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Exploratory study on the use of cockle shell as partial Coarse & Fine aggregate replacement in concrete

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Abstract - *Effort towards protecting natural coarse aggregate and sand for future generation and possibility of integrating cockle shell waste in concrete production. This paper result on the workability, compressive & tensile strength test of concrete with various percentage of cockle shell as partial coarse and fine aggregate replacement. Concrete mix containing 0%, 5%, 10%, 15%, 20%, 25% & 30% cockle shell replacement levels before subjected to water curing for 3 days, 7 days, 28 days & 90 days. The replacements of fine and coarse aggregate are separately & combined casting. Workability, compressive and tensile strength test were conducted in accordance to IS 456.*

Key Words: Cockle shell, Partial coarse & fine aggregate replacement, Tensile strength, Compressive strength.

1. INTRODUCTION

The demand of construction industry is considered, at the same time the need for concrete material production, such as fine aggregate and coarse aggregate increased. The sources of natural aggregate will soon decrease in its supply. Aggregates are obtained from two primary sources, viz. quarries and river beds. The environmental problems occur when the extraction of sand, gravel and other materials exceeds the rate.

To overcome this issue, waste materials has been analyzed and investigated their capability and potential to be used as partial coarse & fine aggregate replacement material in concrete production. By integrating the cockle shell as partial coarse & fine aggregate replacement could reduce consumption of natural fine aggregate use and also contribute towards cleaner environment.

2. EASE OF USE

3.1 Objectives of the study

i. To investigate the effect of concrete containing various percentage of cockle shells as partial coarse aggregate replacement towards compressive strength of concrete.

ii. To investigate the effect of concrete containing various percentage of crushed cockle shell as partial fine aggregate replacement towards compressive strength of concrete.

iii. To investigate the effect of concrete containing various percentage of crushed cockle shell as partial fine aggregate replacement towards workability of concrete.

3.2 Scope of study

Investigate the effect of cockle shell as partial coarse & fine aggregate replacement towards workability, compressive strength and tensile strength of concrete. There are four types of mix use in this study that is

i. Plain concrete with 100% of natural coarse & fine aggregate.

ii. mix containing cockle shells as partial coarse aggregate replacement.

iii. mix containing crushed cockle shells as partial fine aggregate replacement and

iv. another mix containing crushed cockle shell as partial fine aggregate replacement and uncrushed cockle shells as partial coarse aggregate replacement.

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 types of concrete mix. The mixes will be used to produce cubes and is subjected to water curing for 7, 14, 28 and 90 days.

3. EXPERIMENTAL PROGRAM

3.1 Materials

In the preparation of the concrete specimen for the experimental work, the mixing ingredients used are ordinary Portland cement, river sand, granite, cockle shell, and tap water. Both fine and coarse aggregates are collected from the local suppliers. Cockle shells used in the investigation were obtained from a dumping site located in a district of East

Godavari, Kakinada, A.P. The cockle shell at dumping site were filled in the gunny sack and brought to the laboratory for further processing. Then, the shells are cleaned carefully until the mud on its surface was removed. Then, it is dried out and crushed to be fine using crusher for fine aggregate before use for concrete mix. Crushed cockle shells appear additional whitish as compared to river sand.

3.2 Physical properties of aggregates

To get a desirable mixture, physical properties of aggregate is very important. Shape, texture, size gradation, moisture content, specific gravity, and unit weight are the some examples of the properties. The strength, workability and durability of concrete can be determined along with water-cement ratio. The properties of fresh concrete easily affected by the aggregate shape and texture compared to hardened concrete, therefore, riverbeds are suitable. A workable mixture can be produced by using crushed stone where it produces much more angular and elongated aggregates. The aggregates have a higher surface-to-volume ratio and it requires more cement paste to get a better bond characteristics as well as to produce a workable mixture.

Table 1: Physical Properties of Aggregates

Property	Fine Aggregate	Coarse Aggregate
Specific gravity	2.63	2.7
Fineness modulus	3.25	6.61
SSD absorption (%)	0.86	1.12
Void (%)	36.2	39.6
Unit weight (kg/m²)	1690	1815

Commonly the designers and contractors have more flexibility in designing and construction requirement as there are various properties of aggregate.

3.3 Physical Properties of Cockle Shell

Cockle shells is the name of a group of family double shell cardiidae that is one commodity body comes in a variety of forms like reinforcement on the outside as shown in Fig -1 In contrast to most double shell, clams are hermaphrodites. Composition of cockle is tabulated in Table 2.

Table 2: Minerals composition of cockle shell

Component	Percentage (%)
Continuous assessment component (Cac)	98.7
Magnesium (Mg)	0.05
Sodium (Na)	0.9
Phosphorus (P)	0.02
Others	0.2

Fig -1: Cockle shell

3.4 Ranges of the quantities of the Constituent Materials

Typical ranges of proportions and quantities of the constituent materials are given below:

i. Water content: 176 to 180 kg/m^3 It should not exceed 200 kg/m^3.
ii. Cement content: 350 to 450 kg/m^3.
iii. Coarse aggregate content: 35 to 45% by volume of the mix, i.e., 900 to 1200 kg/m^3 of concrete.
iv. The sand content balances the volume of other constituents. Sand ratio should be taken in the range of 25 to 35%.

4. RESULTS AND DISCUSSION

As experimental investigation, the replacement of fine aggregate by crushed cockle shell at 10% contributes towards development of concrete strength. The replacement from 5% and 10% manage to aid towards achievement of higher concrete strength than plain concrete. Probably, the strength increment is due to the effective function of crushed cockle shell as space filler. More than 10% replacement, the compressive strength continuously falls down as content of crushed cockle shell increases.

From chart-1, it is indicated that, combination of suitable crushed and uncrushed cockle shell content could be used to replace natural fine & coarse aggregate for concrete production having improved compressive strength. The act of concrete contains crushed cockle shell as partial sand replacement both in terms of mechanical properties as well as durability aspect.

4.1 Compressive strength

The capability of a concrete to resist the loads liable to lessen the dimension is termed as compressive strength of concrete cube specimen. The compressive strength test is made for cube specimen of sizes 150*150*150mm for 28 days of curing. The test results are shown in fig 4.

Fig -2 Compressive test on cube

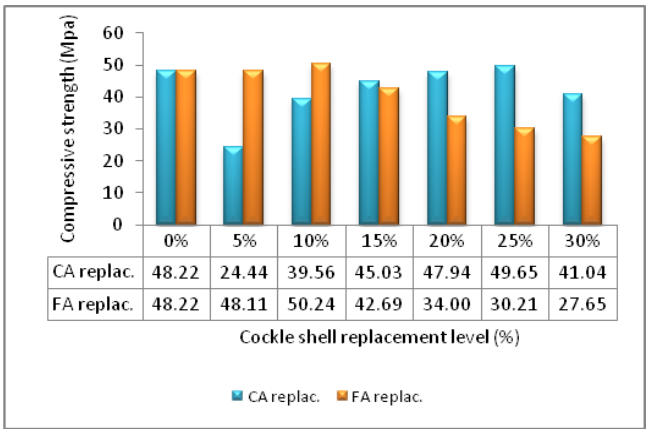

Chart-1: Compressive strength of concrete containing various content of cockle shell at 28days

4.2 Split Tensile strength

The concrete is incredibly weak in tension due to its easily broken nature and it cannot resist the direct tension. The concrete develop cracks when load is subjected to tensile forces. Thus, it is essential to conclude the tensile strength of concrete at which the concrete member may crack. The split tensile strength of concrete cylinder is observed at 28 days of size 300mm * 150mm in diameter. Chart -2 shows the graphical image of split tensile strength.

Fig -3 Tensile test on cylinder

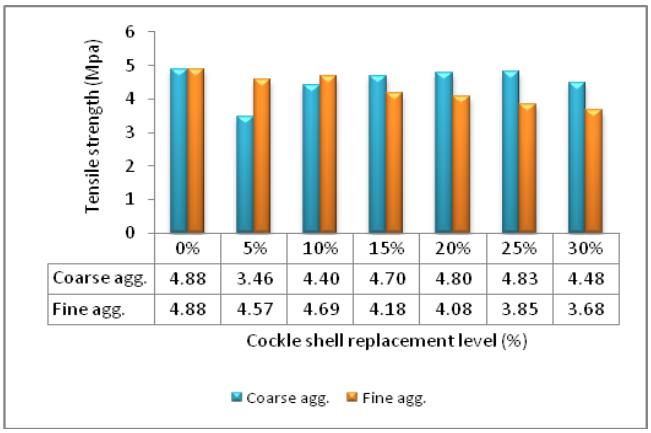

Chart-2: Splitting tensile strength of concrete containing various content of cockle shell at 28days

3. CONCLUSIONS

The study found that addition of cockle shell as partial coarse and fine 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% and fine aggregate by crushed cockle shell at a level of 10% resulted in increase of 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.

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