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A Study on Partial Replacement of Coarse Aggregate with Coconut Shells and full replacement of Natural Sand with Robo Sand

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Abstract

Now-a-days cost of construction materials are affecting the economy of all structures. It is a dominating factor affecting environmental housing system around the world. Conventional aggregates namely gravel, and fine aggregate is sand in concrete will be used to control. While natural aggregate is coconut shell as coarse aggregate will be investigated to replace the aggregate in concrete and Robo sand (Stone dust) as fine aggregate will be replace the sand in concrete. In this investigation, M25 grade of concrete with combination of natural material coconut shell content as Coarse aggregate in the proportion of 0%,5%,10%,20% & 25% will be replaced and Robo sand (stone dust) as fine aggregate with full 100% replacement of natural sand, sample specimens are prepared and will be tested for workability, compressive strength and split tensile strength for 7,14 and 28 days respectively and also showing the comparative results with Conventional M25 grade concrete. By this project investigation, concrete may be less dense, light weight concrete by coconut shells and good quality of concrete by Robo sand.

Keywords: *coconut shell, coarse aggregate, Robo sand, compressive strength, split tensile strength, replacement, workability & light weight concrete.*

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I. INTRODUCTION

The three basic needs of man are food, clothing, and shelter. Civil Engineer has relevance with all basic needs of man directly or indirectly. Production of concrete is increasing due to high growth of infrastructure development and construction activities in the world, Production of concrete demands its constituents like aggregates, cement, water, and admixtures. Sources of conventional aggregates occupy a major part of the concrete. The large-scale production of concrete in construction activities using conventional coarse aggregate. Use of natural aggregates in such a rate leads to a question about the preservation of natural aggregates sources. Considering this in the contemporary civil engineering construction, using alternative materials in place of natural aggregate in concrete production makes concrete as sustainable and environmentally friendly construction material.

Coconut is grown in most of the countries. Coconut shell being a hard and not easily degrade material if crushed to size of sand can be a potential material to substitute sand. By replacing the stone aggregate in concrete which possesses the potential of being used in lightweight construction. Coconut shell concrete has better workability because of the smooth surface on one side of the shell. Structural lightweight aggregate concrete is a significant and resourceful material in up-to-date construction.

As the demand for Natural River sand is surpassing the availability, has resulted in fast depletion of natural sand source. An experimental study was undertaken to find out the effects of various proportions of dust content on properties of fresh concrete and hardened concrete. Thus a investigation is needed to identify suitable substitute that is eco-friendly, inexpensive and better for strength and durability performance.

Robo sand which is popularly known as quarry dust which is available from the crushed stone quarries. Use of robo sand is the solution for the problem of conserving the natural sand and some states have been already banned the use of river sand for construction. As per reports, Robo sand is widely using entire the world for all the projects around the world insist on define use of Robo sand as replacement of natural sand.

II. LITERATURE REVIEW

[1]. As per Akshay s. shelke (2014), coconut shell exhibits good resistance against crushing, impact and abrasion, the partial replacement of coarse aggregate with coconut shell to produce the lightweight concrete. There is no need to treat the coconut shell before use. Coconut shell is compatible with cement and it produces dry density less than 2000 kg/m3.

[2]. S. Rukmangadhara Rao (2015) has reported that he had replaced the natural sand by 0%, 50%, 75% and 100 % respectively. The compressive strength of concrete specimens made with 50%replacementof river sand by Robo sand gives higher strength of 12% to 15% and with 100% replacement gives a higher strength of 3% to 4% as compared to reference mix. By replacement of natural sand with Robo sand, the cost of the construction can be reduced to10% per cum. Higher results then the normal conventional concrete.

[3]. Ismail saisfulla (2017) reported that Coconut shells can be used as partial replacement for the conventional stone aggregates in concrete production. In terms of strength, 20% crushed stone chips can be replaced with coconut shells to produce structural lightweight concrete as per the requirements provided by American Concrete Institute.

[4]. As per Sravika.V and G. Kalyan (2017), The compressive strength of the CS10%+QD30% and CS20%+QD30% was 24.35N/mm2 and 24.98 N/mm2, split tensile strength is 3.454N/mm2 and 3.499N/mm2. The strength of the concrete increases with increase in percentage of coconut shell up to 20% .and there is gradual decrease at 30% replacement. The strength of the Coconut shell and Quarry dust CS10%+QD30% and CS20%+QD30% concrete is increasing comparatively with normal concrete. So, we conclude that the coarse aggregate and fine aggregate replaced with coconut shell aggregate.

[5]. Anand Ramesh (2018) is reported that he is replace the coarse aggregate by 5% and 10% by the coconut shells, there was a rise in compressive strength at 28 days curing time for 5% but strength lowered for 15% replacement of coarse aggregate with coconut shell. Splitting tensile strength decreased for 5% replacement of coarse aggregate with coconut shell.

III. MATERIALS USED

In the present investigation, the following materials are used:

1. Ordinary Portland cement 53 grade
2. Robo sand (Quarry dust) as Natural sand
3. Crushed stone as Coarse aggregate of size 20mm
4. Coconut shells as partial replacement of Coarse aggregate
5. Water

IV. PROPERTIES OF MATERIALS

1.1 Ordinary Portland Cement

1.1.1 Ordinary Portland cement is the most common type of cement in general use around the world. Portland cement was developed from natural cements made in Britain beginning in the middle of the 18th century. Its name is derived from its similarity to Portland stone, a type of building stone quarried on the Isle of Portland in Dorset, England. The most common use for Portland cement is in the production of concrete. Concrete is a composite material consisting of aggregate (gravel and sand), cement, and water.

Table 1: Properties of Ordinary Portland Cement 53 grade

SL.NO.	TESTS	RESULT	SPECIFIED LIMITS
1	Specific Gravity of Cement	3.0	3.15
2	Consistency of Cement	32%	27 - 33 %
3	Initial &Final Setting of Cement	45 min& 9 h. 40 min	Above 30 min & below 10 hours
4	Fineness of cement	6 %	Less than 10 %

1.2 Robo Sand

1.2.1 Well graded crushed stone powder passing through 4.75 mm was used as fine aggregate. The stone dust was air-dried and sieved to remove any foreign particles prior to mixing. We are conducting tests on stone dust are Water Absorption Capacity, Specific Gravity and Fineness Modulus of stone dust aggregate.

Table 2: Properties of Robo Sand

SL.NO.	TEST	RESULT	SPECIFIED LIMITS
1	Specific Gravity	2.69	2.5-3.0
2	Water Absorption	2.4%	Not exceed 3%
3	Fineness Modulus	2.77	Fine sand 2.2 - 2.6, Medium sand 2.6 - 2.9 and Coarse sand 2.9 - 3.2

1.3 Crushed stone aggregate and Coconut shell Aggregate

1.3.1 Normal aggregate that is crushed granite of maximum size 20 mm was used as coarse aggregate. We are conducting tests on coarse aggregate are Water Absorption Capacity, Specific Gravity and Fineness Modulus of coarse aggregate.

1.3.2 Global production of coconut is 51 billion nuts from an area of 12 million hectares. Coconut shells which were already broken into two pieces were collected from local temple; air dried for five days approximately at the temperature of 25^0 to 30^0 C. The material will be crushed manually and passed through 12.5mm sieve and retained on 20 mm sieve was used to replace coarse aggregate with coconut shells. The material retained on 12.5mm sieve was discarded.

Table 3: Properties of Coconut shells and Crushed stone aggregate

SL.NO.	TEST	RESULTS		SPECIFIED LIMITS
		COCONUT SHELLS	CRUSHED STONE	
1	SPECIFIC GRAVITY	1.4	2.75	2.5-3.0
2	WATER ABSORPTION	6%	0.5%	Not more than 2 %
3	AGGREGATE IMPACT VALUE	4.8%	19.6%	Less than 20% exceptionally strong
4	AGGREGATE CRUSHING VALUE	3%	26.8%	For CC should not exceed 30%
5	AGGREGATE ABRASION VALUE	2.1%	23.5%	For CC should not exceed 30%

IV. DESIGN MIX PROPORTIONS AS PER IS 10262:2009

Table 4: Trial mix proportions of M25 grade Coconut shell Robo Concrete

Sl.No.	% of Coconut shell & % of Robo sand	Type of Material (in kg)					Density of wet concrete (kg/m3)
		Cement	Robo sand	Coarse aggregate(stone)	Coconut shell	water	
1	0% CS + 0% RS	437	637	1114	0	214	2402
2	5% CS + 100% RS	437	693	1025	22	218	2395
3	10% CS + 100% RS	437	693	971	44	219	2364
4	15% CS + 100% RS	437	693	916	67	220	2333
5	20% CS + 100% RS	437	693	863	89	221	2303
6	25% CS + 100% RS	437	693	809	111	222	2272

V. RESULTS AND DISCUSSION

Below tables and graphs shows that analysis of workability, Compressive strength and split tensile strength of concrete of M25 grade mix concrete for 7, 14 & 28 days with the replacement of coconut shell as coarse aggregate by 0%, 5%, 10%, 15%, 20% & 25% respectively and natural sand with Robo sand (100%).

1.2 Workability

1.2.1 Slump test – It is to be done to check the normal consistency of concrete and uniform quality of concrete.

Table 4: Below table shows the values of Slump

% Coconut Shell	% Robo Sand	Slump Value (mm)
0	0	94
5%	100%	95
10%	100%	99
15%	100%	104
20%	100%	96
25%	100%	90

Figure1: Slump test

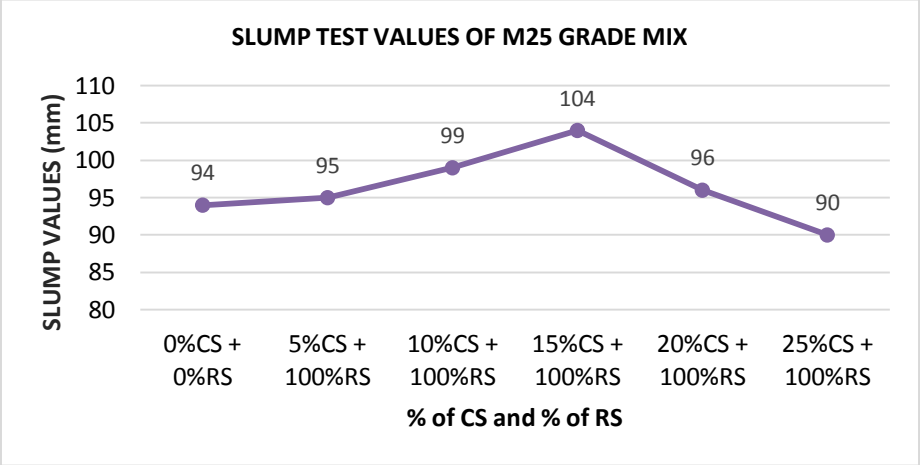

Figure2: Flow chart showing Slump test values

1.3 Compressive Strength Test

1.3.1 Compression strength – Compression test is carried out to know the resistance of concrete against compression. It should be done on cubes for 7 days, 14 days and 28 days respectively.

Figure3: Compression test on cube

Table 5: Below table shows the values of Compression strength

Sl.No.	% of Replacement of aggregates	Compressive Strength (N/mm2)		
		7 days	14 days	28 days
1	0 % CS + 0 % RS	15.84	26.14	27.54
2	5 % CS + 100 % RS	16.20	26.46	28.14
3	10 % CS + 100 % RS	16.44	26.87	28.60
4	15 % CS + 100 % RS	17.02	27.08	28.78
5	20 % CS + 100 % RS	16.48	26.54	28.04
6	25 % CS + 100 % RS	15.80	25.28	27.49

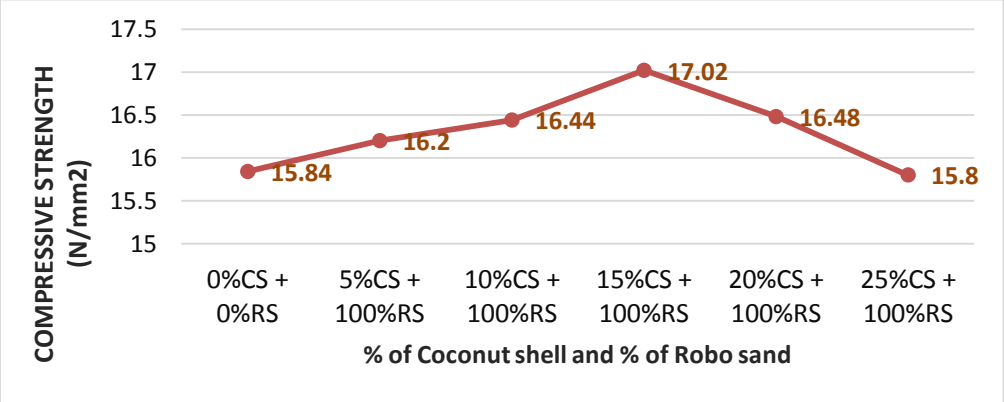

Figure4: Compression test values for only 7 days

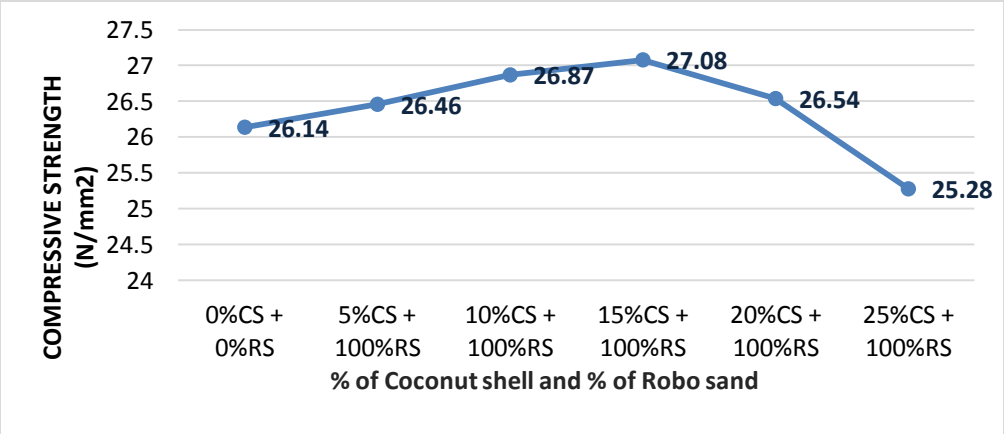

Figure5: Compression test values for only 14 days

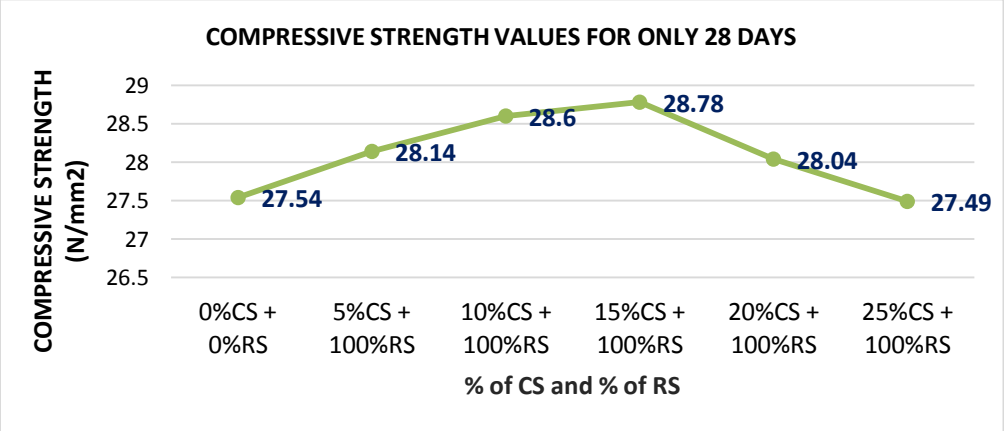

Figure6: Compression test values for only 28 days

1.4 Split Tensile Strength Test

1.4.1 Splitting tensile strength test - It is done on concrete cylinder size of 100mm x 300mm. The cylinders were tested as same as concrete cubes process and conducted test for 7,14 & 28 days. The concrete is weak in tension due to brittle in nature and is not expected to resist the direct tension. So, it is necessary to determine the tensile strength load at which the concrete may develop cracks.

Figure7: Split tensile test on cylinder

Table 5: Below table shows the values of Compression strength

Sl.No.	% of replacement of aggregates	Split tensile strength (N/mm2)		
		7 days	14 days	28 days
1	0 % CS + 0 % RS	2.78	3.47	3.52
2	5 % CS + 100 % RS	2.85	3.55	3.59
3	10 % CS + 100 % RS	2.88	3.59	3.64
4	15 % CS + 100 % RS	2.91	3.62	3.72
5	20 % CS + 100 % RS	2.86	3.57	3.68
6	25 % CS + 100 % RS	2.81	3.52	3.65

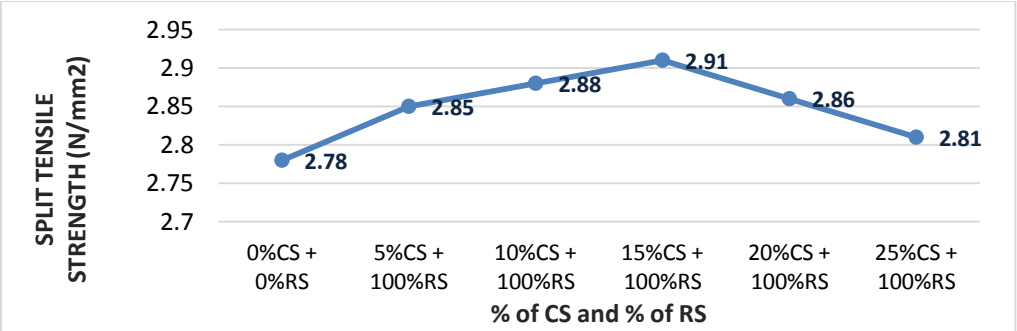

Figure7: Split tensile test values for only 7 days

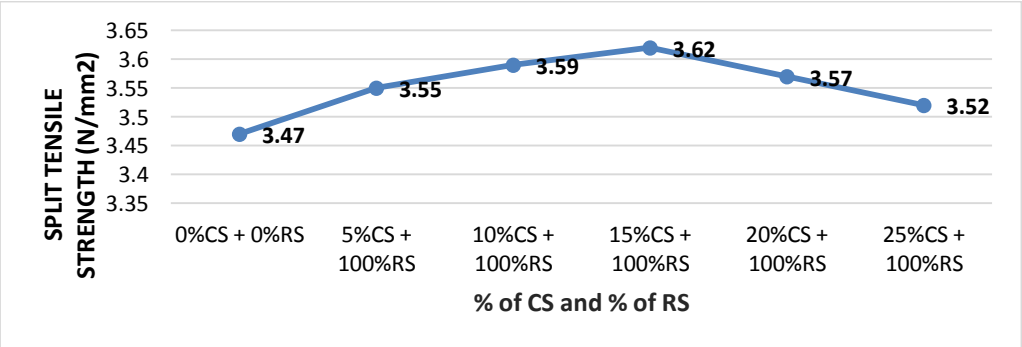

Figure8: Split tensile test values for only 14 days

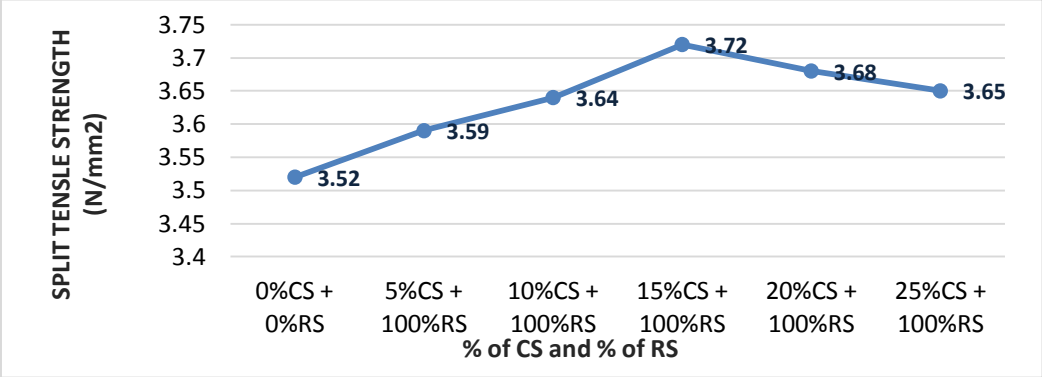

Figure9: Split tensile test values for only 28 days

V. CONCLUSION

1. By replacing the Coconut shell and Robo sand, the strength of M25 grade mix concrete from 5%CS+100%RS to 15%CS+100%RS is comparatively increasing with normal concrete.
2. The compressive strength of 5%CS+100%RS, 10%CS+100%RS & 15%CS+100%RS was 28.14N/mm2, 28.60N/mm2 & 28.78N/mm2 and split tensile strength is 3.59N/mm2, 3.64N/mm2 & 3.72N/mm2.
3. The strength of concrete is gradually increasing with increase in Coconut shell percentage from 5% to 15% and maintain robo sand constant (100%) and there is gradual decrease at 20% and 25% replacement.
4. The density of concrete is decreasing with increasing % of coconut shell, thereby it exhibits under structural light weight concrete occurs.
5. Coconut shell exhibits more resistance against crushing, impact and abrasion compared to crushed granite aggregate. Coconut shell is compatible with the cement.
6. By using the Stone dust in concrete, it improves the quality of concrete and gives good strength and conserve the natural river sand for future generation.
7. Hence, we concluded that Robo sand and Coconut shell would be used as replacement of fine aggregate and coarse aggregate.

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