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Partial Replacement of Coarse Aggregate with Palm Kernel Shell in Concrete

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***Abstract*— This research paper is focused on the experiment done for the partial replacement of coarse aggregate with palm kernel shell (PKS) in concrete and therefore production of lightweight concrete. Palm kernel shell is a waste and thus by using it environment-friendly concrete is produced. For the construction of concrete, the materials which used are cement, sand, coarse aggregate and palm kernel shell. The ratio of these materials are 1: 1.5: 3 by volume batch and the dimension of the cube is 150mm x 150mm x 150mm and the size of coarse aggregate which is used are passed by 16 mm sieve and retained on 12.5mm sieve. Then the partial replacement of coarse aggregate is done by 10%, 13%, 15%, 20%, and 25% and the testing of the cube is done on 7days, 14days, and 28days. This experiment gives the idea about the possible amount of weight reduction of concrete without heavily affecting the strength of concrete.**

Key Words—Partial Replacement; Coarse Aggregate; Palm Kernel Shell; Cement; Concrete.

I. INTRODUCTION

India is Developing country, and for the continuous growth, we need continuous development and the leading factor for the development is infrastructure. Civil engineering is about constructing, managing and maintaining the infrastructure that supports modern society including buildings, bridges, roads, tunnels, dams, etc. This entire Infrastructure involves a large amount of concrete which is very costly and its cost is increasing day by day. So, in this research paper, we show the production of Lightweight Concrete and Cost effective Concrete.

As construction sector is leading the development and at the same time we also are the leading cause of environment disturbance and pollution, so we also have to be a leader in saving the environment by using the waste material for construction purposes. By using this it causes less harm or no harm to the environment. So, this research paper discusses the use of palm kernel shell as partial replacement of coarse aggregates. The concrete which is produced is Cost effective as the specific gravity of palm kernel shell is low as compared to other available coarse aggregate [1] and can be used in building construction also, it is also lightweight concrete [2,3].

Palm kernel is a material which can be easily found and have a lot of uses both commercially and industrially. In Industries it is used for the production of Palm Oil. (In India Palm oil industry is situated in Kerala and is continuously growing).So, we can found Palm Kernel shell as commercially and Industrial waste.

The main aim of this experiment is to produce lightweight concrete and economical concrete by using the environmentally friendly method and thus contributing to the safety of the environment.

II. MATERIALS AND METHOD

The materials used in this experiment are Cement, Sand, Coarse Aggregate, Palm kernel shell (PKS).

CEMENT: The cement is used in this experiment is ordinary Portland cement and is locally available and is as per the requirement of Indian Standard Code.

COARSE AGGREGATE: Granite is used as coarse aggregate and it is available in local market and of size 16mm is used for the experiment.

SAND: Sand is available locally and used.

PALM KERNEL SHELL: Palm kernel shell is a waste, which is available locally and for the large amount it is available in Kerala in Indian.

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Fig. 1. Palm kernel shell.

A. *Testing of Materials*

Testing is done on the materials which are used like cement, sand, and aggregate to check the standard [4, 6].

B. *Casting of Cubes*

The Cube is being cast in the dimension of 150mm x 150mm x 150mm and the volume-batched mix of 1: 1.5: 3 of cement, sand and aggregate is used, as batched by volume performed better than batched by weight [3] and the coarse aggregate of 16mm size is used.

C. *Testing of Cubes*

The mold is open after24 hours of casting and kept for 7, 14, and 28 days for curing. The testing of the cube is done on the compression testing machine in the laboratory of civil engineering department, SRMCEM, Lucknow and all the reading should be recorded [5].

Fig. 2. Compressive testing machine.

III. RESULT AND DISCUSSION

Testing of materials is done for checking the standard of materials and whether it is according to Indian standard or not and suitability of materials for experiments.

A. *Testing of Cement*

Following test are performed on the cement:

1) *Fineness of Cement*

The result of the fineness test performed on the cement is shown in table 1.

TABLE I. FINENESS OF CEMENT

S No.	Weight of Sample (g)	Weight of residue (g)	fineness	percentage
1	100	4.2	0.042	4.2%
2	100	3.7	0.037	3.7%
3	100	3.2	0.032	3.2%

The average value of fineness of cement is 3.7%.

2) *Consistency Value*

The result gets by this test is shown in Table.

TABLE II. CONSISTENCY OF CEMENT

S No.	Weight of Cement	% of water	Quantity of water	Penetration of plunger
1	400 g	28	112	7
2	400 g	26	104	6

B. *Testing of Aggregate*

1) *Water Absorption Test*

Water Absorption of coarse aggregate is done and the result is shown in table 3.

TABLE III. RESULT OF ABSORPTION TEST

S No.	Weight of Dry Aggregate gm(W_1)	Weight of Saturated Aggregate gm (W_2)	Water Absorption gm (W_2-W_1)
1	2000	2010	10

2) *Impact Value Test*

Result gain by this test is shown in table 4.

TABLE IV. RESULT OF IMPACT VALUE TEST

S No.	Wt of Aggregate gm w_1	Wt of aggregate passing through 2.36 mm sieve gm w_2	Impact value %
1	700	60	8.57

3) *Crushing Test*

The crushing value of aggregate is shown in table 5.

TABLE V. CRUSHING VALUE OF AGGREGATE

S No.	Wt of Aggregate gm W1	Wt of Aggregate passing 2.36 mm sieve gm W2	Crushing Value %
1	2500	575	23

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4) Abrasion Value Test

Abrasion test is done with the help of Los angel's abrasion testing machine and the result is presented in Table 6.

TABLE VI. ABRASION VALUE OF AGGREGATE

S No.	Wt of dry sample gm W1	Wt of portion passing 1.7 mm sieve gm W2	Abrasion Value %
1	5000	1635	32.7

C. Testing of Sand

1) Bulking of Sand

The result which is gain by the test is shown in table 7.

TABLE VII. RESULT OF BULKING TEST

S No.	Height of Loose Sand (h)	Height of Saturated Sand (h')	Pore Bulking
1	11	10.8	1.8%

2) Silt Content

The result of Silt content test of sand is shown in table 8.

TABLE VIII. SILT CONTENT OF SAND

S No.	Volume of Sample (v_1) ml	Volume of silt after three hr (v_2) ml	Percentage Silt
1	400	20	5

3) Sieve Analysis

Various composition passing through various IS Sieve is shown in table 9.

TABLE IX. SIEVE ANALYSIS OF SAND

IS Sieve	Weight of Soil Retained (gm)	Cumulative Weight Retained (gm)	Cumulative Weight Retained as % of Total Sand	Cumulative % Passing as % of Total Sand
2mm	113	113	28.25	71.75
1mm	162	275	68.75	31.25
600u	18	293	73.25	26.75
425u	82	375	93.75	6.25
300u	20	395	98.75	1.25
150u	2	397	99.25	0.75
75u	1	398	99.55	0.45
Pan	1	399	99.75	0.25

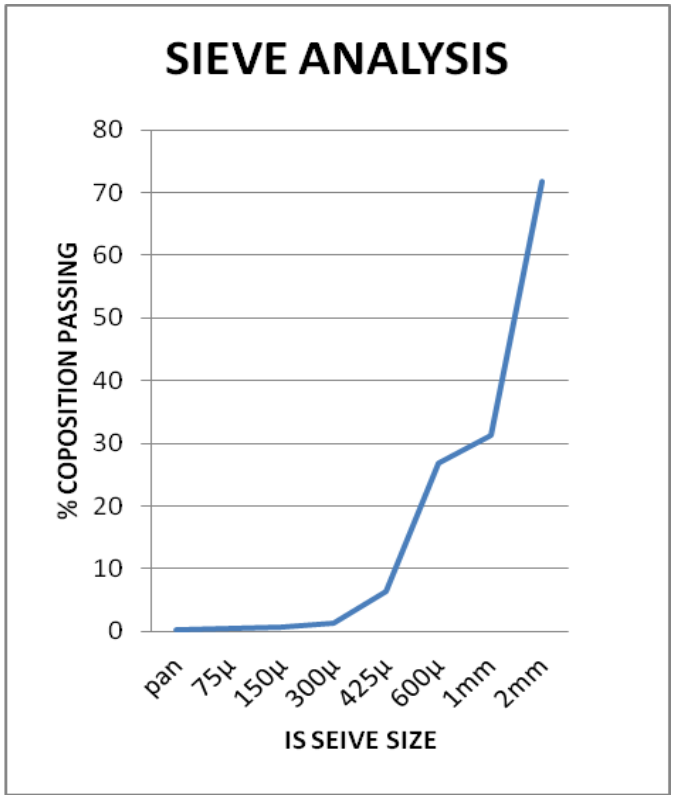

Fig. 3. Graph of sieve analysis.

Fig. 3 shows the percentage of various particle size of sand present in the sample of the sand used for the testing.

By analysis from table 3 to table 9, the result shows that the aggregate and cement are of Indian standard as per IS code.

D. Compressive Strength

The results which we get from the compression testing machine by crushing the cubes after curing are presented in Table 10.

TABLE X. COMPRESSIVE STRENGTH OF CONCRETE

% Partial Replacement	Compressive Strength at different No. of Days in Curing Tank (MPa)		
	7 days	14 days	28 days
0	14.3	18.65	22.5
10	12.8	17.5	18.95
20	10.9	14	15.55

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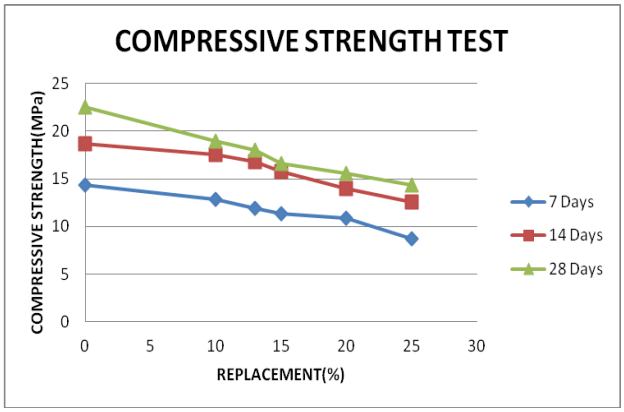

Fig. 4. Compressive strength of concrete.

Fig. 4 shows the compressive strength of concrete block at different percentage replacement of coarse aggregate with palm kernel shell. It shows that there is a rapid decrease in compressive strength of block with the increase in palm kernel shell as a replacement of coarse aggregate.

E. Cost Analysis

The partial replacement of coarse aggregate with palm kernel shell (which is a waste) in concrete can reduce the overall cost of the concrete and therefore construction also. Cost reduction of concrete with respect to increasing percentage replacement of coarse aggregate is shown in Table 11.

TABLE XI. COST REDUCTION OF BLOCK

% of Replacement	Cost of Concrete (1 block)	Cost after Replacement	% Change
0	33.27	33.27	0.0
10	33.27	33.10	0.5
13	33.27	32.95	1
15	33.27	32.77	1.5
20	33.27	32.66	1.8
25	33.27	32.51	2.3

F. Weight Analysis

The weight of different cubes made of the different percentage of palm kernel shell is presented in table 12.

TABLE XII. WEIGHT ANALYSIS OF CONCRETE BLOCK

% of Replacement	Original Weight of Concrete	Weight after Replacement	% Change
0	8	7.99	0.0
10	8	7.86	1.7
13	8	7.83	2
15	8	7.80	2.5
20	8	7.73	3.4
25	8	7.67	4.13

With the increase in the percentage of palm kernel shell in concrete the weight of concrete gets continuously decreasing. Thus producing lightweight Concrete.

CONCLUSION

- With the increasing, the percentage of palm kernel shell in concrete, the compressive strength, cost and weight of the concrete decreases simultaneously.
- At around 10% partial replacement of coarse aggregate with palm kernel shell in concrete gives a significant decrease in cost and weight of the concrete without much affecting the compressive strength of concrete.
- There is a large scope of making the construction environmental friendly by replacing the construction material with waste.

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