STRUCTURAL PERFORMANCE ON PARTIAL REPLACEMENT OF CEMENT BY COCONUT SHELL ASH

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Abstract - *The environmental impact of OPC is significant because its production emits large amount of CO_2 .Utilization of industrial soil waste or secondary materials has been encouraged in construction field for the production of cement and concrete because it contributor for reducing the consumption of natural raw materials as resources .The volume of wastes generated in the world has increased over the years due to increase in population, socioeconomic activities and social development. One of the most attractive option of managing such wastes is to look in to look into the possibility of waste minimization and re-use. The cost of cement used in concrete works is on the increase and unaffordable, yet the need for housing and other constructions requiring this material keep growing within increasing population, thus the need to find alternative binding materials that can be used solely or in partial replacement of cement. Concrete cubes were casted using replacement levels of 0%,10%15%,and 20% of OPC with CSA .The cubes were casted and cured by immersing them in water for 14days and 28days respectively. The Coconut Shell ash is used for the partial replacement cement. Further, use of coconut shell ash as a value added material as in the case of binary blended cement concrete ,reduces the consumption of cement. Reduction of cement usage will reduce the production of cement which in turn cut the CO_2 emissions. The time has come for the review of progress made in the field of development of binary blended cement concrete.*

Key words: **Durability, mechanical properties, sisal fibre , M40**

1. INTRODUCTION

Concrete is widely used as construction material for various types of structures due to its durability. For a long time it was considered to be very durable material requiring a little or no maintenance. Many environmental phenomena are known significantly the durability of reinforced concrete structures. We build concrete structures in highly polluted urban and industrial areas, aggressive marine environments and many other hostile conditions where other materials of construction are found to be nondurable. In the recent revision of IS: 456-2000, one of the major points discussed is the durability aspects of concrete. So the use of concrete is unavoidable. At the same time the scarcity of aggregates are also greatly increased nowadays. Utilization of industrial soil waste or secondary materials has been encouraged in construction field for the production of cement and concrete because it contributes to reducing the consumption of natural resources. They have been successfully used in the construction industry for partial or full replacement for fine and coarse aggregates. The composition of World Cement Consumption in the year 2010 is 3,313 Million Metric Tons. Among that 7.0% in India, 57.7% in China, 9.4% in Developed Countries, 25.9% in Other Emerging. The composition of Coconut Production in India in the year 2009 is 10,894,000 tones. Traditional areas of coconut cultivation are the states of Kerala (45.22%), Tamil Nadu (26.56%), Karnataka (10.85%) and Andhra Pradesh (8.93%). The objectives include ascertaining the optimum replacement level of Portland cement with CSA that will still give required compressive strength as well as compare the setting times of OPC paste with OPC- CSA pastes at various replacement levels.

1.1SCOPE

- To achieve the standard Compressive Strength by partial replacement of Cement with Coconut Shell Ash (CSA).
- Concrete cubes were Casted using Replacement levels of 0%, 10%, 15%, 20% of OPC with CSA.

1.2 OBJECTIVE

- To study the compressive strength properties of concrete with partially replacement of cement by CSA.
- To Reduce the total cost of concrete
- To Decrease the total quantity of cement.

1.3 COCONUT SHELL ASH

The cost of cement used in concrete used in concrete works is on the increase and unaffordable, yet the need for housing and other constructions requiring this material keeps growing with increasing populations, thus the need to find alternative binding materials that can be used solely or in partial replacement of cement. Coconut shells which is an environment pollutant are collected and burnt in the open air for three hours to produce coconut shell ash, which in turn was used as pozzolana in partial replacement of cement in concrete production .Coconut shell ash is agricultural waste. The waste is produced in abundance globally and poses risk to health as well as environment. Thus their effective, conducive and eco-friendly utilization has always been a challenge for scientific applications. Coconut husk used in this study is a waste of coconut on Pasar Mangga . Dua, Surabaya. This study used coconut husk which has been dried and then performed some process that consists of combustion, grinding and sieving to obtain available chemical and mineralogical composition of coconut fiber ash CFA as cement replacement materials. The combustion process carried out in the laboratory of concrete and building material department of civil engineering ITS sukolilo with a total time of burning 6 hours and a maximum temperature of 600c.

2. LITERATURE REVIEW

- **Potentials Of Coconut Shell And Husk Ash On The geotechnical Properties Of Lateritic Soil For Road works**

The lateritic soil samples were obtained from three different borrow pits meant for road construction works. The soil samples were obtained at average depths of 4m to obtain true representative samples of the soils used for the road construction. The samples were spread on different matting to facilitate air drying the coconut shells and the husk were obtained from a market waste dump. The coconut shells and the husk were burnt separately in a metal drum. The ashes formed were allowed to cool down before sieving through 4.75mm BS sieve. The ashes were therefore stored in airtight containers to prevent moisture loss and any form of contamination Preliminary tests (natural moisture content, specific gravity, particle size analysis and Atterberg's limits) were performed on the three soil samples for Classification and identification purposes. Coconut shell and husk ash (CSHA) was added to each of the soil samples in 2, 4, 6, 8 and 10% by weight of the samples. The effects of the coconut shell and husk ash as stabilizing agent on the samples were thereafter determined.

- **Experimental Study On Strength Characteristics On M25 Concrete With Partial Replacement Of Cement With Fly Ash And Coarse Aggregate With Coconut Shell**

The mix proportion for M25 is 1: 1 : 2 and W/C ratio of 0.40 was casted. In general, fly ash is used at about 15-25% of the cement content.

3. MATERIALS

3.1 Coconut Shell Ash

The coconut shell was sun dried for 48 hours to remove moisture from it. It was then subjected to uncontrolled combustion using open air burning for 3 hours and allowed to cool for about 12 hours. The burnt ash was collected and sieved through a IS sieve (75 microns). The resulting ash, which has the required fineness, was collected for use. The oxide composition of the ash was determined and the result is shown in table 1. Using a mix design ratio of 1:2:4 and water binder ratio of 0.5, a total of 12 concrete cubes of size 150mmx150mmx150mm were cast using varying OPC-CSA ratio of 100:0, 90:10, 85:15,and 80:20respectively. The cubes were cured and tested after 14, 28 days respectively. Many researchers have made efforts for preparing carbon black from agricultural by-products such as coconut shell apricot stones, sugarcane bagasse, nutshells, forest residues and tobacco stems. Coconut shells have little or no economic value and their disposal is not only costly but may also cause environmental problems. Coconut shell is suitable for preparing carbon black due to its excellent natural structure and low ash content. Conversion of coconut shells into activated carbons which can be used as adsorbents in water purification or the treatment of industrial and municipal effluents would add value to these agricultural commodities, help reduce the cost of waste disposal, and provide a potentially cheap alternative to existing commercial carbons

3.2PROPERTIES OF CSA

Components	Percentage concentration(%)	
	CSA	OPC
SiO_2	37.97	20.7
Al_2O_3	24.12	5.75
Fe_2O_3	15.48	2.5
CaO	4.98	64
MgO	1.89	1
Mng	0.81	0.2
Na_2O	0.95	0.6
K_2O	0.83	0.15
P_2O_5	0.32	0.05
SO_3	0.71	2.75

3.3 CEMENT

Cement is used right from ancient periods in construction industry. In the most general sense of the word, cement is a binder, a substance which sets and hardens independently, and can bind other materials together. The word "Cement" traces to the Romans, who used the term "opus caementicium" to describe masonry which resembled concrete and was made from crushed rock with burned lime as binder. Cements used in construction are characterized as hydraulic or non-hydraulic. The most important use of cement is the production of mortar and concrete – the bonding of natural or artificial aggregates to form a strong building Material which is durable in the face of normal environmental effects**.**

S.no	Properties	Result
1	Consistency	33
2	Initial Setting time	30min
3	Final Setting Time	520min

3.4 SAND

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. An individual particle in this range is termed as sand grain. These sand grains are between coarse aggregate (2mm to 64mm) and silt (0.004mm to 0.0625mm). Aggregate most of which passes 4.75mm IS sieve is used.

3.5 COURSE AGGREGATE

Aggregates are the most mined material in the world. Aggregates are a component of composite materials such as concrete and asphalt concrete; the aggregate serves as reinforcement to add strength to the overall composite material. Coarse aggregate of size 20mm is sieved and used.

3.6 MORTAR CUBE TEST

Compressive strength of cement is determined by compressive strength test on mortar cubes compacted by means of a standard vibration machine. Standard sand (IS:650) is used for the preparation of cement mortar.

% of Replacement	Compressive strength(N/mm^2)	Average compressive strength (N/mm^2)
0%	56	56.25
	56.3	
	56.5	
10%	55.9	56.23
	56.4	
	56.4	
15%	55.9	55.8
	55.8	
	55.7	
20%	55.8	54.82
	55	
	54.6	

4 MIX DESIGN

4.1MIX CALCULATION RESULTS

Cement	Fine aggregate	Coarse aggregate
492.5 kg/m^3	663 kg/m^3	1256 kg/m^3
1	1.4	3.1

5. FRESH CONCRETE TEST

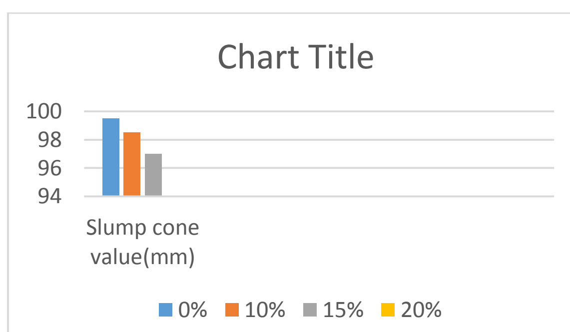
5.1 Concrete Slump Test

The concrete slump test is used for the measurement of a property of fresh concrete. The test is an empirical test that measures the workability of fresh concrete. The slump test result is a measure of the behavior of a compacted inverted cone of concrete under the action of gravity. It measures the consistency or the wetness of concrete.

5.2 Types of Slump

- Collapse Slump
- Shear Slump
- True Slump

% of Replacement	Slump cone value (mm)
0%	99.5
10%	98.5
15%	97
20%	96.5

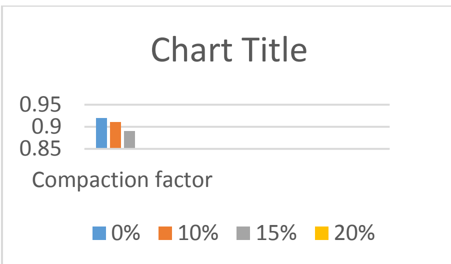


5.3 COMPACTION FACTOR

Compacting factor of fresh concrete is done to determine the workability of fresh concrete by compacting factor test as per IS: 1199 – 1959.

5.3.1 Compaction Factor Results

% of Replacement	Compaction factor
0%	0.92
10%	0.91
15%	0.89
20%	0.87

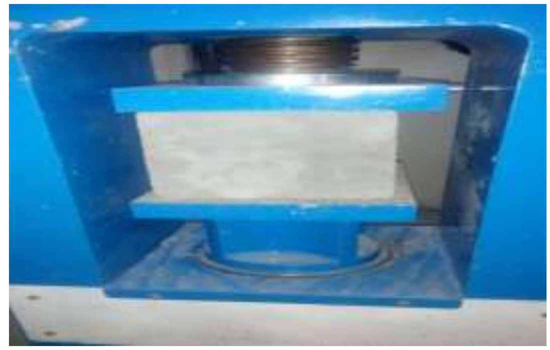


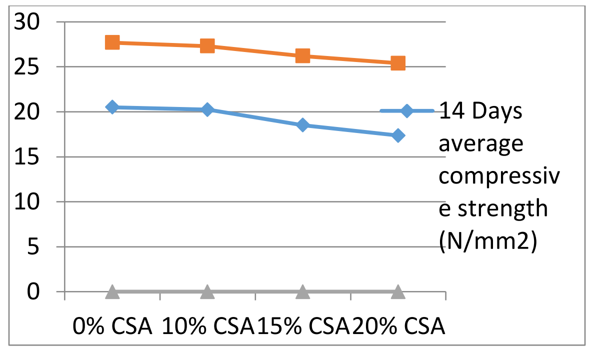
6. HARDENED CONCRETE

6.1Compressive strength test

The compressive strength of concrete is one of the most important and useful properties of concrete. It is generally by testing cubes of size 150x150x150mm that was done by in the lab. In this test cubes are subjected to compressive force in a compressive force in a compressive testing machine and the ultimate load at which the failure occurs is noted. Then the compressive stress is ultimate load by exposed to load and stress value is obtained in N/mm^2.

%Of Replacement	Curing Days	Strength (N/mm^2)
0%	14days	20.5
	28days	27.7
10%	14days	20.23
	28days	27.3
15%	14days	18.52
	28days	26.4
20%	14days	17.3
	28days	25.4





% replacement of with OPC with CSA

Fig.8.3: Comparison of 14 days and 28 days Average compressive strength (N/mm^2) for concrete cubes.

6.2 Split Tensile Strength of Concrete

This test is carried out in a cylindrical specimen of 150 mm diameter and 300 mm length. The cylindrical specimen is placed horizontally between the loading surface of a compression-testing machine and the load is applied until failure of cylinder occurs along the vertical diameter. The split tensile strength is given by the formula 2P/ (ΠDL) and the stress value is obtained in N/mm^2.

Where,

P is the ultimate load at which the cylinder fails.

D and L are the diameter and length of the cylinder.

%Of Replacement	Curing Days	Strength (N/mm^2)
0%	14days	2.52
	28days	2.77
10%	14days	2.99
	28days	3.65
15%	14days	3.68
	28days	4.2
20%	14days	3.88
	28days	4.4

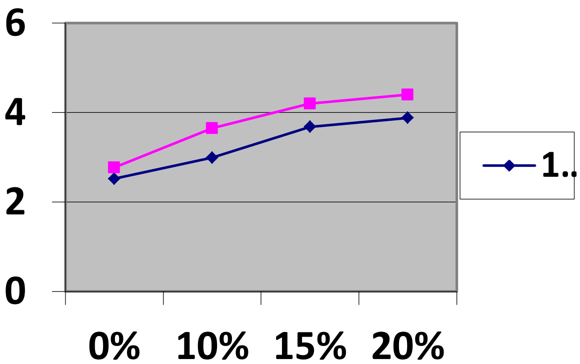


Fig.8.4: Comparison of 14 days and 28 days Average split tensile strength (N/mm²)

6.3Flexural Strength of Concrete

Flexural test was carried out on prism size of specimen 100x100x500mm. The flexural test specimen were cured and tested for 7 days, 14 days and 28 days in testing machine. In this test, the prisms are subjected by applying the load of 1.8kN(180kg/min). Flexural test is intended to give the flexural strength of concrete in tension. The most common plain concrete is subjected to flexure is a highway pavement and the strength concrete for pavement is commonly evaluated by means of bending tests. The modulus of rupture is determined by testing prisms with four point loading in N/mm². For 100mm specimens, the load shall be increased until the specimen fails and the maximum load applied to the test shall be recorded. The appearance of the fracture faces concrete and any unique features in the type of failure shall be noted.

%Of Replacement	Curing Days	Strength (N/mm²)
0%	14days	7.1
	28days	8
10%	14days	7.7
	28days	9.7
15%	14days	8.9
	28days	10.5
20%	14days	10.1
	28days	11.4

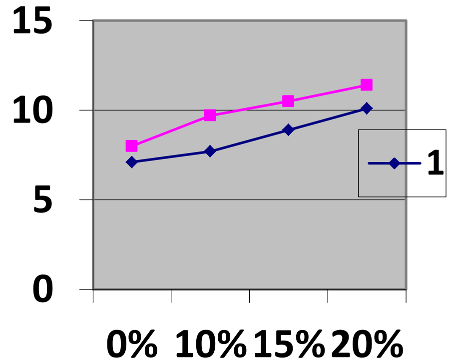


Fig.8.5: Comparison of 14 days and 28 days Average flexural strength (N/mm²)

7. DURABILITY PROPERTIES

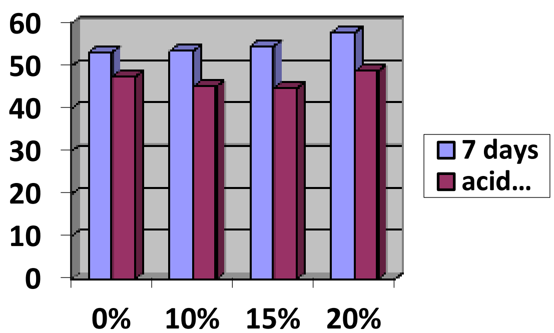
7.1 Acid Attack

The acid attack test was conducted for the concrete cube of size 150x150x150mm size. Concrete specimen is immersed in water and it should be cured for 30 days. After 28 days of curing , the specimens were weighed (W_1) and the specimen immersed with 5% hydrochloric acid by weight of water for acid test for 30 days. The pH was maintained throughout the period of 30 days. After 30 days, the specimen is taken out and it should be weighed as (W_2). Then the compressive strength of cube specimen should be noted at W_1 and W_2 and it is considered as C_1 and C_2. After analyzing , the percentage of weight loss and percentage of strength loss is determined.

% of weight loss after 30 days = $\mathbf{(W_1\text{-}W_2/W_1)\ x100}$

% of strength loss after 30 days = $\mathbf{(C_1\text{-}C_2/C_1)\ x100}$

S.no	% of replacement	7 days curing	Acid curing
1	0%	53.24	47.5
2	10%	53.5	45.1
3	15%	54.6	44.7
4	20%	57.8	48.8



8 .CONCLUSION

8.1 Conclusion for Workability Test

Standard value of Slump cone for the fresh concrete is 99.5 mm. The slump cone value of 10% replacement of CSA is 98.5 mm. This is optimum for the replacement of CSA concrete for good workability. Standard value of compaction factor for the fresh concrete is 0.92. The compaction value of 10% replacement of CSA is 0.91. This is optimum for the replacement of CSA concrete for good workability.

8.2 Conclusion for Compressive Strength Test

The compressive strength of normal M25 grade concrete is 27.7N/mm²The compressive strength of 10% of Replacement of CSA with Cement is 27.3 N/mm² which is equal to 0.99 times of the normal concrete strength. The compressive strength of 15% of Replacement of CSA with Cement is 26.2 N/mm² which is equal to 0.95 times of the normal concrete strength. The compressive strength of 20% of Replacement of CSA with Cement is 25.4 N/mm² which is equal to 0.91 times of the normal concrete strength. The 10% replacement of CSA gives the Effective result.

8.3 Conclusion or Spilttensile Strength Test

The spilt tensile strength of normal M25 grade concrete is 2.77 N/mm². The spilt tensile strength of 10% of Replacement of CSA with Cement is 3.65 N/mm². The spilt tensile strength of 15% of Replacement of CSA with Cement is 4.2 N/mm².The spilt tensile strength of 20% of Replacement of CSA with Cement is 4.4 N/mm².

8.3 Conclusion for Flexural Strength Test

The flexural strength of normal M25 grade concrete is 8 N/mm².The flexural strength of 10% of Replacement of CSA with Cement is 9.7 N/mm².The flexural strength of 15% of Replacement of CSA with Cement is 10.5 N/mm².The flexural strength of 20% of Replacement of CSA with Cement is 11.4 N/mm².

8.4 Conclusion for Acid Attack

The test results, obtained of cube specimens indicated that at 10% compressive strength increases but further increase in CSA percentage, decreases the strength of concrete cubes. The compressive strength increases by 8% for acid curing concrete mix containing 10% of CSA and SF than the control mix.

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