iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 7 **Issue:** V **Month of publication:** May 2019

DOI: https://doi.org/10.22214/ijraset.2019.5574

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.177
Volume 7 Issue V, May 2019- Available at www.ijraset.com

Experimental Investigation on Partial Replacement of Cement by Oyster Shell in Concrete

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Abstract: In this day and age we are in front of most complex safety problems connected to environment. Many things which are made-up for our comfortable life are accountable for polluting environment due to offensive waste management technique. The present exploration assesses the merging of oyster shell in concrete. The consequence of oyster shell as fractional replacement of cement on the compressive strength (primary) of concrete has been investigated. Globally, over 150 countries produce cement and/or clinker, the primary input to cement. In 2001, the United States was the world's third largest producer of cement (90 million metric tons (MMT)), behind China (661 MMT) and India (100 MMT). This work reports an experimental procedure to investigate the effect of using oyster shell powder as partial replacement of cement. Tabby is a type of concrete made by burning oyster shells to create lime, then mixing it with water, sand, ash and broken oyster shells. Tabby was used by early Spanish settlers in present-day North Carolina and Florida, then by English colonists primarily in coastal South Carolina and Georgia. Oyster shell as a alternate for straight cement with partial replacement using M25 grade concrete The main objective is to support the use of these outwardly waste products as a construction material. The objectives of the research proposal are to study the influence of percentage of Oyster shell as partial replacement of cement. The detailed scope of the study is, to investigate mixed concrete containing 5%, 10% and 15% of shell as partial replacement of cement to evaluate the mechanical properties of concrete such as compressive strength, tensile splitting strength, and flexural strength characteristics. This study is designed to appraise the efficiency of Oyster shell by replacing cement in the range of 0% (without Oyster shell), 5%, 10% and 15% with 100% Natural sand and natural coarse aggregates. Four concrete mixes (OSP-0, OSP-5, OSP-10 and OSP- 15 were made by replacing cement with 0 %, 5 %, 10 % and 15 % of Oyster shell powder by mass respectively. The water/cement ratio in all the mixes was kept constant. In view of global warming, efforts are on to reduce the emission of CO2 to the environment. Cement industry is a major contributor in the emission of CO2 as well as in using up high levels of energy resources in the production of cement. Researchers from all over the world are focusing on the ways of utilizing waste, as supplementary cement replacement materials. This waste utilization would not only be economical, but may also help protecting the environment. The replacement of oyster shell powder with cement found to be increase in compressive strength of 10 % replacement. The 10 % replacement shows 5.93 % more strength than conventional concrete
Keywords: Partial Replacement, Oyster Shell, M25 Grade, Test Result

I. INTRODUCTION

Calcium carbonate is one of the most used raw materials in various industries, such as construction materials, food supplement, pharmaceutics, animal feed, plastic production, and others. Calcium carbonate can derive from marine wastes, like crustaceans and bivalve's shells. The worldwide demand for new sources of food has increased exponentially, and following that tendency, especially the oyster culture has been increasingly resorting to farming techniques. In 2016, 438 billion tons of oysters were produced. The majority of the shells were unduly discarded, presenting a public health problem. This study offers a solution based on the reuse and recycling of oyster shell residues in the production region of India.

constituent depending on the size of the specimen. Oyster shells are a viable option because they contain a large amount of calcium carbonate. This can help improve the strength in the concrete Concrete is one of the two most used structure materials in construction. In order to reduce reliance of raw material in concrete producing, the green concrete had been promoted. Green concrete is the concrete that had been produced using recycle or wasted natural materials. One of the ways to produce green concrete is by using modified cement. Cement is the second largest volume materials used by human being after water. Cement plays the role of a binder, a substance that sets and hardens and might bind alternative materials along. During production of cement and hydration process of cement, the amount of CO2 emitted by the industry is nearly 900 kg of CO2 for every 1000 kg of cement produced. This CO2 production causes serious environmental damages. The sea shells are high potential materials to become partial cement replacement and filler in concrete. The calcium carbonate (CaCO3) in the sea shells is more than 90% and is similar to contain of calcium carbonate in the limestone dust that been used in the Portland cement production. Impressively, the crystal structures of seashells are largely composed of calcite and aragonite, which have higher strengths and density than limestone powder. Also, the particle sizes of seashells are between 36μm to 75μm and are similar to the particle size of Portland cement. [1]. Due to the physical and chemical properties of conch and oyster shells, they may be a suitable substitute for cement and aggregates. The crushed shells would be beneficial to the waste industry along with the construction industry. When the shells get crushed they can be substituted for all different types of concrete. Also the calcium carbonate can help improve resistance against heat and chemicals. The shells may increase strength in the concrete due to the uniquely weaved pattern they contain.

A. Shells as a Concrete Component

Shells are currently taking up a large volume in landfills. If they are used in concrete mixes they will have a positive environmental impact. This is beneficial for the industry especially since many admixtures like fly ash are scrutinized for their potential negative environmental impact. Shells can be considered into the aggregate category as well as cement. The shells are a cheaper way to increase the strength of concrete by providing a substance for the cement past to bond to. Shellfish shells gain their strength from a nacre layer that has a crystalline structure in the form of calcium carbonate. Shellfish shells have gained interest in studies revolving around recycled concrete aggregate. The reason why shellfish shells and other seashells are part of this study is because they are easily obtainable from the seafood industry and they have mechanical and chemical properties that make them attractive to the construction industry. After preliminary research, the shells that were chosen are oyster and conch shells. Other shells that could have been used were various types of mussel shells or clam shells. These were selected off of their physical properties as well as their availability. Oysters have high calcium carbonate content and also contain rare impurities that improve strength as well. Oyster shells have been used throughout history to help aid in construction. Quicklime is obtained from oyster shells when the CaCO3 in the shell is heated at an excess of 2000°F or about 1100°C and converted to calcium oxide (CaO), otherwise known as lime. This lime is then used in mortar mixtures and is called tabby. Tabby used in construction has been found commonly in Muslim territories such as Cordoba and Seville in the 15th century for military structures. Perhaps the most common tabby constructed buildings are 11th century British Castles. For example the Wareham Castle, in Dorset, England was found in ruins, but was excavated in the 1950s, revealing that tabby was used for much of the mortaring. For construction purposes, oysters are a viable option because they are easy to acquire and contain high amounts of CaCO3 in the shell's nacre. Nacre, which is commonly called "the mother of pearl", is combined of platelets of CaCO3 within layers of an organic polymer matrix. The combination of the platelets and organic matrix provides the strength of the shell. The shells are readily available, easily cleaned by a combination of scrubbing and bleach, and can be crushed to our size requirements on site.

II. METHODOLOGY

In this project we replace cement by oyster shell powder in various percentage and perform the various test of concrete as below.

A. Test on Hardend concrete like compressive strength, flexural strength, split tensile strength
B. Test on fresh concrete like workability test

To perform this test the we need to cast cube, beam, cylinder

Table No 2.2 Mix Combinations Model Nomenclatures

Sr. No.	Model Name	Replacement
1.	P-100	Control Mix
2.	OSP-5-95	5% oyster shell powder replacement of cement (95% cement + 5% OSP)
3.	OSP-10-90	10% oyster shell powder replacement of cement (90% cement + 10% OSP)
4.	OSP-15-85	15% oyster shell powder replacement of cement (85% cement + 15% OSP)

III. RAW MATERIAL TEST

Following test are performed in laboratory for determining the properties of material

Table 3.1 different test result of material

SR.NO.	Material	Test	Result
1	Cement	Fineness test	8%
		Specific Gravity	3.15
2	Fine aggregate	Specific gravity	2.61
		Fineness test	2.75
3	Coarse aggregate	Specific Gravity	2.65
		Water absorption	0.60%
		Aggregate impact value	18.6%
		Crushing value	18.57%

Table 3.2 Chemical composition of oyster-shell

Sr. No.	Composition	River Oyster	Sea Oyster
1	$CaCO_3$	95.994	89.56
2	SiO_2	1.283	4.04
3	MgO	0.68	0.649
4	Al_2O_3	0.40	0.419
5	SrO	0.35	0.33
6	P_2O_5	0.206	0.204
7	Na_2O	0.98	0.98
8	SO_3	0.724	0.724

Table 3.3 Physical properties of oyster shell

Sr. No.	Color	Ceramic White
1	Specific gravity	1.74
2	Colour	White Powder
3	$CaCO_3$	92.13

IV. MIX DESIGN

Grade of concrete – M25
Type of cement – opc 53 grade
Maximum normal sixe of aggregate – 20 mm
Target mean strength – 31.6 N/mm^2

Table 4.1 mix proportion of M25 grade concrete

SR.NO.	Materials	Quantity (Kg/m^3)	Proportion
1	Cement	437.78	1
2	Natural Sand	641.22	1.46
3	Coarse Aggregate	1178.66	2.69
4	Water	197	0.45

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V. RESULT AND DISCUSSION

A. Compressive Strength

Table No. 5.1.1 Observation of Compressive Strength:

Days	Average Compressive strength		
Mix proportions	7 Days (N/mm^2)	14 Days(N/mm^2)	28 Days(N/mm^2)
OSP-0-100C	21.86	29.30	32.83
OSP-5-95C	23.05	31.30	33.10
OSP-10-90C	24.50	32.90	34.90
OSP-15-85C	24.90	33	34.20

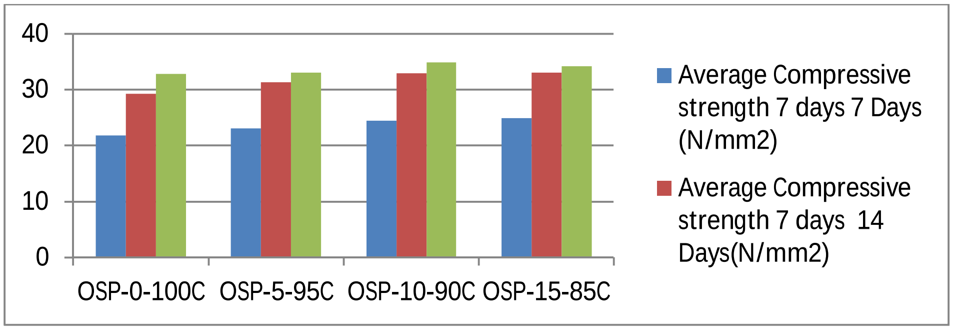

Fig. 5.1.1 Comparison of Average Compressive strength

From the experimental results it is clear that Compressive strength of the M25 Concrete mix when cement is substituted with Oyster shell powder 5 to 10%, then the strength is increased compared with conventional concrete. But in case of 15% the compressive strength is found to not increasing too much up to 7 day and 14 day but its start reducing after 28 day slightly

B. Split Tensile Strength

Table No. 5.2.1 Observation of Split Tensile Strength:

Days	Average Tensile strength		
Mix proportions	7 Days (N/mm^2)	14 Days(N/mm^2)	28 Days(N/mm^2)
OSP-0-100C	1.6	2.1	2.9
OSP-5-95C	1.60	2.4	2.9
OSP-10-90C	1.82	2.2	3.6
OSP-15-85C	1.60	2.1	2.60

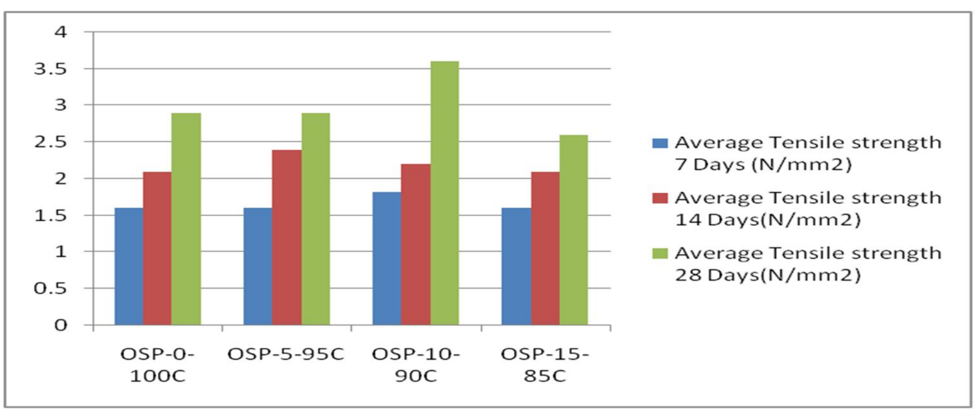

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Fig 5.2.1 Comparison of Split tensile strength

Split tensile strength of concrete specimen with sand and cement (control specimen) 28 days was found to be 2.9 N/mm^2.From the experimental results it is clear that Split Tensile strength of the M25 Concrete mix when cement is substituted with oyster shell powder 5% to10%, then the strength is increased compared with conventional concrete. Oyster shell powder is substituted with cement 15% the compressive strength is found to be reducing.

C. Flexural Strength

Table No. 6.3 Observation of Flexural Strength :

Days	Flexural strength		
Mix proportions	7 Days (N/mm^2)	14 Days(N/mm^2)	28 Days(N/mm^2)
OSP-0-100C	1.95	2.6	3.9
OSP-5-95C	2.2	3.4	4.10
OSP-10-90C	2.55	3.19	3.90
OSP-15-85C	2.45	3.10	3.70

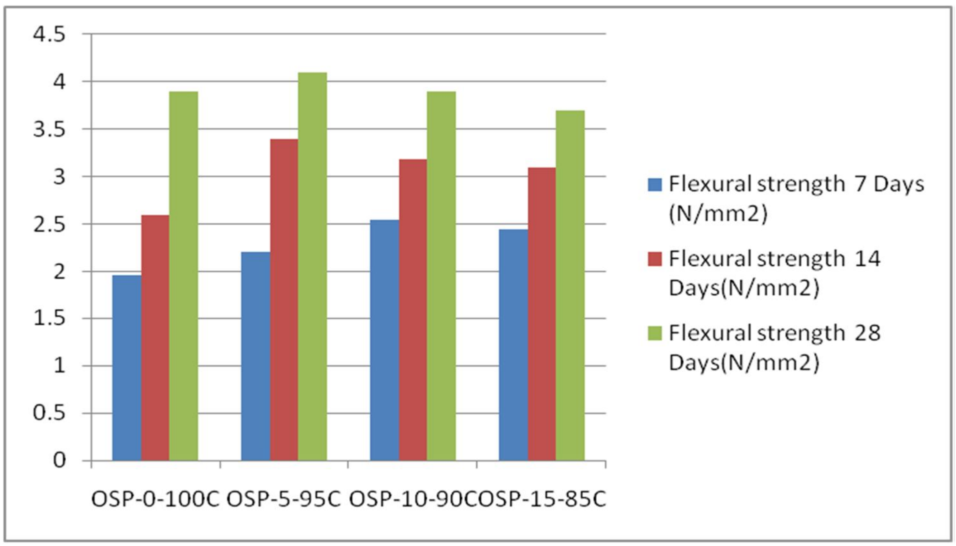

Fig 6.3 Comparison of Flexural strength

Flexural strength of concrete specimen with sand and cement (control specimen) 28 days was found to be 3.9 N/mm^2. From the experimental results it is clear that Flexural strength of the M25 Concrete mix when cement is substituted with oyster shell powder 5%, then the strength is increased compared with conventional concrete. But in case of 10 % and 15 % it shows that flexural strength is start to reduce as compare to conventional concrete

VI. CONCLUSION

Replacement of oyster shell powder with cement found to improve the strength of concrete.

A. The replacement of oyster shell powder with cement found to be increase in compressive strength of 10 % replacement. The 10 % replacement shows 5.93 % more strength than conventional concrete
B. The split tensile strength in 10% replacement is maximum. The split tensile strength is increase by 19.44 % by conventional concrete
C. In flexural test the maximum strength shows in 5 % replacement. The flexural strength is increase by 4.87 % than conventional concrete
D. It is clearly show that the maximum strength obtain in 10 % replacement.
E. If the percentage of replacement is increase the strength started to reduce

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