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An Experimental Investigation on Light Weight Concrete using Coconut Shell and Steel Fiber

Ms. L. Kokila
Assistant Professor, Department of Civil Engineering
Sethu Institute of Technology
Tamilnadu, India

A. Ramya
PG student, Department of Civil Engineering
Sethu Institute of Technology
Tamilnadu, India

***Abstract*— In this project, an experimental investigation of M_{25} grade of concrete with water cement ratio 0.42, by using coconut shell aggregate added in percentage of 0, 5, 10, 15 and 20 to test the effectiveness of coconut shell within the concrete, and also added steel fibers constant proportion of 0.5% by volume of the concrete. The foremost aim of this project is to figure out the density, compressive strength and split tensile strength for 7 and 28 days strength obtained by replacement of coarse aggregate by using the coconut shell aggregate and steel fiber were studied and also the results were compared with the standard concrete.**

Keywords*—Coconut shell; steel fiber; density; compressive strength; split tensile strength

I. INTRODUCTION

This research work is conducted to judge the potential enhancement of compressive strength due to the addition of steel fiber in structural lightweight concrete (LWC). The coconut shell was substituted rather than coarse aggregate partially to develop the lightweight concrete. Lightweight concrete block finds a good range of application within the development industry. By using the lightweight concrete can reduce the self-weight of the structure. It also reduces the worth of construction during this work to seek out some alternative replacement for course aggregate to avoid wasting natural resources.

II. OBJECTIVE OF THE PROJECT

- To study the fundamental properties of concrete incorporated by coconut shell by conducting density, compressive strength, split tensile strength.
- The main objective is to encourage the use of these waste products as construction materials in low-cost housing.

III. MATERIALS USED

A. Coconut Shell Aggregate

Coconut shell is an abundantly available stuff which may waste material which can be used as potential or replacement material in the construction. Coconut shell passing through 20mm IS sieve and retaining on 12.5mm IS sieve. Coconut shells were soaked in water for 24hours so utilized in concrete as coconut shells have more water absorption than coarse aggregate. The properties of Coconut shell aggregate as given in Table I.

TABLE I. PROPERTIES OF COCONUT SHELL AGGREGATE

S. No	Properties	Results
1	Specific Gravity	1.13
2	Water Absorption (%)	24

B. Cement

Locally available 43 grades ordinary cement (PPC) of Sankar brand has been employed during this investigation for all concrete mixes. The cement used was fresh and with none lumps. The physical properties of Cement are given in Table II.

TABLE II. PROPERTIES OF CEMENT

S. No	Properties	Results
1	Specific Gravity	3.12
2	Fineness Modulus (%)	7
3	Consistency (%)	32
4	Initial Setting Time (minutes)	30
5	Final Setting Time (minutes)	600

C. Fine Aggregate

The manufactured sand helps concrete to fill the voids between coarse aggregates and makes concrete more compact and dense, thus increasing the strength of concrete. The fine aggregates used in the investigation confirmed to Indian standard specifications as shown in Table III.

TABLE III. PROPERTIES OF FINE AGGREGTAE

S. No	Properties	Results
1	Specific Gravity	2.62
2	Water Absorption	0.815
3	Fineness Modulus	3.84
4	Coefficient of Uniformity	6
5	Coefficient of Curvature	1

D. Coarse Aggregate

Good-quality of aggregate which is clean, hard, strong, have durable particles, and be free from of absorbed harmful chemicals, coatings of clay, or other contaminates which might affect hydration of cement. The coarse aggregates shall confirm to the requirement of IS 383 as shown in Table IV.

TABLE IV. PROPERTIES OF COARSE AGGREGATE

S. No	Properties	Results
1	Specific Gravity	2.83
2	Water Absorption	0.195

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E. *Steel Fiber*

Steel Fibers made from mild steel wire confirming to IS: 280-1976 with Aspect ratio 60 has been used.

The materials used for this project were cement, fine aggregate, coarse aggregate, coconut shell and steel fiber as shown in Fig. 1.

Fig. 1. Materials Used

IV. EXPERIMENTAL INVESTIGATION

A. *Mix Design*

Concrete specimens casted using M_{25} grade of concrete designed as per IS 10262: 2009. Mix ratio obtained 1:1.5:2.2 with a water-cement ratio of 0.42. Coarse aggregate was replaced by coconut shell aggregate at various percentages such as 0, 5, 10, 15, and 20 and add 0.5 percentage of steel fiber in volume of concrete.The details of different mix proportions are given in Table V.

TABLE V. MIX PROPORTIONS

Mix ID	Cement (kg/m^3)	Fine Aggregate (kg/m^3)	Coarse Aggregate (kg/m^3)	Coconut Shell (kg/m^3)	Steel fiber (kg/m^3)
CS_0SF_0	469	719	1041	0	0
$CS_0SF_{0.5}$	469	719	1041	0	0.5
$CS_5SF_{0.5}$	469	719	989	52	0.5
$CS_{10}SF_{0.5}$	469	719	937	104	0.5
$CS_{15}SF_{0.5}$	469	719	885	156	0.5
$CS_{20}SF_{0.5}$	469	719	833	208	0.5

B. *Preparation of test specimens*

Six cubes for every proportions were tested for 7 and 28 days compressive strength of size 150 × 150 × 150 mm. Six cylinders for every proportions of size 150mm diameter and 300mm length were tested to find the 7 and 28 days split tensile strength.

C. *Density*

Density of concrete was calculated by dividing the mass by the volume of concrete specimen as shown in Table VI.

TABLE VI. DENSITY OF CONCRETE

S.No	Mix ID	Weight (kg)	Volume (m^3)	Density (kg/m^3)
1	CS_0SF_0	9.15	0.00338	2708
2	$CS_0SF_{0.5}$	9.52	0.00338	2811
3	$CS_5SF_{0.5}$	8.94	0.00338	2646
4	$CS_{10}SF_{0.5}$	8.47	0.00338	2507
5	$CS_{15}SF_{0.5}$	8.06	0.00338	2383
6	$CS_{20}SF_{0.5}$	7.78	0.00338	2302

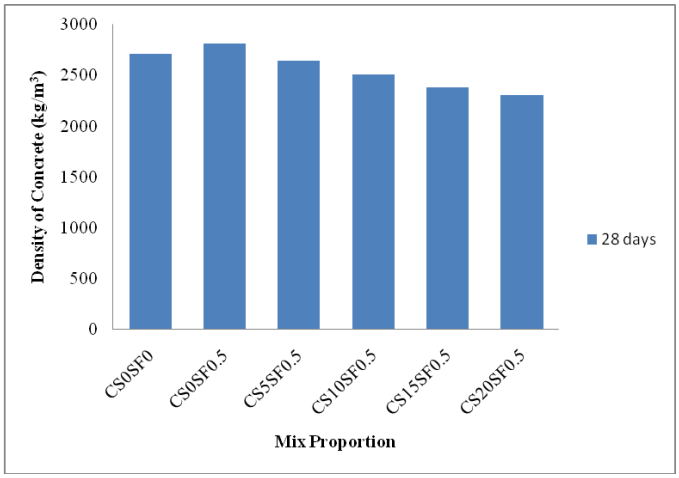

Fig. 2. Density of Concrete

D. *Compressive Strength*

Compressive strength is defined as resistance of concrete to axial loading. It had been tested in Compressive Testing Machine (C.T.M) and readings were recorded up to the ultimate crack.

Compressive strength= Maximum load/Cross Sectional Area

TABLE VII. AVERAGE COMPRESSIVE STRENGTH AT VARIOUS PROPORTIONS

S.No	Mix ID	Compressive Strength at 7 days (N/mm^2)	Compressive Strength at 28 days (N/mm^2)
1	CS_0SF_0	14.84	31.02
2	$CS_0SF_{0.5}$	12.10	32.5
3	$CS_5SF_{0.5}$	12.47	29.47
4	$CS_{10}SF_{0.5}$	12.77	28.46
5	$CS_{15}SF_{0.5}$	11.38	27.17
6	$CS_{20}SF_{0.5}$	10.99	24.06

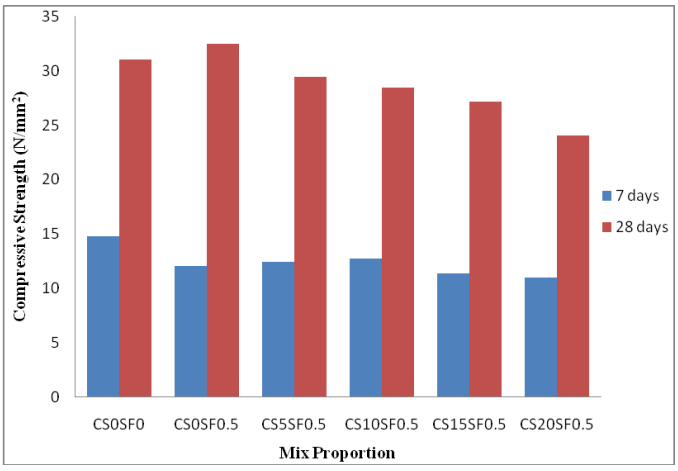

Fig. 3. Shows the Average Compressive Strength at various proportions

E. *Split Tensile Strength*

Specimen of size 150 mm diameters and 300mm length were casted. The test was conducted on the Compression Testing Machine. Cylinder specimens were placed under the

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Compression Testing Machine in a horizontal direction perpendicular to the direction in which they are casted.

The tensile strength was found by using equation,

$F = 2P/\Pi Ld$

Where, F=tensile strength in N/mm²

P = Maximum load applied

d = measured depth of specimen

L= Length of specimen

TABLE VIII. AVERAGE SPLIT TENSILE STRENGTH AT VARIOUS PROPORTIONS

S.No	Mix ID	Split Tensile Strength at 7 days (N/mm²)	Split Tensile Strength at 28 days (N/mm²)
1	CS_0SF_0	2.36	3.43
2	$CS_0SF_{0.5}$	2.49	3.87
3	$CS_5SF_{0.5}$	2.21	3.56
4	$CS_{10}SF_{0.5}$	2.05	3.18
5	$CS_{15}SF_{0.5}$	1.67	2.65
6	$CS_{20}SF_{0.5}$	1.33	2.37

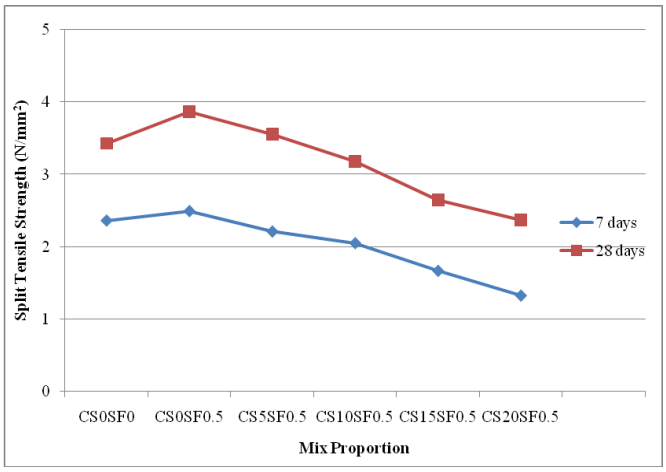

Fig. 4. Shows the Average Split Tensile Strength at various proportions

V. CONCLUSIONS

Coconut shells can be used as replacement of coarse aggregate up to percentage of 0, 5, 10, 15, and 20. More than the 15 percentage replacement decreases in strength is seen. For optimum result upto 15% replacement of coconut shell is good.

a) Density of dry concrete is within the range of 2811-2302 kg/m^3. Light weight concrete was achieved.

b) The 28 days compressive strength were fulfilled the minimum strength by 15 percentage replacement of Coconut Shell aggregate with added 0.5% of Steel Fiber.

c) The optimum Split tensile strength value was obtained by 0% replacement of Coconut Shell aggregate with added 0.5% of Steel Fiber.

d) The compressive and split tensile strength was decreased very less up to 15 percentage replacement of coconut shell aggregate with addition of 0.5 percentage steel fiber when compared to the standard concrete.

e) It can be used for all type structural member such as Floor slab, sunshade, loft, kitchen table top and cub-board slab utilizing the waste material which is produced in large quantities.

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