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Experimental Study on Partial Replacement of Coarse Aggregate by Coconut Shell and Fine Aggregate by Quarry Dust in Concrete

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Abstract – In developing countries where concrete is widely used, the high and steadily increasing cost of concrete has made construction very expensive. The production of concrete requires various materials like Cement, Fine aggregate and Coarse Aggregate .Due to extensively use of concrete which lead to an increase in cost of materials. Therefore an alternate material is used for partial replacement of Fine aggregate and coarse aggregate in concrete. This project is experimented to reduce the cost of concrete. In this research work experiments have been conducted with collection of materials required and the data required for mix design are obtained by sieve analysis and specific gravity test. Sieve analysis is carried out from various fine aggregates (FA) and coarse aggregates (CA) samples and the sample which suits the requirement is selected. Specific gravity tests are carried out for fine and coarse aggregate.

In this project Fine aggregate is replaced by Quarry dust of 30 % along with the partial replacement of coarse aggregate with coconut shell. The coarse aggregate is replaced with 10 %, 20%, 30% and 40 % by coconut shell. The design Mix used for the project is M20 grade (1:1.5:3) with W/C Ratio 0.5.The Conventional concrete and Coconut shell with quarry dust concrete specimens were casted and tested for compressive strength and split tensile strength for 7 and 28 days 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/mm^2.

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1. INTRODUCTION

Concrete is the civil engineering construction material. Its manufacturing involves the utilization of ingredients like cement, sand, aggregates, water and admixtures. The Demand for the construction material is increasing day by day due to the infrastructural development across the world. During coarse aggregate production greenhouse gases emission are produced which are major concern for global warming and climate change .Excavating of Fine aggregate causing environmental problems such as water retentions in lakes and rivers. Therefore, there is a need to find some alternate or sustainable materials to use concrete mix.

Day to day different types of waste materials production is increasing and creating many environmental issues. Making use of these waste materials in manufacturing of concrete will decrease environmental pollution and the cost of concrete. The concrete mixture consists of coarse and fine aggregate. Coarse aggregate is naturally available and factory crushed. Fine aggregate is often obtained from river beds. This became very scarce as the Government of Telangana has imposed ban on the mining of the same due to the environmental hazards. The quality of the river sand normally depends on its source and most of the time it varies quite a lot. As the use of fine aggregate in concrete is more than 30% of the composite, its mechanical properties affect the quality of concrete. The alternative material should be waste materials in the aspects of reduction in environmental load and waste management cost, reduction of production cost of concrete. Hence crushed sand has been identified as a substitute for river sand and coarse aggregate occupy more than 30% in concrete there for coarse aggregate is partially replaced by coconut shell in concrete by this agriculture waste material get reduced and minimize environment problems.

Production of cement Coconut shell and quarry dust in India

1.1 Cement

The composition of World Cement Consumption in the year 2012 is 3,313Million Metric Tons. Among that 7.0 % in India, 57.7 % in China, 9.4% in Developed Countries,25.9% in Other Emerging.

1.2 Coconut shell

India is the third largest producer of coconut products in the world. Coconut trees are widely cultivated in the southern states of India, especially Kerala. Kerala got its name itself derived from a word,'kera' meaning coconut tree.

Traditional areas of coconut cultivation in India are the states of Kerala, Tamil Nadu, Karnataka, Pondicherry, Andhra Pradesh, Goa, Maharashtra, Odisha, West Bengal and the islands of Lakshadweep and Andaman and Nicobar. The composition of Coconut Production in India in the year 2009 is 10,894,000tonnes.Traditional areas of coconut cultivation are the states of Kerala (45.22%), Tamil Nadu (26.56%), Karnataka (10.85%) and Andhra Pradesh (8.93%).

Kerala is densely populated state and most of its population uses coconut or it's byproducts in their daily activities. Coconut shells thus get accumulated in the mainland without being degraded for around 100 to 120 years. Disposal of these coconut shells is therefore a serious environmental issue. In this juncture, the study on use of coconut shells ash as a substitute or replacement of cement in concrete is gaining importance in terms of possible reduction of waste products in the environment and finding a sustainable alternative for non-renewable natural stone aggregates.

Fig:1.1 coconut shells

1.3 Quarry dust

Quarry dust, a byproduct from the crushing process of stones which is available abundantly from rock quarries at low cost in many areas can be an economical alternative to the river sand. Quarry dust can be defined as residue, tailing material after the extraction and processing of rocks to form fine particles less than 4.75 mm. Quarry dusts, which is generally considered as a waste material, causes an environmental load due to disposal problem. Quarry dust being by and large, a waste product, will also reduce environmental impact, if consumed by construction industry in large quantities. Hence, the use of quarry dust as fine aggregate in concrete will reduce not only the demand for natural sand but also reduce environmental problems. Moreover, the incorporation of quarry dust will offset the production cost of concrete and hence, the successful utilization of quarry dust as fine aggregate will turn this waste material into valuable resource.

Fig: 1.2 Coconut Shells

2. MATERIALS USED

2.1 Cement

The most important use of cement is the production of mortar and concrete, which is a combination of cement and an aggregate to form a strong building material that is durable in the face of normal environmental effects. In the present investigation OPC 53 grade cement is used

S. No.	Properties	Values Obtained
1	Specific gravity	3.15
2	Standard consistency	35%
3	Initial setting time	65 min
4	Final setting time	300 min

Table 2.1: Results of Tests on Cement

2.2 Aggregate

Sand is naturally occurring granular material composed of finely divided rock and mineral particles. The most common constituent of sand is silicon dioxide, usually in the form of Quartz. Normally fine aggregate is used as fine aggregate for

preparing concrete. The aggregate which passed through 4.75mm is called fine aggregate. The aggregate which retained above 4.75mmseive is called coarse aggregate .20mm size aggregate is used

Table 2.2: Results of Tests on Fine Aggregate

S. no	Properties	Values
1	Specific gravity	2.6
2	Water absorption	0.82%
3	Zone	II

Table 2.3: Results of Tests on Coarse Aggregate

S. No	Properties	Values
1	Specific gravity	2.65
2	Fineness modulus	2.2
3	Water absorption	0.19%

2.3 Coconut shell

Coconuts are referred to as "man's most useful trees", "king of the tropical flora" and "tree of life". Coconuts or its scientific name cocosnucifera are the most important of cultivated palms and the most widely distributed of all palms. Coconut shells are cheap and readily available in high quantity. The coconuts were broken manually to drain out the water. The coconut half shells were sun-dried for three days. The cleaned coconut shells obtained from vemulawada temple karimnagar were cut into pieces of 20mm size dimensions.

Fig : 2.1 Crushed Coconut Shell

Physical Properties of Coconut Shell Aggregate

S. No	Physical Property	Test Results
1	Specific Gravity	1.33
2	Water Absorption (%)	24
3	Bulk Density(kg/m)	800
4	Shell Thickness	(2-7)mm

Table 2.4: Results of Tests on coconut shell Aggregate

2.4 Quarry Dust

Quarry dust is a product obtained from aggregate crushing plant, where the rocks are made Processed to form fine particles of less than 4.75 mm. The production of quarry dust Plants. where there are nearly about 14 crushing plants located in Karimnagar.

Table 2.5: Properties of Quarry Dust

Properties of Quarry dust		
1	Quarry dust Specific gravity	2.57
2	Fineness modulus	2.41
3	Density	1.85gm/cc

3. EXPERIMENTAL INVISTIGATION

3.1 GENERAL

In the present study we are partially replacing the coarse aggregate by coconut shell a (CS) and fine Aggregate by Quarry Dust for M20 Grade concrete in different percentages 0%, 10%+30%, 20%+30%, 30%+30%, and 40%+30%,are casted 15 no of cubes of 150mm x 150mm x150mm and 15 No 150mm x 300mm cylinder. To achieve the objectives of the investigation the experimental program was planned to cast around 30 No of Specimen. And the specimen were tested under 200 ton compression testing machine to study the compressive strength and split tensile strength of the specimen, The details of the experimental program is shown below.

3.2 Mix Proportion

The concrete mixture proportions for M20 Grade concrete are 1:1.5:3 and water cement ratio 0.5, the specimen were casted using varying CS + QD Ratio. The Coarse aggregate replaced by CS and QT (30%) constant in different Percentage

Table No: 3.1 Mix Proportion

% CS+QD	Coarse Aggregate		Fine aggregate	
	% Coarse Aggregate	% Coconut SHELL	% Fine Aggregate	% Quarry Dust
0%+0%	0	0	0	0
10%+30%	90	10	70	30
20%+30%	80	20	70	30
30%+30%	70	30	70	30
40%+30%	60	40	70	30

4. TEST & RESULTS

4.1 Workability test

Slump test

Ingredients of mixes are properly mixed so as to produce homogeneous and uniform fresh concrete in macro-scale in order to know its workability using slump test. The results of same test for the conventional concrete and various CS and QT 30% concrete are shown in table 4.1.

% coconut Shell	% Quarry Dust	Slump (mm)
0	0	60
10	30	66
20	30	70
30	30	69
40	30	75

Table 4.1 Slump Test

4.2 Compressive Strength of Concrete Cubes:

This test is done to determine the cube strength of concrete mix prepared. The test is conducted on the 7th day and the 28th day and its observation are listed below in the form of a graph. Compressive strengthvalues with replacement for coarse aggregates by coconut shell with 10%, 20%, 30% and 40% and Fine aggregate by quarry dust with 30%.

Table No: 4.2 Compressive Strength of Concrete Cubes

S.No	% OF REPLACEMENT OF CS + QD	Compressive Strength (N/mm2)	
		7th Day	28th Day
1	0%	16.21	22.82
2	CS 10% + QD 30%	17.01	24.35
3	CS 20% + QD 30%	16.9	24.98
4	CS 30% + QD 30%	15.61	23.31
5	CS 40% + QD 30%	13.9	21.12

4.3 Tensile strength of cylinder: This test is done to determine the tensile strength of the cylinders. The test is conducted on the 7th day and the 28th day and its observation are listed below in the form of a graph. The cylinder is placed in a horizontal position and the load is applied gradually and value is recorded if the cylinder splits into two half or if the cylinder fails while applying the load on it.Tensile strength values with replacement for coarse aggregates by coconut shell with 10%, 20%, 30% and 40% and Fine aggregate by quarry dust with 30%.

Table No: 4.3 Split Tensile Strength of Concrete

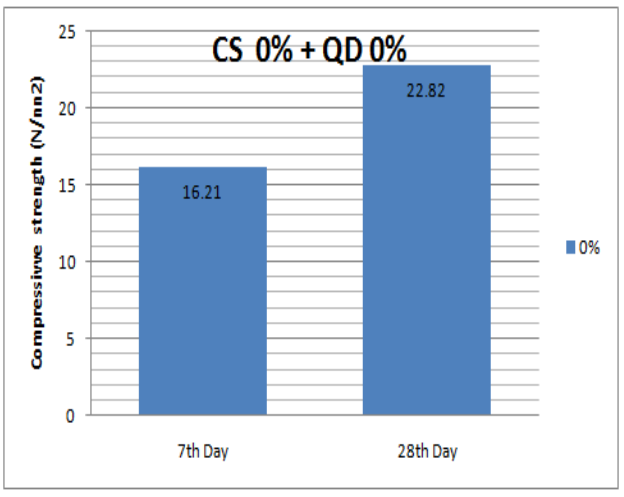
S.No	% OF REPLACEMENT OF CS & QD	Split Tensilw Strength (N/mm2)	
		7th Day	28th Day
1	0%	2.818	3.344
2	CS 10% + QD 30%	2.887	3.454
3	CS 20% + QD 30%	2.878	3.499
4	CS 30% + QD 30%	2.766	3.380
5	CS 40% + QD 30%	2.610	3.217

Fig No:4.1 Split tensile test

Fig No:4.2 Curing tank

Graphs:

Results of Compressive strength



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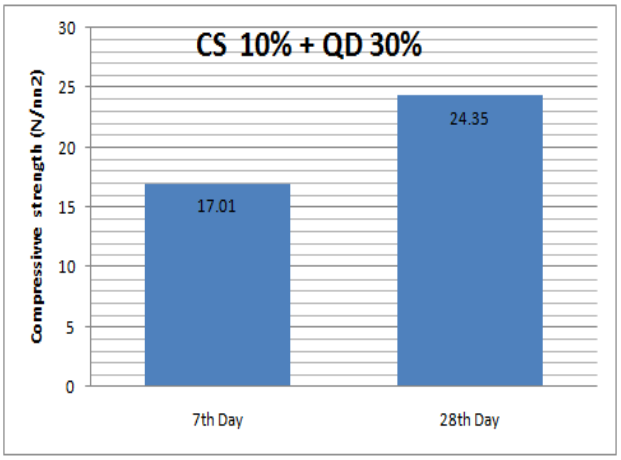
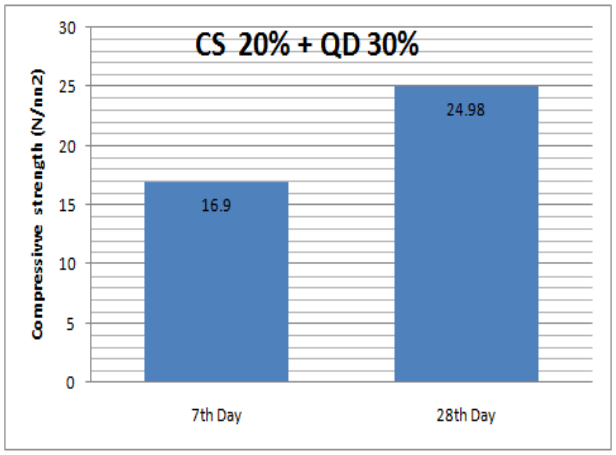
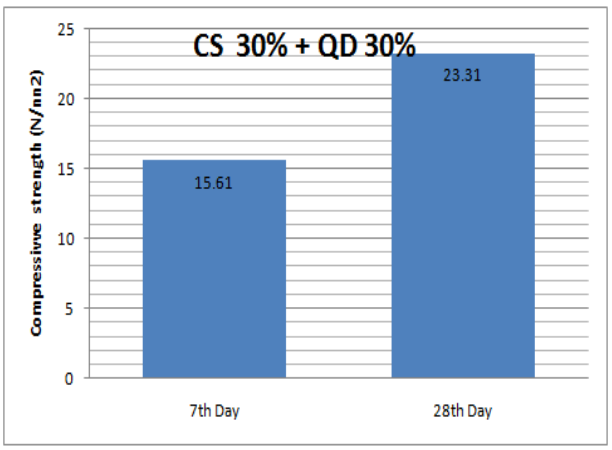
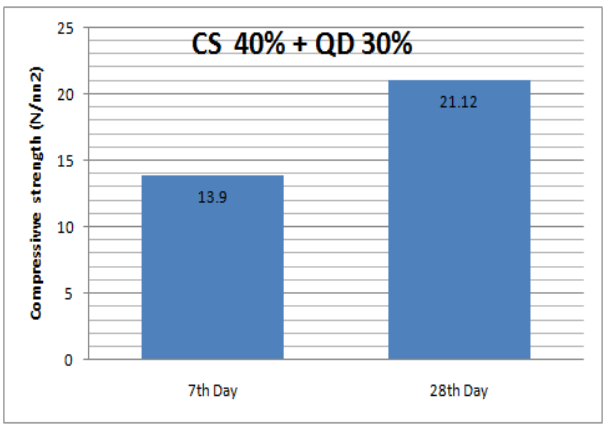
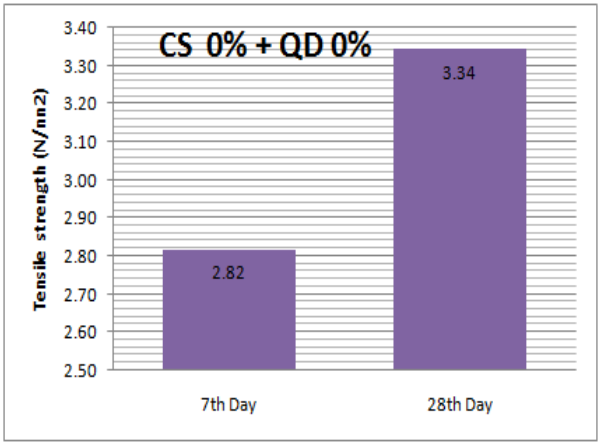


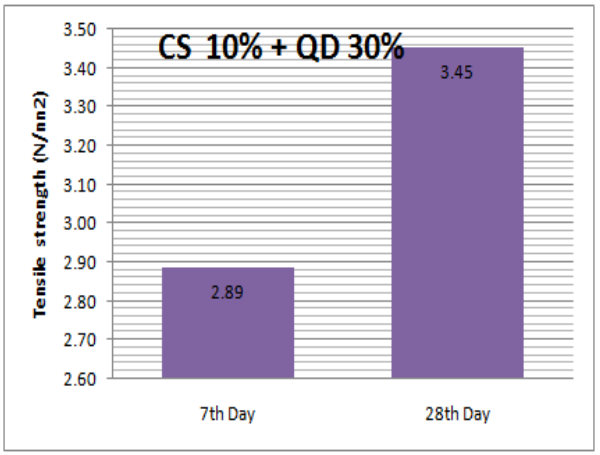


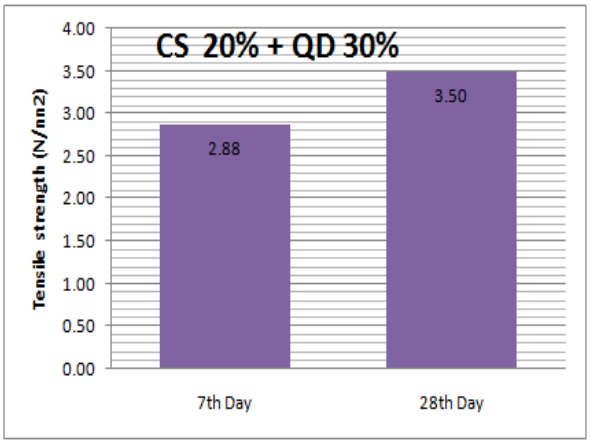


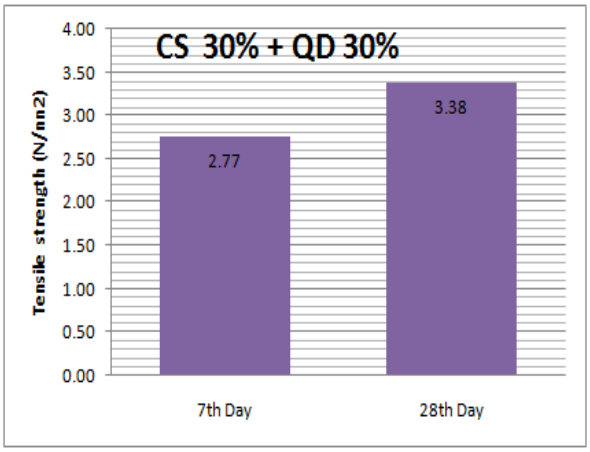


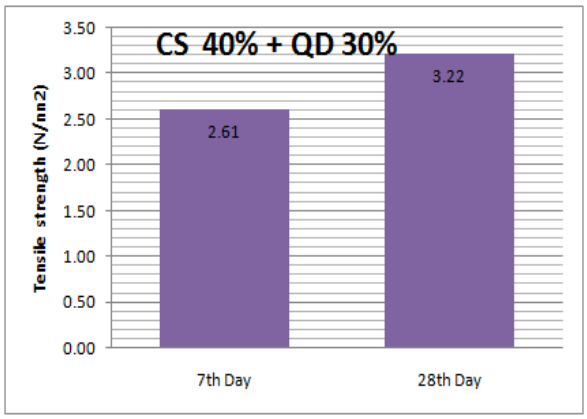
Results of Split Tensile strength











Production cost of concrete

Table No 4.4 Production Cost of Concrete

Normal concrete (M20 Grade) Rate/m^3	CS 20%+ QD 30% concrete Rate/m^3
Rs:3000/-	Rs:2500/-

As shown in table No.4.4 The cost of CS 20% +QD 30% was decreased by 16.6% due to replacement of coconut shell 20% and Quarry dust 30% in concrete

CONCLUSION

- 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/mm^2.
- 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%+QD 30% and CS 20%+QD 30% concrete is increasing comparatively with normal concrete
- So we conclude that the coarse aggregate and fine aggregate replaced with coconut shell aggregate at 20% and quarry dust at 30% in concrete is suitable for construction.
- Moreover it reduces 16.6% cost construction by reducing the cost of coarse and fine aggregate and it also reduces the environmental pollution due to fly ash and seashell.

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