

Comparing the Strength Properties by Partial Replacement of Coarse Aggregate with Coconut Shell and Fine Aggregate with Quarry Dust on M20 and M40 Grade Concrete

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Abstract: In construction industry the rising cost of construction materials is the major factor. The high cost of conventional building materials is the greater factor effecting housing delivery in the world. The project aim is to analyze compressive strength characteristics of concrete produced using crushed, granular coconut shell and quarry dust as substitute for conventional coarse and fine aggregate respectively with partial replacement. Coconut shell is the natural material which is commonly available in all over the world. It is an abundant, versatile, renewable and cheap remain in the environment as waste material. Quarry dust which is a waste product from aggregate crushers could replace sand. It has very recently gained good attention to be used as an effective filler material instead of fine aggregate. So the utilization of these materials for construction will be an important step to improve sustainability and eco-friendly construction. They must be accessible to the standard individuals and be low in financial value. It is economically profitable material in the construction field. The main purpose is to encourage the use of these waste products as construction material to reduce the cost of housing. In this studies, two different concrete mixtures i.e., M 20 and M 40 with different combination of natural materials content namely 0%, 5%, 10% and 15% of coconut shell and as well as 0%, 15%, 30% and 45% of quarry dust. The compressive strength of concrete reduced as the percentage replacement of coconut shell increased and to compensate this compressive strength quarry dust is replaced with fine aggregate. Properties like compressive strength, water absorption, specific gravity were investigated in the laboratory. Workability decreased with increase in coconut shell replacement and increased with increased in quarry dust replacement. All precautions are taken to maintain serviceability, strength and durability. Thus it will be helpful for civil engineers and society to adopt this concept to fulfill the basic need of human that is housing.

Key words: Coconut shell, Quarry dust, Coarse aggregate, Fine aggregate, Cement, Compressive strength.

I. INTRODUCTION

Concrete manufacturing involve consumption of ingredients like cement, aggregates, water and admixture. In developing countries wherever abundant agricultural and industrial wastes are discharged, these wastes are often used for numerous functions in

construction. So a trail has been created during this study to utilize the coconut shell as partial replacement of coarse aggregate. Sustainable building systems can have a direct implication on the betterment of livelihood conditions of communities. 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.

Unfortunately, the extraction of natural aggregates has led to establishing human made quarries that have drastic environmental impact on the nature and surroundings. The high demand for concrete in the construction using normal weight aggregates such as gravel and granite drastically reduces the natural stone deposits and this has damaged the environment thereby causing ecological imbalance. Therefore, there is a need to explore and find out suitable replacement material to substitute the natural stone. Coconut Shells (CS) are not commonly used in the construction industry but are often dumped as agricultural wastes. The aim of this review is to spread awareness of coconut fibers as a construction material. However, the environmental impact can be reduced by making more sustainable use of this waste. On the other hand, the advantages and utilization of by product such as quarry dust and CS or aggregates obtained as waste materials are pronounced in the aspects of reduction in environmental load and waste management cost, reduction of concrete production cost. Furthermore, in this study the effect of quarry dust as sand replacement on concrete was also investigated. By replacement of quarry dust, the requirement of land filling area can be reduced and can also solve the problem natural sand scarcity. Quarry dust satisfies the reason behind the alternative material as a substitute for sand at very low cost.

Coconut is grown in more than 86 countries worldwide, with a total production of 54 billion nuts per annum. India occupies the premier position in the world with an annual production of 13 billion nuts. The concrete obtained using coconut shell as aggregates satisfies the minimum requirements of concrete.

Coconut shell may offer itself as a coarse aggregate as well as a potential construction material in the field of construction industries and this would solve the environmental problem of reducing the generation of solid wastes simultaneously.

Quarry dust is the byproduct of the crushing process which is a concentrated material to use as aggregates for concreting purpose, especially as fine aggregates. In quarrying activities, the rock has been crushed into various sizes, during the process the dust generated is called quarry dust and it is formed as waste. Therefore, quarry dust should be used in construction works, which will reduce the cost of construction and construction material would be saved. Quarry dust has been used for different activities in the construction industry such as building materials, aggregates. The suitability of quarry dust as a sand replacement material shows that the mechanical properties and also elastic modulus are improved.

Objectives of this study: The aim of this study is to assess the utility and efficiency of coconut shells as a coarse aggregate as an alternative to natural aggregate in concrete, as well as the quarry dust as a fine aggregate.

- To study the mechanical properties and cost analysis comparison with conventional concrete and partial replacement of coconut shell, quarry dust in concrete.
- To find economical solution for high construction material.

II. MATERIALS

The constituent materials used in this investigation were procured from local sources.

These materials are required for conducting various tests on concrete. We are using cement, quarry dust, coarse aggregate, fine aggregate, coconut shell and water.

2.1 Cement: Port land slag cement (PSC) is manufactured by either inter-grinding in the Portland cement clinker, gypsum and granulated slag or blending the ground granulated blast furnace slag with ordinary Portland cement by means of mechanical blenders. It works synergistically with Portland cement to increase strength, reduce permeability, improve resistance to chemical attack and inhibit rebar corrosion. Slag cement is used in virtually all concrete applications.

2.2 Fine Aggregate: Well graded river sand passing through 4.75 mm was used as fine aggregate. It consists of natural sand or, subject to approval, other inert materials with similar characteristics, or combinations having hard, strong, durable particles.

2.3 Coarse Aggregate: Coarse aggregate shall consist of naturally occurring materials such as gravel, or resulting from the crushing of parent rock, to include natural rock, slag's, expanded clays and shale's (lightweight aggregates) and other approved inert materials with similar characteristics, having hard, strong, durable particles, conforming to the specific

requirements of this Materials substantially retained on the No. 4 sieve, shall be classified as coarse aggregate.

2.4 Coconut Shell: The coconut palm is one of the most useful plants in the world. Coconut shells are mostly used as an ornament, making fancy items, house hold utensils, and as a source of activated carbon from its charcoal. The study of CS as an alternative for aggregates is another way of using the contributions a coconut tree will provide. Coconut shells which were already broken into two pieces and are collected from local temple; air dried for five days approximately at the temperature of 25 to 30 C; removed fiber and husk on dried shells; further broken the shells into small chips manually using hammer and sieved through 12.5mm sieve. The material passed through 12.5mm sieve was used to replace coarse aggregate with coconut shells. The material retained on 12.5mm sieve was discarded. Specific gravity at saturated surface dry condition of the material was found as 1.20. 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, 15 fine particles passing through IS sieve 9, IS sieve 15, IS sieve 30 were taken and analyzed without any treatment. Also coconut shells fines passing through IS sieve 15 was taken and analyzed with treatment.



Fig2.1: Cement



Fig 2.2: Fine Aggregate



Fig 2.3: Coarse aggregate



Fig 2.4: Coconut Shells

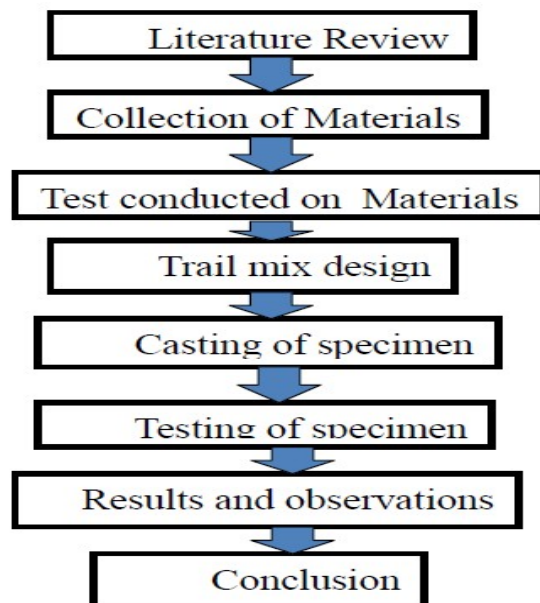
III. PROPERTIES OF MATERIALS

Table 3.1: Physical properties of Materials

Physical properties of materials	Results
Normal consistency of cement	26%
Initial setting time of cement	28minutes
Final setting time of cement	9hours 57minutes
Specific gravity of cement	3.1
Fineness of cement	2%
Water absorption of coconut shell	32.8%
Specific gravity of coarse aggregate	2.86
Specific gravity of fine aggregate	2.4
Specific gravity of coconut shell	1.2

IV. METHODOLOGY

The methodology explained in step by step procedure is going to be done in the project.



Mix Proportions and Experimental Investigations:

Mix design prepared by using “Indian Standard Method”

IS: 456 – 200 & IS: 10262 - 2009

M20 grade proportions are - 1: 1.7: 3.3, W/C = 0.5

M40 grade proportions are - 1: 1.3: 2.53, W/C = 0.4

An experimental study is conducted to find out the compressive strength and workability of concrete test at 7days, 14days and 28days.

- A – M20 Grade conventional grade concrete
- A1 – Cement + (85%Sand +15%Quarry dust) + (95% Coarse aggregate + 5% CC shells)
- A2 – Cement + (70%Sand +30%Quarry dust) + (90% Coarse aggregate + 10% CC shells)
- A3 – Cement + (55%Sand +45%Quarry dust) + (85% Coarse aggregate + 15% CC shells)
- B – M40 Grade conventional grade concrete
- B1 – Cement + (85%Sand +15%Quarry dust) + (95% Coarse aggregate + 5% CC shells)
- B2 – Cement + (70%Sand +30%Quarry dust) + (90% Coarse aggregate + 10% CC shells)
- B3 – Cement + (55%Sand +45%Quarry dust) + (85% Coarse aggregate + 15% CC shells)

V. RESULTS AND DISCUSSIONS

5.1 Comparison of workability on various mixtures:

Table 5.1: Slump values of M20 Trail mix

Sl. No.	Type of mixture	Slump value (mm)
1	A	17
2	A1	22
3	A2	26
4	A3	30

Table 5.2: Slump values of M40 Trail mix.

Sl. No.	Type of mixture	Slump value (mm)
1	B	15
2	B1	19
3	B2	23
4	B3	27

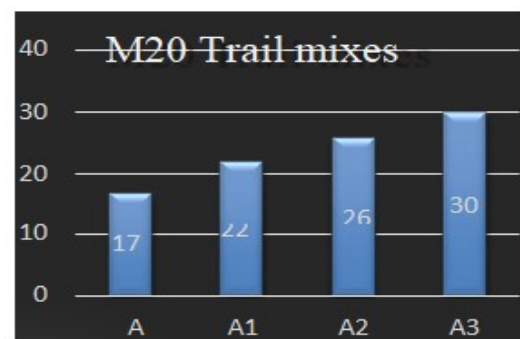


Fig 5.1: Slump values of M20 Trail mix

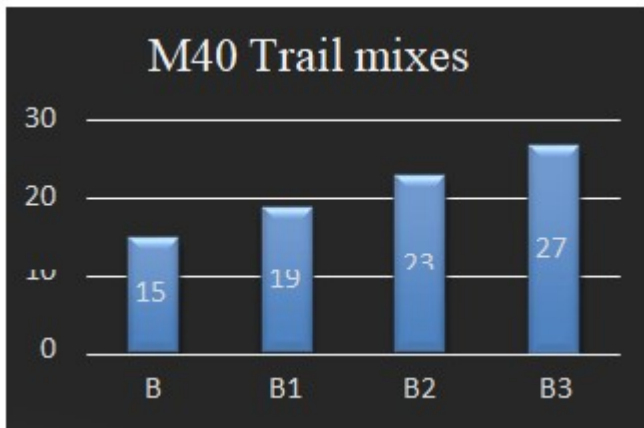


Fig 5.2: Slump values of M20 Trail mix

From the graph we can observe the increase of slump values with replacement of coconut shell to the coarse aggregate as well as quarry dust to the fines aggregate.



Fig 5.3: Slump test



Fig 5.4: Casting



Fig 5.5: Concrete Cubes

5.2 Compressive Strength Studies on Concrete Cubes:

Table 5.3 Compressive strength of M20 and M40 concrete trail mixes

Sl.No.	Type of Mixture	7days (MPa)	14days (MPa)	14days (MPa)
1	A	13.02	18.21	20.54
2	A1	14.75	19.63	22.54
3	A2	14.52	19.21	22.06
4	A3	13.85	18.59	21.86
5	B	26.82	36.92	40.52
6	B1	25.82	35.21	39.16
7	B2	24.6	34.18	38.25
8	B3	24.5	33.67	37.43

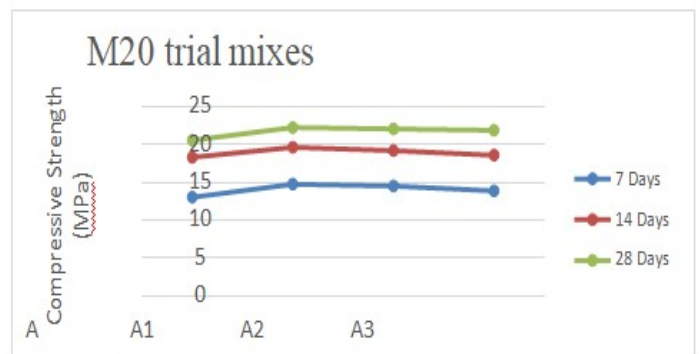


Fig 5.6: Compressive strength of M20 concrete trail mixes

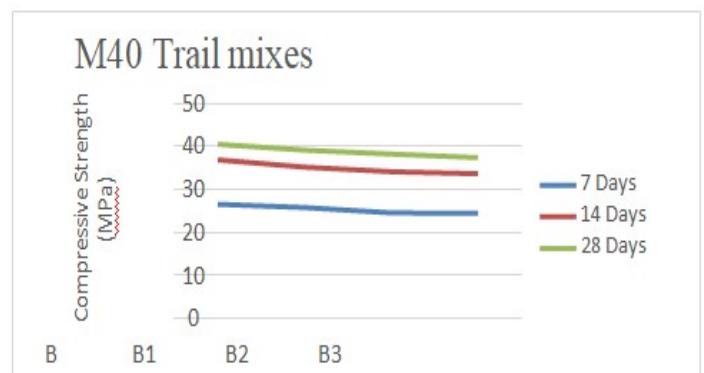


Fig 5.6: Compressive strength of M40 concrete trail mixes

5.3 Discussion on Strength Results

From the graphs of **M 20** grade concrete, there we can observe marginal decreasing of compressive strength of concrete cubes with partial replacement of coconut shells to the coarse aggregate and as well as Quarry dust to the fine aggregate.

From the graphs of **M 40** grade concrete, there we can observe decreasing of compressive strength of concrete cubes with partial replacement of coconut shells to the coarse aggregate and as well as Quarry dust to the fine aggregate.

Here the cost analysis taken from Indian Standard building cost materials, Govt. of NCT of Delhi

Table 5.4: Quantity estimation for the M20 grade concrete with different trail mixtures

Sl.No	Material	Quantity (m ³)			
		A	A1	A2	A3
1	Cement (bags)	7.5	7.5	7.5	7.5
2	Fine Aggregate	0.425	0.361	0.297	0.233
3	Coarse Aggregate	0.825	0.783	0.745	0.701

Table 5.5: Quantity estimation for the M40 grade concrete with different trail mixtures

Sl.No	Material	Quantity (m ³)			
		A	A1	A2	A3
1	Cement (bags)	9	9	9	9
2	Fine Aggregate	0.403	0.343	0.282	0.222
3	Coarse Aggregate	0.785	0.746	0.707	0.667

Table 5.6 Cost estimation for the M20 grade concrete with different trail mixtures

Sl. No	Type of Mix	Material	Quantity (m ³)	Rate per m ³	Cost in rupees	Total cost
1	A	Cement (bags)	7.5	300	2250	3590
		Fine Aggregate	0.425	820	348.5	
		Coarse Aggregate	0.825	1200	990	
2	A1	Cement (bags)	7.5	300	2250	3490
		Fine Aggregate	0.361	820	296.2	
		Coarse Aggregate	0.783	1200	940.5	
3	A2	Cement (bags)	7.5	300	2250	3385
		Fine Aggregate	0.297	820	244	
		Coarse Aggregate	0.742	1200	891	
4	A3	Cement (bags)	7.5	300	2250	3290
		Fine Aggregate	0.233	820	191.7	
		Coarse Aggregate	0.701	1200	841.5	

Table 5.7 Cost estimation for the M40 grade concrete with different trail mixtures

Sl.No	Type of Mix	Material	Quantity (m ³)	Rate per m ³	Cost in rupees	Total cost
1	B	Cement (bags)	9	300	2700	3980
		Fine Aggregate	0.403	820	331	
		Coarse Aggregate	0.785	1200	942.9	
2	B1	Cement (bags)	9	300	2250	3880
		Fine Aggregate	0.361	820	296.2	
		Coarse Aggregate	0.783	1200	940.5	
3	B2	Cement (bags)	9	300	2700	3780
		Fine Aggregate	0.2825	820	231.7	
		Coarse Aggregate	0.707	1200	848.6	
4	B3	Cement (bags)	9	300	2700	3690
		Fine Aggregate	0.222	820	182.1	
		Coarse Aggregate	0.667	1200	801.4	

VI. CONCLUSION

In this work, coarse aggregate replaced with coconut shell and fine aggregate with Quarry dust by volume. Specimens were cast by replacing 5%, 10%, and 15% of coarse aggregate with coconut shells as well as 15%, 30% and 45% with quarry dust with fine aggregate. Compression tests were conducted on the cast specimens after 7, 14, and 28 days as mentioned in the IS code.

The main points of this report are:

1. Addition of Quarry dust increases workability of coconut shells concrete. Increase in coconut shells percentage decreased density of the concrete.
2. The properties exhibited by the concrete made with coconut shell as coarse aggregate and as well as Quarry dust as fine aggregate matches with the conventional concrete.
3. Coconut shell concrete with 0%-15% replacement of coconut shells, with this increase of Quarry dust from 15%-45% shows decreasing compressive strength in concrete.
4. But the replacement of coconut shells in place of aggregates and addition of Quarry dust to fine aggregate will increase the compressive strength properties of concrete compared to the conventional concrete.
5. From the experimental study, it is concluded that the quarry dust can be used as a replacement for fine aggregate.
6. It is found that percentage replacement of coconut shell and quarry dust in concrete, compressive strength is decreased in M 20 grade concrete, though

this strength is not less than the conventional concrete. As well as in M 40 grade concrete the compressive strength is decreased then conventional concrete.

7. For the designed mix proportions of M 20 and M 40 grades of concrete the desired characteristic strengths for cubes are achieved in both conventional concrete and coconut shell, Quarry dust concrete.
8. Using the coconut shell as aggregate in concrete can reduce the material cost in construction because of the low cost and abundant agricultural waste.
9. The cost wise comparison of the coconut shell concrete with the conventional concrete proves that the quarry dust concrete stands to be cost effective saving about total cost involved.
10. From one cube calculation bulk amount of shell replacement can be evaluated & reduces over all construction cost.
 - The concrete with partial replacement of coconut shell and quarry dust shown marginal decreasing compressive strength than conventional concrete in M 20 grade and decrease in M 40 grade.
 - The cost wise comparison of the coconut shell concrete with the conventional concrete that the quarry dust concrete stands to the effective saving about total cost involved.

- On one hand the waste disposal problem is solved and on other hand the coconut shell and quarry dust is utilized.

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