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Experimental investigation on partial replacement of coarse aggregate by coconut shell in concrete

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ABSTRACT

The high cost of conventional building materials is a major factor affecting housing delivery in the world. This has necessitated research into alternative materials of construction. In this study, coconut shell is used as light weight aggregate in concrete. The properties of coconut shell and coconut shell aggregate concrete is examined and the use of coconut shell aggregate in construction is tested. The project paper aims at analyzing flexural and compressive strength characteristics of with partial replacement using M25 grade concrete. The project also aims to show that Coconut shell aggregate is a potential construction material and simultaneously reduces the environment problem of solid. Beams are casted, tested and their physical and mechanical properties are determined. The main objective is to encourage the use of these seemingly waste products as construction materials in low-cost housing.

Keywords: Cement, Aggregate, Coconut shell, compressive strength, Split tensile strength and Flexural strength

INTRODUCTION

Generally in design of concrete mix, cement, fine aggregates and coarse aggregates are using from long back, which plays a crucial role in designing of a particular grade of concrete. Today's world is a concrete jungle. With the ever increasing population of the world, in general and the developing countries there is the tremendous pressure on the Civil Engineer to develop a cost effective as well as eco friendly structure to fulfil the need of the human being. In these components only cement is manufactured and both fine and coarse aggregate has been obtained naturally. This has brought up with a great destruction to the environment. And further the disposal of the huge amount of demolition waste was another problem. To solve both these problems use of waste materials such as coconut shell waste. These materials have also benefits that these materials are easily available and economical. In this research these wastes are used in 20mm Coarse aggregates simultaneously. The study has been conducted on these wastes used in concrete. This used as partial replacement of coarse aggregate. The coconut shell is a material which can be a substitute for coarse aggregate. Coconut shell concrete has better workability because of the smooth surface on one side of the shell. The impact resistance of coconut shell concrete is high when compared with conventional concrete.

OBJECTIVES

This study was conducted to achieve the following objectives

i) To study the strength developments hardened concrete with waste coconut shell aggregate.

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ii) To determine the effect of various percentage of coconut shell waste as partial coarse aggregates replacement towards compressive strength of concrete.
iii) To study and evaluate the strength properties of coconut shell based concrete building blocks viz: hollow and filled blocks with various options of shells orientations to understand its capability to be used as a filler/composite/reinforcement material.

MATERIAL DESCRIPTION

The materials used in the projects are cement, Fine aggregate, coarse aggregate, Coconut shell waste are detailed below:

Cement

Cement is the essential ingredient to bind all other materials to form workable concrete. The Ordinary Portland Cement of 53 grades was used in this experimentation conforming to IS: 12269:1987 is used in this experimental project.

Table No 1: Physical property on cement

PROPERTY	SPECIFICATIONS
Specific gravity	3.15
Fineness	2.6 %
Normal consistency	32
Initial setting time	32 Minutes
Finial setting time	10 hours

Fine aggregate

Locally available zone II river sand used as fine aggregate. The specific gravity was determined and was found as 2.53 conforming to I.S. – 383-1970.

Coarse aggregate

Crushed angular shape aggregate from a local source was used as coarse aggregate. The specific gravity was not recycled in any form at present. This cause impacts to environment, so it can be reused as construction materials. The used aggregates were in the range of 20 mm to 25mm IS sieve size and it collects from the local crusher. The tests conducted on coarse aggregate include specific gravity, water absorption, aggregate crushing value test, and aggregate impact value test. Mainly this type of recycled aggregate is used for the developments of concrete with non-conventional aggregates to improve the properties of concrete and reduce the cost.
Specific gravity - 2.87

Advantages

- Stronger bonds
- Light weight concrete

Coconut shell

- Coconut shell are crushed uniformly to about 20mm size manually using hammer and sieved through 20mm IS sieve. In coconut shell waste about 25%-30% of daily production goes as waste.
- The coarse aggregate used in this project work are 20mm grade of size.

Fig No 1: Coconut shell waste

Water

Portable water was used for the experimentation.

DESIGN MIX

As per IS 10292-2000 designed by M25 grade of concrete and water cement ratio 0.5.

Table No: 2 Mix proportion

Materials	Quantity	Mix ratio
Cement(kg/m^3)	383.2	1
FA(kg/ m^3)	800.94	1.27
CA(kg/ m^3)	1087.75	2.44
Water(lits)	191.6	0.45

Mixing of Concrete, Casting and Curing of test Specimens Hand mixing was done during the entire process of casting of specimens. Initially the dry mix constituents of the mix namely cement, fine aggregate and coarse aggregate was mixed for two minutes in the mixer and then the water were added and mixing continued for another 2 minutes. The total mixing time was kept at 4 minutes until a homogeneous mixture was obtained. Compaction was achieved by means of Tamping rod.

Fig No 2: Mixing of concrete

EXPERIMENTAL RESULTS

Fresh concrete

The fresh concrete properties slump test is conducted. The slump value of concrete was 72mm.

Hardened concrete

The hardened concrete specimen properties are checked by compressive strength, split tensile strength and flexural strength.

Compressive strength

For every percentage of replacement 10 cubes have been casted. Among them, 5 cubes were tested on the 7th and the other 5 cubes were tested on the 28th day. Totally 10 cubes were casted and 7th & 28th day testing has been completed. Compressive test of concrete is carried out on specimens like cube by compression testing machine.

$f_c = (P/A)$ N/mm^2
Where,
P = Load at which the specimen fails in Newton(N)
A = Area over which the load is applied in mm
f_c = Compressive Stress in N/mm2

Table No 3: Compressive Strength Results

Grade of concrete	% of Coconut shell waste	7days (N/mm^2)	28 days (N/mm^2)
	0	19	29.10
	10	17	28.53
M25	20	15	27.42

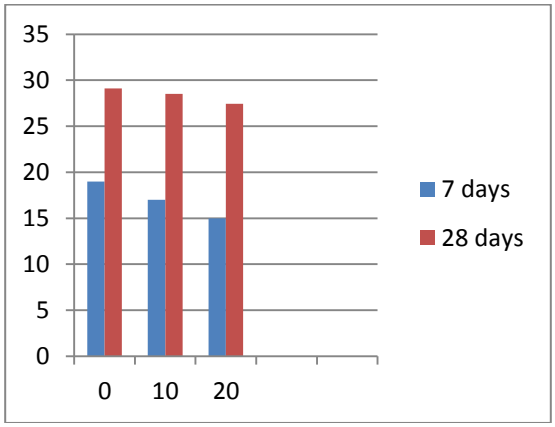

Fig No 3: Analysis of compressive strength

Fig No 4: Testing of cube

Split tensile Strength

For every percentage of replacement 3 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 6 cylinders were casted and 7th day and 28th day testing has been completed. Split tensile Strength test of concrete is carried out on specimens like cylinders by compression testing machine. The Split tensile strength of the specimen was calculated by using the formula

$f_t = (2P/\Pi dl)$ N/mm^2

Where,

P = Maximum load in N applied to the specimen

d = Measured length in cm of the specimen

l = Measured diameter in cm of the specimen

f_t= Tensile strength N/mm^2

Table No 4: Split Tensile Test Results

Grade of concrete	% of Coconut shell	7days (N/mm)	28 days (N/mm^2)
M25	0	1.90	-
	10	2.02	-
	20	1.85	-

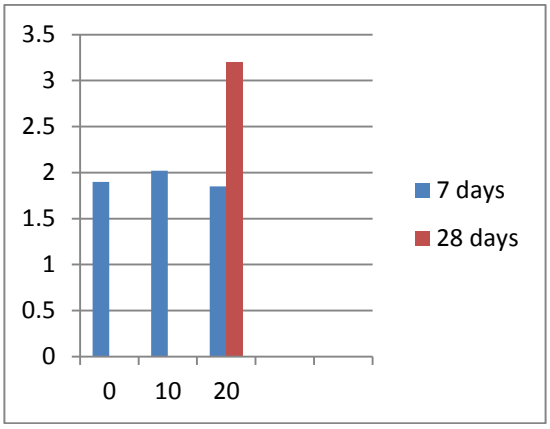

Fig No 5: Analysis of split tensile strength

Fig No 6: Testing of cylinder

Flexural Strength Test

For every percentage of replacement 3 beams have been casted. The 3 beams were tested on the 28th day**.** Totally 6 prisms were casted and 7th day and 28th day testing has been completed. Flexural strength is the one of the measure of the tensile strength of concrete. The flexural strength of the specimen was calculated by using the formula

$F_b = (Pl/bd_2)$ N/mm^2

Where,
P = Load at which specimen fails in (N)
l = Effective span in mm
b = Breadth of the specimen in mm
d = Depth of the specimen in mm

Table No 5: Flexural Strength Test Results

Grade of concrete	% of Coconut shell	7days (N/mm^2)	28 days (N/mm^2)
M25	0	3.98	-
	10	3.65	-
	20	3.72	-

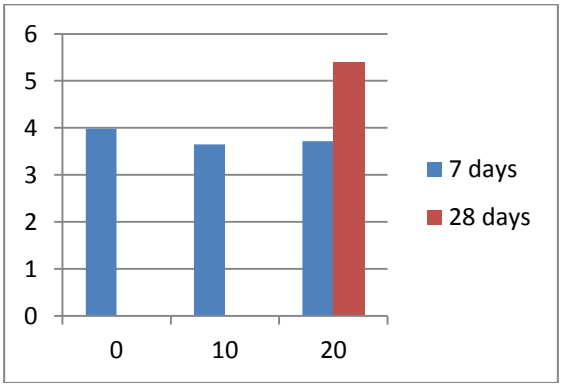

Figure no 7: Analysis of Flexural Strength

Fig No 8: Testing of prism

CONCLUSION

From the test results, the coconut shell has a future as lightweight aggregate in concrete. It also reduces the total cost of concreting, because of the low cost and its ease of availability is profusion. Coconut Shell Concrete can be used in rural areas and places where coconut is profusion and the places where the regular aggregates are not economic. It is concluded that the Coconut Shells are more suitable as low strength-giving lightweight aggregate when used to replace common coarse aggregate in production concrete. Coconut shell s more power to resist crushing, and impact compared to traditional granite aggregate. There is no need to treat the coconut shell before use as an aggregate except for water absorption.

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