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RESEARCH ARTICLE OPEN ACCESS

Effect of Eggshell Powder and Coconut shell Aggregate on M40 and M50 grades of concrete

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ABSTRACT
Concrete is widely used construction material in the world. Utilization of concrete is increasing at higher rate Most of the ingredients of Concrete are extracted from natural resources. To reduce the use of these natural resources some other alternatives, which are ecofriendly materials are to be explored .In the present study coconut shell aggregate is used as replacement for coarse aggregate and egg shell powder is used as replacement of cement.

In this study, the properties of concrete with 5% replacement of cement with egg shell powder and 2.5%, 5%, 10% partial replacement of coarse aggregate with coconut shell for M40 and M50 grades of concrete were studied. A total of 72 cubes were casted and their properties such as workability, compressive strength, impact strength, density of concrete were evaluated. The results were analyzed and compared with the conventional concrete. The results showed that the compressive strength of coconut shell mix concrete existed to be more or less equivalent to the conventional concrete.

Keywords – Coconut shell aggregate, Compressive strength, Egg Shell powder

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I. INTRODUCTION

The Construction industry is playing a vital role in the deterioration of the environment by depleting natural resources, utilizing huge quantities of energy from fossil fuels and also generating large volumes of by-products. Conventional concrete production which uses cement as a constituent is one of the major contributors for emissions of greenhouse gases. With increasing concern over the excessive exploitation of natural resources, coconut shell aggregates and egg shell powder which are produced from environment waste are viable new sources of structural aggregates and binding material. The Indian sub-continent produces more than 10 crore tons of coconuts in the world ,which is the third largest producer. A lot of these have importance in our culture and religion. The coconut is extracted and the shells are thrown away. These coconut shells are dumped into landfills or burnt which poses a threat to the environment .Annual egg shell production in India is 1.61 million. Eggs used in different domestic uses produces eggshell as a waste material which is to be dumped into land fils.

In the present study coconut shells are used as a partial replacement for coarse aggregates and egg shell powder is used as partial replacement for cement in concrete to reduce waste products in the environment and find a sustainable alternative for non-renewable natural stone aggregates and cement.

II. MATERIAL DESCRIPTION

A. Materials

Ordinary Portland cement 53 grade is used for the present work. The specific gravity of cement was found out in the laboratory and is obtained as 2.54. River Sand with maximum size of 4.75 mm and specific gravity 2.54 was used in our experimental work. Based on sieve analysis and according to IS 383:1970, fine aggregate is of Zone II. Coarse aggregates of nominal size 20mm and sub round in shape are used for the experimental work with specific gravity of 2.78. Coconut shells used for partial replacement of coarse aggregates was passing through 20mm and retained on 10mm IS sieve. Specific gravity of coconut shells was found to be 1.28.

B. Specific Gravity

The specific gravity of all the materials has been tested in the laboratory using specific gravity bottle for cement and pycnometer for fine aggregate, coarse aggregate and coconut shells and the results are as follows:

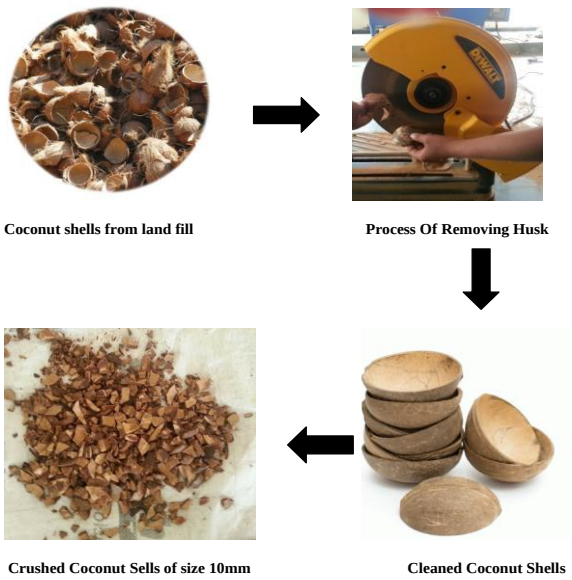

Figure 1. Preparation of Coarse aggregate

TABLE 1: Specific Gravity Of The Materials

Materials	Specific Gravity
Cement	2.54
Fine Aggregate	2.54
Coarse Aggregate	2.78
Coconut Shells	1.28
Egg shell	0.65

III. MIX DESIGN

Mix design is carried out for M40 and M50 grade concrete as per IS 10262 -2009 for Nominal concrete; concrete with 2.5%, 5%, 10% replacement of coarse aggregates and replacement of cement by Egg shell powder. 20mm sub rounded aggregate. Exposure condition is severe. Mix Id is assigned for different percentage replacements. For each mix Id 9 cubes are casted to test 7, 14 and 28 days strength.

TABLE 2: Mix Proportions

Mix Id	Mix Design	Replacement of cement with egg shell powder	Replacement of coarse aggregate with coconut shell	Cement (Kg)	FA(Kg)	CA-C(Kg)	CA(Kg)
OPC1	M40	0%	0%	11.27	19.47	-	34.87
OPC2		5%	2.5%	11.27	19.47	0.84	33.03
OPC3		5%	5%	11.27	19.47	1.64	31.29
OPC4		5%	10%	11.27	19.47	3.22	28.09
OPC5	M50	0%	0%	12.52	18.54	-	34.53
OPC6		5%	2.5%	12.52	18.54	0.83	32.71
OPC7		5%	5%	12.52	18.54	1.63	30.99
OPC8		5%	10%	12.52	18.54	3.09	27.82

IV.EXPERIMENTAL PROCEDURE

Concrete cubes of sizes 150mm x 150mm x 150mm were prepared with different percentage replacement of coarse aggregate Concrete is placed in cube moulds in 3 layers by tamping each layer with 25 blows. The concrete is removed from moulds after 24hrs and placed in water for curing Cleaned and surface dried specimens were placed in the testing machine. The platen was lowered and touched the top surface of the specimen. Compressive strength test of cubes is tested at the age of 7,14and 28 days respectively as per IS:516:1959. Workability test is conducted using slump cone as per IS:1199-1959.

4.1 Impact Test

Impact strength of aggregates according to IS 283-1970 specifies that the aggregate impact value should not exceed 30%.

Table 3: Impact Test Values For Coarse Aggregates & Coconut Shells

Aggregate Type	Wt of Empty Mould (gms)	Wt of Mould + Aggregates (gms)	Impact Value = Difference in wts / Initial wt x 100
Coarse Aggregate	1908	2457	28.77
Coconut shells	1908	2087	9.3

Figure 2: Placing Of Concrete

Figure 3: Cube compressive testing on hardened concrete

4.2 Tests On Hardened Concrete
Test Result of Compressive Strength for M40, M50 Grade Nominal Mix and for concrete mixes of various percentages of coarse aggregate replaced by coconut shell and cement replace by Egg shell powder.

TABLE 4 : Compressive Strength of different mixes of M40 and M50 Grades of concrete

Mix ID	MIX DESIGN	REPLACEMENT OF CEMENT WITH EGG SHELL POWDER %	REPLACEMENT OF COARSE AGGREGATE WITH COCONUT SHELL %	COMPRESSIVE STRENGTH(MPA)		
				7 DAYS	14 DAYS	28 DAYS
OPC1	M40	0%	0%	38.67	45.44	51.79
OPC2		5%	2.5%	41.86	51.78	56.15
OPC3		5%	5%	38.61	47.27	51.56
OPC4		5%	10%	33.44	42.35	45.99
OPC5	M50	0%	0%	43.64	59.26	66.78
OPC6		5%	2.5%	46.32	63.17	67.30
OPC7		5%	5%	39.96	54.27	64.09
OPC8		5%	10%	35.09	45.55	48.56

V. RESULTS AND DISCUSSIONS

5.1 Test Results on Fresh Concrete

The slump is a measure indicating the consistency or workability of cement concrete. Slump cone test was conducted on fresh concrete mixes of all percentages to check the slump value of fresh concrete was in the range of 25 – 50 mm in this experimental work. The obtained results were tabulated as follows.

TABLE 5: Slump Values for different mixes

Mix Id	Slump(mm)
OPC1	40
OPC2	30
OPC3	30
OPC4	25
OPC5	40
OPC6	40
OPC7	30
OPC8	28

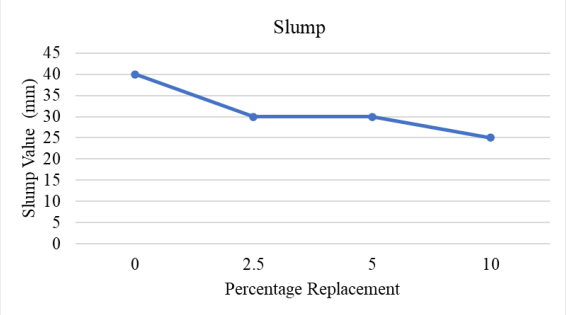

Figure 4: Variation Of Slump for different mixes of M40 Grade

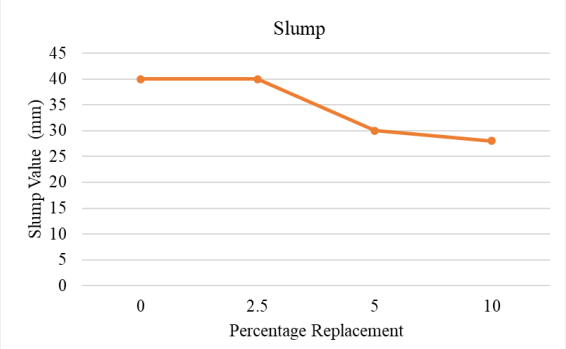

Figure 5: Variation Of Slump for different mixes of M50 Grade

The concrete mix of both the grades had slump values between 25-50 mm. The trend in Fig 4 and Fig 5 shows the slump decreased with increase in Coconut Shell percentage and addition of egg shell powder. This observation suggests that addition of Coconut Shell and egg shell powder decreases the workability. The decreased workability of Coconut Shell concretes may be due to their particle shape as compared to the nominal mix concrete.

5.2 Test Results On Hardened Concrete

The compressive strength of concrete from table 4 shows that the strength of the concrete increased with age. The 7 days strength for all the replacements of egg shell and coconut shell is found to be 70% to 75% of the target strength which is same as that of conventional concrete. From 14days to 28days the strength gain of all the mixes is 9% to 10% which is same as that of nominal concrete.

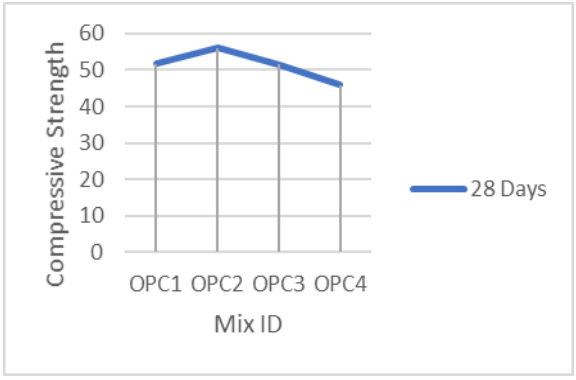

Figure 6: Compressive Strength of different mixes M40 Grade

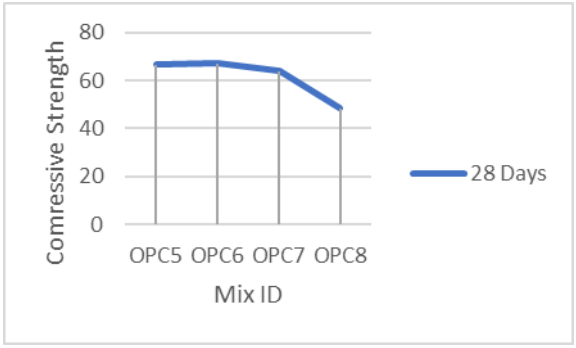

Figure 7: Compressive Strength of different mixes of M50 Grade

The trend from Fig 8 shows the compressive strength is maximum at 2.5% coconut shell and 5% eggshell for M40 grade mix .The increase in strength is 8.4% compared to nominal M40 mix. The compressive strength decreased for 5%and 10% replacement of coconut shell with a maximum decrease of 11% in 10% coconut shell replacement The trend from Fig 9 shows the compressive strength at 2.5% coconut shell and 5% egg shell for M50 grade of concrete is almost same as that of nominal M50 grade of concrete. The compressive strength decreased for 5% and 10% replacement of coconut shell with a maximum 27% decrease in strength at 10% replacement of coconut shell.

5.3 Density for different mixes of M40 and M50 grades

TABLE 6: Density of M40 and M50 Mix

Mix Id	Density (Kg/m^3)
OPC1	2408.8
OPC2	2375.7
OPC3	2368.2
OPC4	2280.8
OPC5	2425.1
OPC6	2365.0
OPC7	2353.1
OPC8	2273.1

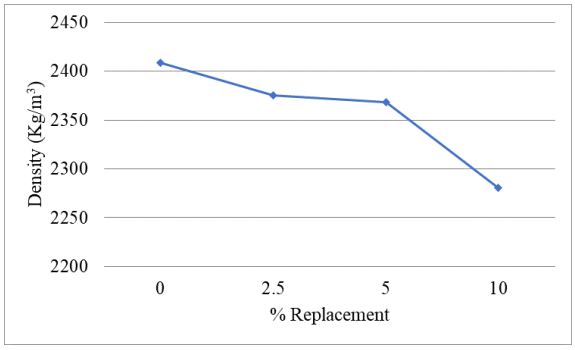

Figure 8: Density of different mixes of M40 Grade concrete

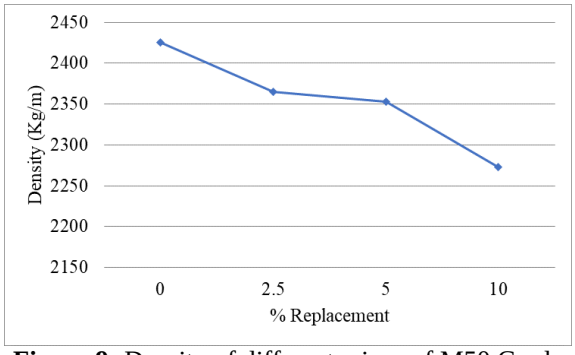

Figure 9: Density of different mixes of M50 Grade

The trend of the Fig 10 shows that as the percentage replacement of coconut shells increases, the density of the concrete decreases consequently. By comparing the density of percentage of partial replacements of coconut shells with nominal mix the density of 2.5%, 5% and 10% replacements are 1.37 %, 1.6% , 5.3% respectively of the conventional concrete for M40.

From fig 11 by comparing the density of partial replacements of coconut shells with nominal mix the density of 2.5%, 5% and 10% replacements are 2.4 % ,2.9% , 6.2 % respectively of the M50 conventional concrete.

VI .CONCLUSION

- The maximum compressive strength was attained at 2.5 % replacement (of coconut shells) along with 5% replacement of cement with Egg shell powder. While the minimum strength was attained at 10 % replacement. The long-term compressive strength, however is likely to exceed, considering the strength development trends.
- As the impact strength of aggregates according to IS 283-1970 specifies that the aggregate impact value should not exceed 30% by weight for concrete for wearing surfaces. The impact value of coconut shells obtained was less than 10% which is exceptionally good which acts as a strength inducing parameter.
- Increase in percentage replacement by coconut shell and egg shell reduces the workability of concrete.
- Coconut shell exhibits more resistance against impact compared to crushed coarse aggregates.
- Density reduced with increase in percentage replacement of coconut shell.

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