following conclusions have been drawn:

(1) By replacing the normal weight aggregate by coconut shell aggregates, the mass of coarse aggregate reduces about 47% due to high porosity of coconut shell leading it to low value of specific gravity.

(2) By replacing the normal weight aggregate with coconut shell aggregate, the concrete made from it falls under the category of light weight concrete.

(3) It lacks in compressive strength as compared to conventional concrete but it can be used at places where low strength economical concrete is needed.

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