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EFFECT OF PARTIAL REPLACEMENT OF CEMENT WITH FLY ASH AND COARSE AGGREGATE WITH COCONUT SHELL IN CONCRETE

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Abstract

The waste materials utilization in concrete production is very much helpful to reach the goal of the sustainable construction. Therefore, this study intends to use of coconut shells and fly ash by replacing coarse aggregate and cement respectively in concrete. The paper reports on the performance of M30 grade of concrete mixes containing different ratios of coconut shell having 20 mm maximum size as coarse aggregate. Portland pozzolana Cement 33 grade and coarse, sand were used to produce standard concrete cubes. Compressive strength tests were carried out on concrete specimens at various ages. Test results indicates that except M 30 mix there is no significant effect on compressive strength of concrete up to 20 percent replacement of normal 20 mm coarse aggregates with coconut shells. But beyond that, strength started decreasing gradually with increase the proportion of tile aggregates in concrete.

Keywords- Coconut shell, Fly ash, Concrete

1. INTRODUCTION

Concrete is the composite material around the world and is most widely used of all types of construction work. It is a man made product, consisting of cement, aggregate, water and admixtures. It is used quite the other manmade material in the world. About 10-15 billion tons of concrete is produced every year. It is increasing due to high growth of infrastructure development and construction activities in the world. A Large amount of natural aggregates, sand and water are being consumed in concrete production. Consequently, to minimize these researches have concentrated on the use of waste materials as potential alternatives in the construction industry, especially in concrete construction. In fact, a waste materials (i.e.., fly ash, coconut shell, rubber, glass, coconut coir, slag, plastics etc) in concrete constitution is one of the prime research interests to reach the goal of achieving sustainable construction. The concrete production in construction activities using conventional aggregate like granite immoderately reduces the natural stone deposits and affecting the environment, hence causing ecology imbalance. Therefore consumption of other waste materials in situ of natural aggregate in concrete production not only occur protects environment but also makes concrete a sustainable and environment friendly construction material. Hence to overcome such problems, aggregate can be replaced with coconut shell. It reduces the disposal problem, atmospheric pollution and improve the mechanical properties of concrete. Thus, the main aim is to utilize the coconut shells and to

achieve their strength with different percentage of coconut shell aggregate in concrete.

The aim of this work is to evaluate the properties of concrete with partial replacement of coarse aggregate with coconut shell and also cement with fly ash studied. In this study we made M25 Grade of concrete.

COCONUT SHELL

In this work, Coconut shells use as partial replacement of coarse aggregate which is crushed granite. Coconut shells unruffled from the local temple after it

clean, sun dried, removed fibers to evaluate its properties. Coconut shells needs no pre treatment, except for water absorption. Due to this property, before use coconut shells were soaked in potable water for twenty four hours.

FLY ASH

In this work, the use of fly ash as a partial replacement for Portland cement will usually reduce water demand. Usually strength development is extremely slow due to pozzolanic reaction of ash. Later age strength is higher. Class f type of fly ash reduces alkali -silica reactivity due to the dense structure and hence expansion is reduced which increases durability. The pozzolanic reaction between fly-ash and lime generates less heat, leading to reduced thermal cracking when fly ash is used to replace their percentage of Portland cement.

2. LITERATURE REVIEW

The various literatures of sunshine weight concrete with the characteristics of high compressive strength are reviewed during this chapter. Along with that the utilization of coconut shell as coarse aggregate to replacing the coarse aggregate is additionally reviewed for analyzing the strength. The abstract and conclusions of varied authors in their literature is stated during this chapter for the study of strength characteristics of concrete.

Parag S. Kambli & Sandhya R. Mathapati (2014) prepared three different Mix Designs for M20, M35, M50 grades of concrete. Percentage replacement by coconut shell varied as 0%, 10%, 20%, 30%, 40% respectively. It is concluded during this study that for M20 grade concrete cubes with 30% replacement of CS aggregates had given strength of 23 MPa at 28 days. Concrete cubes with 30% replacement of CS aggregates had given strength of 42 MPa at 28 days for M35. For M50 grade concrete cubes with 30% replacement of CS aggregates had given strength of 51 MPa at 28 days.

Amarnath Yerramala Ramachandrudu C (2012) in his experimental study, coarse aggregate was partially replaced by coconut shell and fly-ash. Percentages of replacement by coconut shell were 10%, 15%, 20% and Percentages of coconut shell replacement by fly-ash were 5%, 25%. He concluded in his study that workability decreased with increase in CS replacement. Compressive and split tensile strengths of CS concretes were less than control concrete.

Damre Shraddha and Shrikant Varpe (2014) replaced conventional coarse aggregate with

coconut shell and concluded that- with 50% replacement of coarse aggregates by coconut shells, the strength attained reduces invariably from 10%-20% as compared to the traditional coarse aggregate concrete. With 50% replacement of coarse aggregates by coconut shells, the flexural strength attained reduces invariably from 10%-15% as compared to the coarse aggregate concrete.

Vishwas p. kulkarni (2013) studied that Aggregates provide volume at low cost, comprising 66 percent to 78 percent of the concrete. Conventional coarse aggregate namely gravel and fine aggregate is sand in concrete are going to be used as control. While natural material is coconut shell as course aggregate are going to be investigate to replacing the aggregate in concrete. Lightweight concrete is typically made by incorporating natural or synthetic light weight aggregates or by entraining air into a concrete mixture. Coconut shell exhibits more resistance against crushing, impact and abrasion, compared to crushed granite aggregate. Coconut shell can be grouped under lightweight aggregate. There is no need to treat the coconut shell before use as an aggregate except for water absorption. Coconut shell is compatible with the cement. The 28-day air-dry densities of coconut shell aggregate concrete are less than 2000 kg/m3 and these are within the range of structural lightweight concrete. Coconut shell aggregate concrete satisfies the wants of ASTM C 330.

Maninder Kaur & Manpreet Kaur (2012) published a review paper in which it is concluded that use of coconut shells in cement concrete can help in waste reduction and pollution reduction. It is also expected to serve the aim of encouraging housing developers in investing these materials in house construction. It is also concluded that the Coconut Shells are more suitable as low strength-giving lightweight aggregate when wont to replace common coarse aggregate in concrete production.

J.P. Ries (2011) studied that Lightweight aggregate (LWA) plays important role in today's move towards sustainable concrete, Lightweight aggregates contributes to sustainable development by lowering transportation requirements, optimizing structural efficiency that results in a reduction in the amount of overall building material being used, conserving energy, Reducing labor demands and increasing the survive life of structural concrete.

3. OBJECTIVES

The objectives are briefly summarized below.

- To study the properties of coconut shells, and to produce coconut shells aggregate concrete with 28 days compressive strength more than 20N/mm^2.
- To study the strength properties of concrete in replacement of coarse aggregate with coconut shells and cement with fly ash.
- To study the behaviour of compressive strengths.
- Experimental study on strength characteristics of M30 grade concrete. Furthermore, mix with both coconut shell and fly ash was employed with replacement of 10%, 20% & 30% of coarse aggregate with coconut shells and 10% of fly ash with cement.
- To determine the percentage strength of concrete at 7 and 28 days.

4. METHODOLOGY

The physical, chemical, mechanical properties of coconut shells, and the compatibility of coconut shells with cement were studied. Based on the standard procedures and methods followed for the production of conventional Light weight concrete (LWC), the coconut shell aggregate concrete were produced. Number of 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 were taken into consideration during the selection of the optimum coconut shell aggregate concrete mix. Also, the coconut shell cement ratio and w/c ratio of concrete mix was optimized.

M30 concrete mix designs has chosen to carry out the tests to find the effect of coconut shell and fly ash in concrete will be replaced by coarse aggregate and cement respectively with the proportion of 0%, 10%, 20 & 30% of coconut shell and 10% of fly ash for each mixes.

5. DESCRIPTION OF MATERIALS

5.1 CEMENT

Locally available 33 grades Portland Pozzolana Cement (PPC) of ULTRATECH brand has been used in the present investigation for all concrete mixes.

S.NO	PROPERTIES OF MATERIALS	RESULTS
1	Consistency	33%
2	Setting Times Initial	31min
	Final	9hr 52min
3	Compressive Strength	33 N/mm^2
4	Specific Gravity	2.99
5	Fineness	2%

5.2 COARSE AGGREGATE

Normal aggregate that's crushed blue granite of a size of 10mm & 20 mm was used as coarse aggregate. We are conducting tests on coarse aggregate are Water Absorption Capacity, relative density and Fineness Modulus of coarse aggregate. Aggregate generally occupy 70% to 80% of volume of concrete and thus it have an important influence on its properties of concrete. Good quality of aggregate which is clean, hard, strong, have durable particles, and be freed from absorbed harmful chemicals, coatings of clay, or other contaminates which will affect hydration of cement or reduce the paste-aggregate bond.

S.NO	PROPERTIES OF MATERIALS	RESULTS
1	Specific gravity	2.72
2	Water absorption	0.88%
3	Maximum size	20mm
4	Minimum size	10mm
5	Fineness Modulus	7.2

5.3 FINE AGGREGATE

Well graded river sand passing through 4.75 mm was used as fine aggregate. The sand was air-dried and sieved to get rid of any foreign particles before mixing. We are conducting tests on fine aggregate are Water Absorption Capacity, relative density and Fineness Modulus of fine aggregate. It should be consist of natural sand or crushed stone sand. It should be hard, durable and clean and be free from organic matter etc. Fine Sand shouldn't contain any appreciable amount of clay balls and harmful impurities like alkalis, salts, coal, decayed vegetation etc. Locally available river sand is employed in experiment which is passing

through 4.75mm IS sieve and retained on 75 micron IS sieve.

S.NO	PROPERTIES OF MATERIALS	RESULTS
1	Specific gravity	2.62
2	Water absorption	2.04%
3	Maximum size	4.75mm

5.4 FLY ASH

Fly ash closely resembles volcanic ashes utilized in production of the earliest known hydraulic cements about 2,300 years ago. Fly ash is the best known, and one of the most commonly used pozzolana in the world. Instead of volcanoes, today's ash comes primarily from coal-fired, electricity-generating power plants. These power plants grind coal to powder fineness before it's burned. Fly ash the mineral residue produced by burning coal is captured from the facility plant's exhaust gases and picked up to be used. The difference between ash and hydraulic cement becomes apparent under a microscope. Fly ash particles are almost totally spherical in shape, allowing them to flow and blend freely in mixtures. That capability is one among the properties making ash a desirable admixture for concrete.

The use of ash as a partial replacement for hydraulic cement will usually reduce water demand. Usually strength development is extremely slow thanks to pozzolanic reaction of ash. Later age strength is higher. Class f ash reduces alkali -silica reactivity due to the dense structure and hence expansion is reduced which increases durability. The pozzolanic reaction between ash and lime generates less heat, leading to reduced thermal cracking when ash is employed to exchange a percentage of hydraulic cement.

S.NO	SPECIFICATIONS	RESULTS
1	Specific gravity	2.4
2	Colour	Whitish grey

5.5 COCONUT SHELL

Coconut shells which were already broken into small chips manually using hammer and sieved through 10mm sieve. The material passed through 10mm sieve was used to replace coarse aggregate with coconut shells. The material retained on 10mm sieve was discarded. Water absorption of the coconut shells was 23% and specific gravity at saturated surface dry condition of the material was found as 1.33. The sugar present in wood may cause incompatibility between wood and cement. Since the coconut shells aggregates are wood based, to estimate the sugar present in coconut shells. It determine the compatibility requirements for the coconut shells cement composite are maximum hydration temperature, time taken to achieve maximum temperature, ratio of the setting times of coconut shells fines-cement mixture, neat cement and inhibitory index. Inhibitory effect is that the measure of the decrease in heat release during the exothermic chemical change of cement hydration.

S.NO	PROPERTIES OF MATERIALS	RESULTS
1	Specific gravity	1.33
2	Water absorption	23%
3	Maximum size	20mm
4	Minimum size	10mm
5	Shell thickness	2-8mm

6. MIX DESIGN

Mix design is that the process of choosing an optimum proportion of cement, fine and coarse aggregates and water to supply a concrete with specified properties of workability, strength, and durability. The best mix involves a balance between economy and the properties of concrete. Based on the properties of the available materials, the combination proportions of the coconut shells concrete were first approximated using absolute volume method. This approximation gave a starting from which modifications of trial mixes were made to realize a practical outcome and to supply coconut shells aggregate concrete of the specified properties. Hence, the combination design for the coconut shell aggregate concrete during this study was supported performances of trial mixes and therefore the measure of the chosen mix was so adjusted to get the most favourable mix proportion. Finally, an optimum mix was selected. In order to investigate properties of coconut shells concretes, four mixes were employed. Control mix that is, without coconut shells and fly ash was made (M1). Furthermore, a mix with 10% of coconut shells and 10% of fly ash (M2) was made, then 20% of coconut shell and 10% of fly ash was made (M3), then also employed, in which, 30% of coconut shells was replaced with coarse aggregate and 10% of fly ash was replaced with cement (M4).

The mixes were made as follows:

Replacement by weight	No. of cubes	Cement (kg)	Fine aggregate (kg)	Coarse aggregate (kg)		Water (litre)
				10mm	20mm	
For 0%	6	9.35	17.67	10.78	10.78	4.20
For 10%	6	8.42	17.67	9.702	10.78	4.20
For 20%	6	8.42	17.67	8.624	10.78	4.20
For 30%	6	8.42	17.67	7.546	10.78	4.20

Note : Replacement of fly ash is constant at 10% for each mixes but replacement of coarse aggregate of 10mm is changes for 10%, 20% and 30% respectively.

Mixes:

Mix Name	Cement (kg)	Fine Aggregate (kg)	Coarse Aggregate (kg)		Fly ash (kg)	Coconut Shells (kg)
			10mm	20mm		
M1 (NC,0%)	9.35	17.67	10.78	10.78	0	0
M2 (10%CS+10%FA)	8.42	17.67	9.702	10.78	0.935	1.078
M3 (20%CS+10%FA)	8.42	17.67	8.624	10.78	0.935	2.156
M4 (30%CS+10%FA)	8.42	17.67	7.546	10.78	0.935	3.234

Where, NC= Normal concrete; CS= Coconut shell; FA= Fly-ash

7. RESULTS & DISCUSSION

COMPRESSIVE STRENGTH TEST

Calculate the compressive strength of concrete cubes the universal testing machine having capacity of 2000 KN was used. During this test the strength obtained in KN. The measured compressive strength of the specimen shall be calculated by dividing the utmost load applied to the specimen during the test by the cross sectional area calculated from mean dimensions of the section and shall be expressed to the closest N/mm2. The Compressive strength is defined as resistance of concrete to axial loading. Cubes are put within the machine and after tighten its wheel start button is pressed as pressure is begin to use. Reading of meter is write when cracks are there on cubes. More over the compressive strength of 10%, 20%, 30% are reached the target strength of M30 grade mix, i.e, 38.25 N/mm2.

Compressive strength is calculated by following formula:

Compressive Strength = P/A

Where, P is load in KN and A is area of cube in mm2.

7.1 Compressive strength at 0% replacement (M1):

Cement content = 425kg/m^3
w/c = 0.45

Table (a): at 0% replacement

	7 days (N/mm^2)				28 days (N/mm^2)			
	Cube 1	**Cube 2**	**Cube 3**	**Mean**	**Cube 1**	**Cube 2**	**Cube 3**	**Mean**
	32.23	34.21	31.96	**32.80**	42.32	45.12	46.33	**44.59**

7.2 Compressive strength of replacement at 10% of Coconut shell with 10mm of aggregate and 10% of Fly-ash with cement (M2):

Cement content = 425kg/m^3
w/c = 0.45

Table (b): at 10% replacement of C_A

	7 days (N/mm^2)				28 days (N/mm^2)			
	Cube 1	**Cube 2**	**Cube 3**	**Mean**	**Cube 1**	**Cube 2**	**Cube 3**	**Mean**
	29.22	31.26	30.50	**30.32**	45.12	39.27	41.51	**41.96**

7.3 Compressive strength of replacement at 20% of Coconut shell with 10mm of aggregate and 10% of Fly-ash with cement (M3):

Cement content = 425kg/m^3
w/c = 0.45

Table (c): at 20% replacement of C_A

	7 days (N/mm^2)				28 days (N/mm^2)			
	Cube 1	**Cube 2**	**Cube 3**	**Mean**	**Cube 1**	**Cube 2**	**Cube 3**	**Mean**
	24.81	29.23	27.72	**27.25**	39.76	38.96	40.12	**39.61**

7.4 Compressive strength of replacement at 30% of Coconut shell with 10mm of aggregate and 10% of Fly-ash with cement (M4):

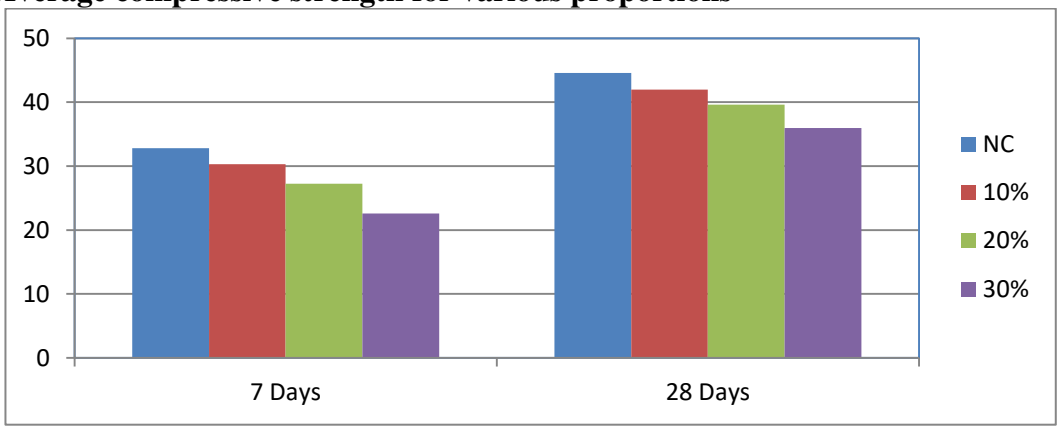
Cement content = 425kg/m^3
w/c = 0.45

Table (d): at 30% replacement of C_A

	7 days (N/mm^2)				28 days (N/mm^2)			
	Cube 1	**Cube 2**	**Cube 3**	**Mean**	**Cube 1**	**Cube 2**	**Cube 3**	**Mean**
	22.81	23.23	21.72	**22.58**	37.76	34.96	35.12	**35.94**

7.5 GRAPH

Average compressive strength for various proportions



Curing days

(CS= Coconut shell, FA= Fly ash, NC= Normal concrete)

8. CONCLUSION

In this work, Coconut shells can be used as partial replacement for coarse aggregate up to 10%, 20% and 30%. More than the 20% replacement decreases in strength is seen. The optimum result for the 20% replacement coconut shell is good. Results of experiments on compressive strength for coconut shells replaced concretes have been presented with those of control concrete. However, The performance of coconut shells aggregate concrete having a marginal variation then normal aggregate concrete. The main points of this study are:

1. Addition of coconut shells as coarse aggregate will decreases the workability and addition of fly ash as cement replacement increases workability of coconut shells concrete. Increasing percentage of coconut shells, decreased the densities of the concretes.
2. By replacement of coconut shells in place of aggregates will have been decreased marginally the strength properties of concrete compared to the normal concrete.
3. More than the 20% replacement decreases in strength is seen, For optimum result the 20% replacement coconut shell is good.
4. The specific gravity of coconut shell is lower than to the coarse aggregate and the water absorption is higher for coconut shell than coarse aggregate, so the strength decreased as comparison with the conventional concrete.
5. The cube compressive strength of concrete at the age of 7 days resulted in marginal reduction with 10% and 20% replacement of coarse aggregate with coconut shell.
6. The replacement of the 10%coconut shells as coarse aggregate and 20%fly ash as cement will decreases the marginal value of 0.525% in compression strength.
7. The replacement of the 20%coconut shells as coarse aggregate and 20%fly ash as cement will decreases the marginal value of 0.205% in compression strength.
8. It was found that without addition of fly ash; only by replacement of coconut shell strength has decreased at 10% and 20% when compared to normal concrete.
9. When fly ash was replaced for cement along with coconut shell as coarse aggregate replacement the strength property was improved.

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