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AN EXPERIMENTAL INVESTIGATION ON PHYSICAL, CHEMICAL AND MECHANICAL PROPERTIES OF CONCRETE BLOCKS MIXED PARTIALLY WITH BURNT COCONUT SHELL POWDER

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ABSTRACT

Huge amount of energy, natural stones, sand and water are being consumed to produce concrete as per the needs of construction industry. This is resulting in depletion of natural resources, making concrete production unsustainable. The need to attain sustainability in concrete production and use is ever existing demand. One of these approaches is replacement of the basic ingredients of concrete with non-conventional materials which include reused/recycled/renewable/locally available/biodegradable materials, making the end product sustainable. In line with this requirement, abundant agricultural and industrial wastes are being generated every year all over the world. These wastes have the potential to be used in making of concrete. The present study deals with one such potential agricultural waste, coconut husk. The study aims at finding out the sustainability of burnt coconut shell powder as a construction material and the reduction in density produced by using it as a replacement of fine aggregate and coarse aggregate. Trial mixes were conducted for the conventional concrete and replaced concrete (10%, 20% and 30% of sand with burnt coconut shell powder) for M30 and M40 grade. The compressive strength of M30 and M40 concrete cubes containing 10%, 20% and 30% burnt coconut shell powder is recorded.

Key words: Burnt coconut shell powder, Compressive strength, Natural sand and cement paste.

INTRODUCTION

The most popular material in the world used for construction is concrete. Concrete is a heterogeneous material, which is made by mixing cement, sand, coarse aggregates, admixtures (if any) and water in a definite ratio. The above mentioned materials are the conventional materials and with the rapid increase in construction, the use of conventional

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materials is leading to the scarcity of the conventional materials. For the past few years the cost and availability of sand has drastically increased. There are many replacements which have been proposed for the sand like Quarry dust, river sand, fine crumb rubber, rice husk etc., as in[1-4]. The basic function of fine aggregates (sand) is to aid workability and consistency in the mix. The use of materials like river sand, fine crumb rubber, quarry dust etc led to environmental constraints (i.e. depletion of sand deposits, increase in pollution due to crumb rubber production and increase in substantial cost of quarrying). The burnt coconut shell powder also known as burnt charcoal powder may be used as fine aggregates instead of sand partially. The study requires the tests on compressive strength, workability and consistency of the design mix for M30 and M40.

EXPERIMENTAL

Materials and their properties

Cement used for the study is of grade OPC-43. The burnt coconut shell powder is produced by Drum method. A. M. S Drum Kiln is a set of six 2.54 cm diametric holes which are on the bottom, upper and middle layers.

Table 1: Properties of the materials used for experiment

Constituents	Properties as per initial tests	
OPC Cement	Grade	OPC - 43
	Specific gravity	3.05
	Fineness modulus	0.16
Sand	Size range	Pan to 4.75 mm
	Specific gravity	2.67
	Fineness modulus	3.28
Coarse aggregates	Size	12.5 to 20 mm
	Specific gravity	2.63
	Fineness modulus	3.076
Burnt coconut shell powder	Size	< 4.75 mm
	Specific gravity	1.344
	Fineness	4.06
	Class B Extinguisher	Flammability : 2.0
Water	Normal water with pH value ranging from 6.5 to 9.5	

The process of making burnt coconut shell powder includes the removal of moisture from the coconut shells and have wide importance in laundries, food and metallurgy industries. Table 1 shows various properties of the materials used.

Experimental investigation

Mix design

In the study, the replacement is done on two grades M30 and M40 for which the mix proportion by weight is 1:1.695:2.640 and 1:1.976:2.322 respectively. For the study, sand is replaced by burnt coconut shell powder (specific gravity 1.32) from 0 to 30% in the difference of 10% each.

Workability of fresh concrete

Workability of fresh concrete is determined by Slump Cone test. Slump cone test is performed with various water cement ratios. The slump value of 65 mm obtained to corresponding water cement ratio is finalized. Table 2 shows the variation of water cement ratios with varying content of burnt coconut shell powder. Table 3 and 4 shows the initial tests (Sieve analysis and specific gravity) performed on burnt coconut shell powder.

Table 2: Water cement ratio with different percentages of burnt coconut shell powder

Percentage replacement	Water cement ratio	
	M30	M40
0 %	0.450	0.400
10 %	0.440	0.390
20 %	0.445	0.385
30 %	0.440	0.390

Compression test of the specimen

Three cubes of each grade with each replacement are tested after 7, 14, 28 days are tested on Compression testing machine by applying a load of 4-40 N/min. Table 5 shows the compressive strength of all the cubes after 7, 14 & 28 days of curing and the deviation from the conventional compressive strength.

Table 3: Sieve analysis test for burnt coconut shell powder

S. No.	Sieve size (mm)	Weight of residue (Kg)	% of Weight of residue	Cumulative retained weight	% of Passing
1	4.75	0.01	1	1	99
2	2.36	0.03	3	4	96
3	1.18	0.08	8	12	88
4	600 µ	0.20	20	32	68
5	300 µ	0.31	31	63	37
6	150 µ	0.19	19	82	18
7	Pan	0.18	18	100	0

Fineness modulus = $\frac{\sum \text{Cummulative \% Retained}}{100} = 4.06$

Table 4: Specific gravity of burnt coconut shell powder

Weight of different specimens	Observation (Kg)
Weight of empty pycnometer, W_1	0.662
Weight of pycnometer + Sand, W_2	1.4
Weight of pycnometer + Sand + water, W_3	2.20
Weight of pycnometer + Water , W_4	1.49

$$\left(\frac{W_2 - W_1}{(W_2 - W_1) - W_3 - W_4)}\right) = 1.344$$

RESULTS AND DISCUSSION

The Specific gravity and Fineness modulus of cement, fine aggregate and coarse aggregate lie well within the specified range as per IS codes. The compressive strength of M30 & M40 Concrete cubes is recorded. Taking into consideration the weight and the conductive nature of concrete various properties are to be verified. The results are being published in further two stages: Initial stage and Final stage.

Initial stage

As discussed above, with the replacement of sand with burnt coconut shell powder water cement ratio is changing. Table 2 shows the variation of water content with various

replacements of sand with burnt coconut shell powder. After curing for 7, 14 and 28 days, the compression test is performed and the bearing load is calculated.

Final stage

In this stage, the mix design for 10%, 20% and 30% replacement is finalised taking into account the water cement ratio and specific gravity of burnt coconut shell powder. Sand is replaced with burnt coconut shell powder on volume basis. The values shown in Table 3 are per m^3, the values are converted according to the size of the moulds (150 x 150 x 150). Nine cubes for each replacement percentage of burnt coconut shell powder are casted and kept for curing. After curing for 7, 14 and 28 days, the cubes are being tested for compression in compression testing machine. Fig. 1 and 2 shows the compressive strength comparison for conventional, 10%, 20% and 30% replacement among each other.

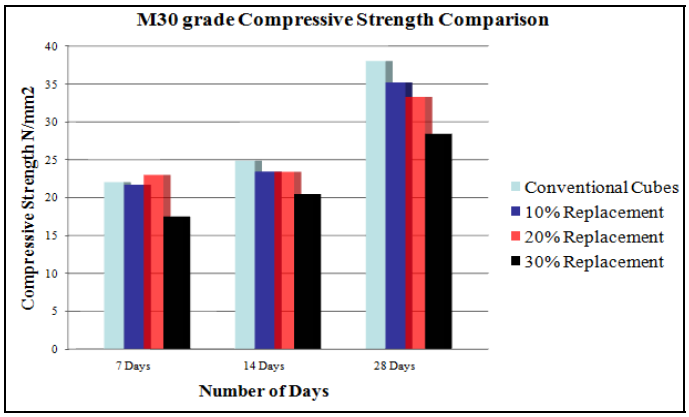

Fig. 1: Conventional values vs. replaced values for M30 Grade

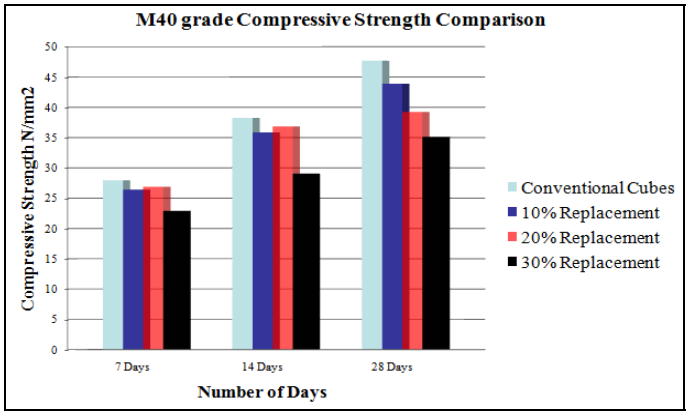

Fig. 2: Conventional values vs. replaced values for M40 grade

CONCLUSION

The tests on burnt coconut shell powder indicate that it is finer than sand and is light in weight as compared to sand. Moreover, it provides extra carbon for the formation of Silica Gel which acts as binding material but due to immediate formation of CO_2 a retarder is to be used to get more quantity of carbon. A study is done on the effect of using various percentages of burnt coconut shell powder in the production of concrete. It is noted that the compressive strength of concrete has a trend in reduction with increasing percentages of burnt coconut shell powder. The concrete obtained by replacing burnt coconut shell powder with sand till 20% can be used for the construction of retaining walls and non - load bearing structures. Using burnt coconut shell powder in concrete production may help solve a vital environmental issue apart from being a solution to the problem of inadequate fine aggregates in concrete. According to the results obtained by the compressive tests, the concrete developed after adding burnt coconut shell powder till 20% can be used as a replacement of conventional concrete in case of any emergency.

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