An Experimental Study on Concrete with Partial Replacement of Cement by Rice Husk Ash & Coconut Shell Ash

T.Subramani[1], C.Kathirvel[2], S.Ragul[3], S.Pirainilavan[4], V.Siva Nathan[5]

[1]Professor & Dean, Department of Civil Engineering, VMKV Engineering College, Vinayaka Missions Research Foundation (Deemed to be University), Salem, India

[2] Associate Professor, Department of Civil Engineering, VMKV Engineering College, Vinayaka Missions Research Foundation (Deemed to be University), Salem, India

[3,4,5]UG Student, , Department of Civil Engineering, VMKV Engineering College, Vinayaka Missions Research Foundation (Deemed to be University), Salem, India

Abstract

The high cost of conventional construction material affects economy of structure. With increasing concern over the excessive exploitation of Natural aggregates, lightweight aggregate produced from waste is a viable new source of structural material. In this work we have partially replaced cement with coconut shell ash and rice husk ash. The time has come for the review of progress made in the field of development of binary blended cement concrete. 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 keeps growing with increasing population, thus the need to find alternative binding materials that can be used solely or in partial replacement of cement. The environmental impact of OPC is significant because its production emits large amount of CO2. Utilization of industrial soil waste or secondary materials has been encouraged in construction field for the production of cement and concrete because it contributes for reducing the consumption of natural raw materials as resources. Reduction of cement usage will reduce the production of cement which in turn cut the CO2 emissions.

Keywords: Construction, CO_2, Convectional and Materials

1. INTRODUCTION

1.1 General

The construction industry relies heavily on conventional materials such as cement, sand and granite for production of concrete. Concrete is the basic civil engineering composite. The quality of concrete is determined by the quality of paste/mix. It is the world's most consumed man made material. Its great versatility and relative economy in filling wide range of needs has made it a competitive building material. The demand for concrete for today's infrastructural development is rising day-by-day. In light of this, the non-availability of natural resources to future generation has also been realized. Concrete production is not only a valuable source of societal development but also a significant source of employment. Following a natural growth in population, the amount and type of waste materials have increased accordingly creating thus environmental problems. Historically agricultural and industrial wastes have created waste management and pollution problems. Different alternative waste materials and industrial by-products such as fly ash, bottom ash, recycled aggregates, crumb rubber, saw dust, brick bats etc. were replaced with natural aggregates. Although these materials are traditionally considered as "primitive" and therefore inferior to more highly processes in terms of safety, durability, performance, occupant's health and comfort with respect to environmental issue, consumption of environmental products and energy within the construction industry has created a significant demand for raw materials and for production thereby contributing to the many environmental problems associated with diverse ecosystem. The wastes have generally no commercial value and are locally available at a minimal transportation cost. The use of these wastes has complemented other traditional materials in construction and hence provides practical and economic advantages. Also proper utilization of these wastes conserves the natural resources and protects the environment. Apart from the above mentioned waste

2. METHODOLOGY

Figure 1 shows the methodology of the study.

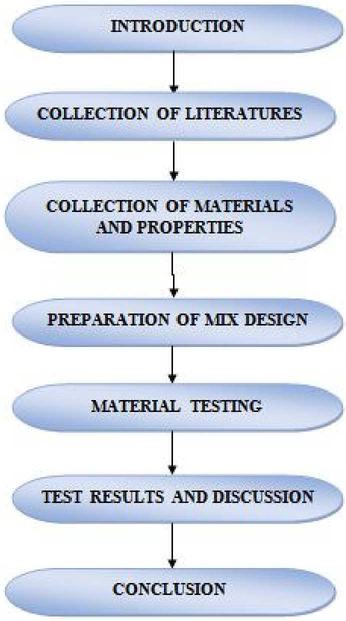

Figure 1 Methodology

3. MATERIAL COLLECTION

3.1 Cement

Cement is a binder, a substance used for construction that sets, hardens and adheres to other materials, binding them together. Cement is seldom used on its own, but rather to bind sand and gravel (aggregate) together. Cement is used with fine aggregate to produce mortar for masonry, or with sand and gravel aggregates to produce concrete. Cements used in construction are usually inorganic, often lime or calcium silicate based, and can be characterized as being either hydraulic or non-hydraulic, depending upon the ability of the cement to set in the presence of water (see hydraulic and non-hydraulic lime plaster).Non-hydraulic cement will not set in wet conditions or underwater; rather, it sets as it dries and reacts with carbon dioxide in the air. It is resistant to attack by chemicals after setting.

Table 1 shows the properties of cement.

Table 1: Properties of Cement

Physical Properties	**Values of OPC used**	**Requirements as per IS 8112-1989**
Standard Consistency	29.2%	-
Initial Setting Time	45 Minutes	Minimum of 30 minutes
Final Setting	Time 265 Minutes	Maximum of 600 minutes
Specific gravity	3.15	-

3.2 Fine Aggregate

Fine aggregates generally consist of natural sand or crushed stone with most particles passing through a 9.5mm sieve. As with coarse aggregates these can be from Primary, Secondary or Recycled sources.

Table 2 shows the Properties of fine aggregates.

Table 2: Properties of fine aggregate

PROPERTIES	VALUE
Specific Gravity	2.85
Fineness modulus	2.58
Water absorption	1%
Density	1754.3kg/m^3
Surface Texture	Smooth

3.3 Coarse Aggregate

Aggregates are inert granular materials such as sand, gravel, or crushed stone that, along with water and portland cement, are an essential ingredient in concrete. For a good concrete mix, aggregates need to be clean, hard, strong particles free of absorbed chemicals or coatings of clay and other fine materials that could cause the deterioration of concrete. Figure 4 shows the coarse aggregate.

Table 3 shows the properties of coarse aggregates.

Table 3: Properties of Coarse aggregates

PROPERTIES	VALUE
Specific weight (g/cm^3)	2.70
Sieve 200	1.29%
H_2O absorption	1.15
Fineness modulus	3.24
Specific gravity	2.66
Size	Passing through 4.75mm sieve

3.4 Water

The amount of water in concrete controls many fresh and hardened properties in concrete including workability, compressive strengths, permeability and water tightness, durability and weathering, drying shrinkage and potential for cracking. The ratio of the amount of water, minus the amount of water absorbed by the aggregates, to the amount of cementitious materials by weight in concrete is called the water- cementitious ratio and commonly referred to as the w/cm ratio. The w/cm ratio is a modification of the historical water-cement ratio (w/c ratio) that was used to describe the amount of water, excluding what was absorbed by the aggregates, to the amount of the portland cement by weight in concrete. Figure 5 shows the water.

3.5 Coconut Shell Ash

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. Figure 2 shows the coconut shells and muffle furnace.

Figure 2 Coconut shells and Muffle furnace

Figure 3 shows the coconut shell ash.

Figure 3 Coconut shell ash

Table 4 shows the chemical composition of CSA.

Table 4: Chemical Composition of CSA

Chemical composition	**%**
Carbon (C) (%)	9.80
Silica fume (SiO2) (%)	64.20
Alumina (Al2O3) (%)	6.51
Iron (Fe2O3) (%)	6.98
Calcium (CaO) (%)	10.56
Sulphuric Anhydride (SO3) (%)	1.05
Glucose (%)	0.1
Fructose (%)	0.1
Sucrose (%)	0.1

3.6 Rice Husk Ash

Rice husk ash is produced by burning the outer shell of the paddy that comes out as a waste product during milling of rice. India is one of the leading producers of Rice. Globally rice paddy of about 600 million tons is being produced, accounting for an annual production of 120 million tons Rice Husk. In most of the cases, the husk produced during the processing of the rice is either burnt or dumped as waste material. Rice husk ash contains 90%-95% of reactive silica. It is estimated that the world rice harvest is about 588 million tons per year and India is the second largest producer of rice in the world with a production of 132 million tons per year annually. Since they are bulky disposal of husk present an enormous problem. Each ton of paddy produces about 200kg of husk and this rice husk can be effectively converted through controlled burning. At around 500ºC a valuable siliceous product that can enhance the durability of concrete in the chemical composition of rice husk ash is obtained. Table 5 shows the physical properties of rice hush ash.

Table 5: Physical properties of rice husk ash

S.No	**Particular properties**	
1	Colour	Grey
2	Shape texture	Irregular
3	Mineralogy	Non-crystalline
4	Particle size	<45microns
5	Specific gravity	2.37
6	Odour	Odourless

4. MIX DESIGN

4.1 Mix Proportion

Table 6 shows the shows the mix proportion for 10% replacement of coconut shell.

Table 6: Mix Proportion For 10% Replacement of Coconut Shell

Cement (kg)	FA (kg)	CA (kg)	Coconut Shell (kg/m^3)	Water (liter)
330	452.61	1189.9	132.21	165

Table 7 shows the mix proportion for 20% replacement of coconut shell.

Table 7: Mix Proportion For 20% Replacement of Coconut Shell

Cement (kg)	FA (kg)	CA (kg)	Coconut Shell (kg/m^3)	Water (liter)
330	452.61	1057.7	264.43	165

5. TEST PROCEDURE

5.1 Compressive Strength

Compression tests are used to determine how a product or material reacts when it is compressed, squashed, crushed or flattened by measuring fundamental parameters that determine the specimen behaviour under a compressive load. Compression test is conducted at the end of the 7th and 28th day of casting the specimens. The load was applied without any shock and continuously until the failure of the specimens. The maximum load is applied to the specimens until the failure is recorded.

fc= load/ Cross sectional area

5.2 Splitting Tensile Strength

Tensile strength is one of the basic and important properties of concrete. A knowledge of its value is required for the design of concrete structural elements subject to transverse shear, torsion, shrinkage and temperature effects. Its value is also used in the design of prestressed concrete structures, liquid retaining structures etc. The cylindrical specimen shall have the diameter not less than four times the maximum size of the coarse aggregate and not less than 150 mm. The length of the specimens shall not be less than the diameter and not more than twice the diameter. .

5.3 Water Absorption Test

The average dry weight of cube specimens after removing from moulds was measured and the average weight of cube specimens after submerging in water for curing was measured at 28 days of age. The percentage of water absorption was measured for each concrete specimen and it gave indirect measure of durability.

6. TEST RESULT

6.1 Test Results

Table 8 shows the test results.

Table 8: Test results

S.NO	NAME OF THE TEST	SPECIMEN		DATE OF TESTING	LOAD IN (kN)			STRENGTH IN (N/mm^2)		
					0%	10%	20%	0%	10%	20%
1	COMPRESSION	CUBE	7	2602/2019	364.5	384.7	337.5	16.2	17.1	15.0
			14	05/03/2019	506.25	522.0	459.0	22.5	23.2	20.4
			28	19/03/2019	609.75	618.7	589.5	27.1	27.5	26.2
2	SPLIT TENSILE	CYLINDER	7	2602/2019	120.16	134.3	106.0	1.7	1.9	1.5
			14	05/03/2019	176.7	183.7	141.3	2.5	2.6	2.0
			28	19/03/2019	226.1	240.3	190.8	3.2	3.4	2.7

Figure 4 shows the compression strength test – Bar chart.

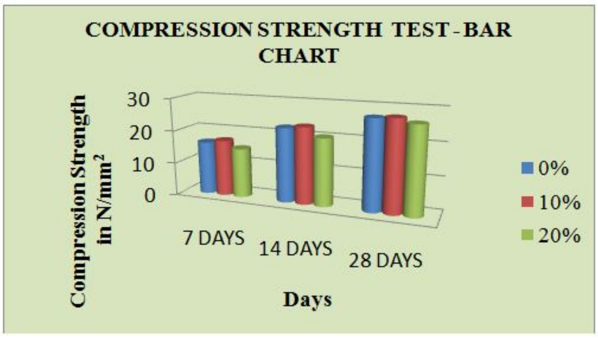

Figure 4 Compression Strength Test - Bar Chart

Figure 5 shows the split tensile strength test bar chart.

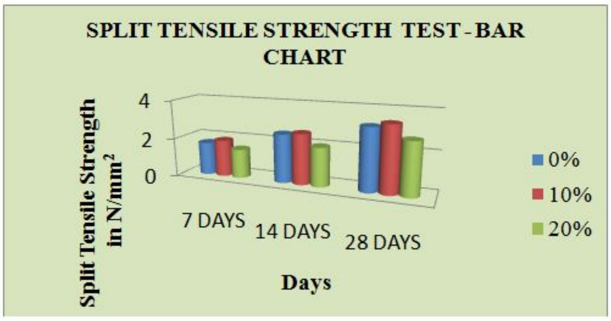

Figure 5 Split Tensile Strength Test - Bar Chart

6.2 Slump Cone Test

Table 9 shows the slump cone test.

Table 9 Slump cone test

S.NO	% OF REPLACEMENT	SLUMP VALUE (mm)
1	0%	120
2	10%	135
3	20%	100

Figure 6 shows the Slump Cone Test.

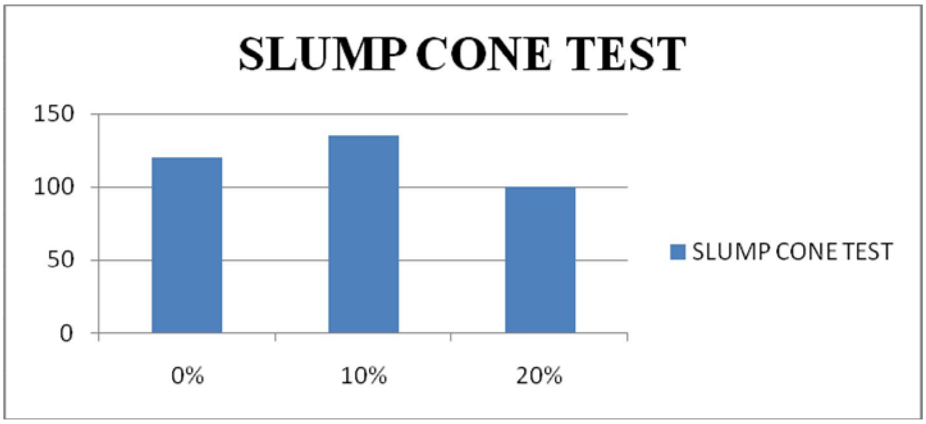

Figure 6 Slump Cone Test

7. CONCLUSION

From the experimental results and discussion, the combination of Coconut Shell and rice husk ash potential as lightweight aggregate in concrete. Also, using the combination of Coconut Shell and rice husk ash as aggregate in concrete can reduce the material cost in construction because of the low cost and abundant agricultural waste. By using different Coconut Shell and rice husk ash content of 10%, 20%, the Optimum Stability of the Coconut Shell Mix is found out. It is observed from the graph that the Stability value increases with increase in bitumen content and the decreases gradually which helps us to find out the performance of different fillers used in Coconut Shell and rice husk ash mix (20%). From the graph, it is found that

- Production of Sustainable Light-weight concrete is attained.
- Carbon Emission observed during aggregate manufacturing is considerably reduced varying from 6%-9% in 20% replacements since the quantity of aggregates used is certainly lessened. Overall cost reduction of the construction is observed.
- Increase in percentage replacement by coconut shell increases workability of concrete.

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AUTHOR

Prof. Dr. T. Subramani Working as Professor and Dean of Civil Engineering in Vinayaka Missions Kirupananda Variyar Engineering College, Vinayaka Missions Research Foundation (Deemed to be University), Salem, Tamilnadu, India. Having more than 28 years of Teaching experience in Various Engineering Colleges. He is serving as reviewer for many International Journals and also published 250 papers in International Journals. He has presented more than 107 papers in conferences, especially 77 in International and 30 National Level. He has authored 07 books. Guided more than 259 students in PG projects. Currently he is guiding 03 Ph.D., Research Scholars. He is serving as examiner and Valuer for B.E & M.E Degree Theory and Practical Examinations for Madras University, Periyar University, Anna University, Annamalai University and Vinayaka Missions Research Foundation [Deemed to be University]. He is Question paper setter and Valuer for UG and PG Courses of Civil Engineering in number of Universities. He is serving as Chairman of Board Of Studies (Civil Engineering), Vinayaka Missions Research Foundation [Deemed to be University], also a member of Board of studies in Periyar University. He is Life Fellow in Institution of Engineers (India) and Institution of Valuers. Life member in number of Technical Societies and Educational bodies like MISTE, MIGS, MIRC,ISRMTT, UWA, Salem District Small and Tiny Association (SADISSTIA), SPC – Salem Productivity Council. He has delivered much technical talk in various field. He is a Chartered Civil Engineer and Approved Valuer for many banks. He is a Licensed Building Surveyor in Salem City Municipal Corporation-Salem, and Licensed Civil Engineer in Salem Local Planning Authority- Salem. He is the recipient of many prestigious awards.

C.Kathirvel Completed his Master of Engineering (M.E) in the Branch of Environmental Engineering at Vinayaka Mission’s Research Foundation, Salem, Currently he is Working as Associate Professor of Civil Engineering in VMKV Engineering College, Vinayaka Missions Research Foundation (Deemed to be University),Salem, TamilNadu, India. Having more than 10 years of teaching experience He published 17 International Journal Publications and presented more than 15 papers in International Conferences. His work focuse specifically water divining

S.Pirainilavan is perusing B.E Degree in the branch of Civil Engineering at V.M.K.V. Engineering College, Vinayaka Missions Research Foundation (Deemed to be University), Salem, Tamilnadu, India. He has well knowledge in AUTOCAD drawing, Stadd pro and Revit. His hobbies are singing, drawing, cycling and cooking.

S.Ragul is perusing his B.E Degree in the branch of Civil Engineering at V.M.K.V. Engineering College, Vinayaka Missions Research Foundation (Deemed to be University), Salem, Tamilnadu, India. He has well knowledge in AUTOCAD drawing.

V.Sivanathan is perusing B.E Degree in the branch of Civil Engineering at V.M.K.V. Engineering College, Vinayaka Missions Research Foundation (Deemed to be University), Salem, Tamilnadu, India. He has well knowledge in AUTOCAD drawing.