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Study of Cockle Shell as Replacement of Aggregate in Concrete

V.Sravani [a],D.Mohammed Rafi [b]

[a]M.tech Student,Civil engineering, CRIT College, and Anantapur,Andhra Pradesh,India
[b]Asst.professor,Civil engineering, CRIT College, and Anantapur,Andhra Pradesh,India

A B S T R A C T

This research focused on investigating the effect of cockle shell content when used as partial coarse & fine aggregate replacement towards workability, compressive strength and tensile strength of concrete. For this research, seven different percentages that is 0%, *5%*, 10%, 15%, 20%, 25% and 30% of cockle shell has been used which produces several type of concrete mixes. Slump test has also been conducted to study the effect of various mixing ingredients toward the workability of concrete. Specimens of 150mm x 150mm x 150mm has been cast and cured in water until 90 days. The compressive strength of the specimens has been tested at 7 days, 14 days, 28 days and 90 days. All the experiments conducted accordance to the existing standard.

Keywords: Cockle,Compressive Strength,Slump,Tensile Strength.

INTRODUCTION

In this phase of globalization, the construction companies are considered to be a major productive sector, which incessantly growing demand increased, at the same time the need for concrete material production, such as fine aggregate and coarse aggregate is increased. The moment will come where the resource of natural aggregate will soon decrease and will encounter a reduction in its supply. Aggregates are obtained from two primary sources, namely quarries and river beds. The environmental problems occur when the rate of extraction of sand, gravel and other materials exceeds the rate at which natural processes generate these materials.

In sort to defeat this issue, various types of dissipate materials has been analyzed and investigated their capability and potential to be used as partial coarse & fine aggregate replacement material in concrete production. The best of author's knowledge, no work has been reported on the properties of concrete containing cockle shells as partial coarse and fine aggregate replacement material. Integration of cockle shell as partial coarse and fine aggregate replacement could reduce consumption of natural aggregates use and also contribute towards cleaner environment.

Significance of study

This research is imperative to increase information on effect of mixing cockle shell in concrete towards workability, compressive and tensile strength of concrete produced using cockle shell as aggregates replacement. Usage of cockle shell in concrete production would reduce the quantity of cockle shell ending at landfill thus assisting towards cleaner environment. Furthermore, integration the excessive use of gravel and river sand can be reduce and avoid the depletion of natural coarse & fine aggregate in future.

LITERATURE REVIEW

K. Muthusamy and N. A. Sabri – "Cockle Shell: A Potential Partial Coarse Aggregate Replacement in Concrete."

This paper presents the result on the workability and compressive strength of concrete containing various percentage of cockle shell content as partial coarse aggregate replacement

Seni Gunaan & Kreatif – "Cockle Shell as an alternative construction material for Artificial Reef."

Cockle shell is abundantly available in Malaysia as a by-product from seafood industry. This waste is not yet exploited in other applications except that it has been used in small-scaled craft production. The mineral composition of the cockle shell which consist of Calcium (Ca), Carbon (C), Magnesium (Mg) and Silica (Si) which is similar to that sand, gravel and cement suggest its potential as an alternative material in fabricating artificial reef.

the shell.

Nurazzimah Zamri, K. Muthusamy: "Exploratory study on the use of crushed cockle shell as partial sand replacement in concrete."

This research explores the potential use of cockle shell as partial sand replacement in concrete production. Cockle shell used in this experimental work were crushed to smaller size almost similar to sand before mixed in concrete. A total of six concrete mixtures were prepared with varying the percentages of cockle shell viz. 0%, 5%, 10%, 15%, 20% and 25%. All the specimens were subjected to continuous water curing. The compressive strength test was conducted at 28 days.

Methodology

This chapter more on method for preparation and test used in this experiment. It will start with the flow of methodology for this study which is the summary of methodology for this project. It will be continued by the preparation of materials, where the materials are water, cement, river sand as the fine aggregate, cockle shell as partial coarse aggregate replacement and crushed cockle shells as partial sand replacement. Next in this chapter will discuss about mix design and samples preparation. Samples involve are cubes and cylinders. It will explain how the samples are made. Finally, it will follow up by explanation of testing method. Laboratory testing involve in this section is compressive strength and also split tensile strength test.

Water

Water is essential in concrete as it allow hydration process to occur. Without water, there will be no reaction between cement and other concrete materials. Water will react with cement to produce C-S-H gel. In any mix, water use should not be contaminated it should be in neutral state with pH level not less or more than 7. In this research, the water use is tap water which is supply nearby concrete lab in UMP.

Cement

In concrete, cement act as a binder. It will bind the aggregate together to become one fine solid concrete. Cement becomes a binder once it reacts with water. Immediately after cement is in contact with water, a chemical process will occur. The process is known as hydration process. In hydration process, cement and water will combine and produce substances such as lime crystal, Ca(OH)2, some unhydrated cement and calcium silicate hydrate gel (C-S-H). The substance that responsible for binding all the materials is CSH gel. It will act as a paste and bond all the material to become a solid concrete.

Fine Aggregate

Sand is used as fine aggregate in concrete. The main function of fine aggregate is to make the concrete denser. Sand is small in size, which allows it to slip through into void between coarse aggregate. The lesser the void inside concrete the denser it will be. Hence it will increase it mechanical strength and durability. River sand and crushed cockle shell are used as the fine aggregate in concrete in this research.

Coarse Aggregate

The coarse aggregate used in concrete mix is of nominal size of 20 mm aggregates with a specific gravity of 2.7. The partial aggregate used in this research is Cockle shell.

Cockle Shell

A group of mostly small, edible, saltwater clams, marine bivalve molluscs in the family Cardiidae is known as cockle. Abundant species of cockles live in sandy, sheltered beaches throughout the world. The distinctive rounded shells of cockles are bilaterally symmetrical, and are heart-shaped when viewed from the end.

Workability test

Workability is the ability of fresh (plastic) concrete mix to fill the form/mould properly with the desired work (vibration) and without reducing the concrete's quality.

Workability is measured by performing the following two tests:

i) Slump Cone Test

ii) Compaction Factor Test

i) Slump cone Test:

Slump test is the most commonly method for measuring the consistency of concrete which can be employed either in laboratory or at site of work. The internal surface of the mould is thoroughly cleaned and freed from moisture and adherence of any old set concrete before commencing the test.

ii) Compaction Factor Test

The compacting factor test is one of the most efficient tests for measuring the workability of concrete. This test is designed primarily for use in the laboratory but it can also be used in the field. It is more precise and sensitive than the slump test and is particularly useful for concrete mixes of very low workability as are normally used when concrete is to be compacted by vibration. Such dry concrete are insensitive to slump test

Compressive Strength

Compressive strength test is carried out to determine the maximum load that can be withstand by concrete. It is depended on the mix design and curing conditions of the concrete. Compressive strength of concrete under moisture curing is greater than air curing at 90 days. The 28 days compressive strength of the concrete will decrease with the increase of percentage aggregate in the concrete specimen. It shows that the total aggregate volume in concrete will influence the strength of concrete. Higher aggregate density and lower water-cement ratio will enhance the compressive strength of the concrete.

Split tensile Strength

Tensile strength can be obtained through splitting cylinder tensile strength test. The tensile strength was proportional to the compressive strength of the concrete. Increasing of the percentage of coarse aggregate in concrete will decrease the tensile strength. Aggregate quality, water absorption coefficient of aggregate, and macro-porosity of aggregate would definitely affects the tensile strength of the concrete. Basically, it can be seen that tensile strength of the concrete is directly influenced by the compressive strength of the concrete which determined by the aggregate characteristic and also curing method

DISCUSSION OF THE TEST RESULTS

Discussions

The study found that addition of cockle shell as partial coarse aggregate replacement reduces the concrete workability due to its shape and rougher texture. However, it is motivating that the replacement of natural coarse aggregate by cockle shell at a level of 25%, fine aggregate by crushed cockle shell at a level of 10% and both aggregates replacement by crushed & uncrushed cockle shell at 10%, 25% are increased in compressive strength and also to the compared to control specimen. Integration of too much of cockle shell produces harsher mix which causes disrupt the strength performance

% Replacement	Coarse aggregate replacement			
	7 days	14 days	28 days	90 days
0%	27.00	391.56	47.22	52.78
5%	15.00	17.44	22.44	41.34
10%	19.44	25.22	38.56	43.58
15%	21.89	26.78	44.03	48.59
20%	22.78	28.78	46.94	50.94
25%	29.67	32.33	48.65	53.63
30%	20.56	31.09	40.04	44.38

Compressive strength of Cockle shell concrete cubes (N/mm^2)

Split tensile strength

Percentage Replacement	28 days		
	Coarse aggregate	Fine aggregate	Combined
0%	4.76	4.78	4.77
5%	3.36	4.75	4.79
10%	4.30	4.86	5.05
15%	4.59	4.547	4.84
20%	4.74	4.14	4.87
25%	4.83	3.874	5.14
30%	4.38	3.58	4.83

Split tensile strength test of Cylinder at 24days (N/mm^2)

Percentage Replacement	90 days		
	Coarse aggregate	Fine aggregate	Combined
0%	5.03	5.03	5.02
5%	4.34	5.04	5.15
10%	4.57	5.10	5.22
15%	4.82	4.61	5.4
20%	5.01	4.52	5.12
25%	5.07	4.22	5.26
30%	4.61	4.12	5.12

Split tensile strength test of Cylinder at 90days (N/mm^2)

CONCLUSION

1) Mix containing cockle shells as partial coarse aggregate replacement.

The study found that addition of cockle shell as partial coarse aggregate replacement reduces the concrete workability due to its shape and rougher texture.

However, it is motivating that the replacement of natural coarse aggregate by cockle shell at a level of 20%, there is an increase in both compressive strength and tensile strength and also to the compared to control specimen.

2) Mix containing crushed cockle shells as partial fine aggregate replacement

By this mix we found that addition of crushed cockle shell as partial fine aggregate replacement increases the concrete workability due to its powder form as sand.

And also it increases the both compressive strength and tensile strength of concrete at the level of 15% replacement.

3) One more mix containing crushed cockle shell as partial fine aggregate replacement and also uncrushed cockle shells as partial coarse aggregate replacement.

The combination of both cockle shell and crushed cockle shell (powder) as partial coarse and fine aggregate replacement reduces the concrete workability due to its shape and rougher texture.

It is Surprising that the compressive strength and tensile strength is increased at the level of both 15% and 20% replacement.

The integration of too much of cockle shell produces harsher mix which causes disrupt the strength performance

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