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Parametric Study on Concrete by Partial Replacement of Aggregates with Sea Shells and Coconut Shells

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***Abstract*—** Use of sea shells and coconut shells in concrete has attracted widespread attention from construction industry due to the multiple sustainability benefits they offer. This paper critically reviews the current state of knowledge and technology of using sea shells and coconut shells to concrete. Detailed review on the various preparation techniques and the resulting properties of sea shells and coconut shells are presented and the effects of sea shells and coconut shells on the fresh and hardened concrete properties are discussed in this paper. The effect of sea shells and coconut shells on workability, plastic shrinkage, and compressive strength, splitting tensile strength, flexural strength, crack behavior and dry shrinkage is discussed in this paper. Pull-out behavior of the coconut shell in the concrete are also reviewed. Finally, some applications of the sea shells and coconut shells concrete are discussed.

Key words: Sea shells concrete, Coconut shells concrete, fresh properties of sea shells and coconut shell concrete, compressive strength

I. INTRODUCTION

The concept of environmentally friendly technology has inspired the researchers to do more in protecting the environment. Utilization of waste materials as alternative building materials has become the popular way to overcome the environmental problem in most developing countries. Waste materials such as Coconut Shells and Sea Shells have great potential to be used as building materials.

The basic constituents of concrete are cement, water and aggregate. In which aggregate tends to represent a relatively high volume percentage of concrete. Recent investigation of sea shells and coconut shells has indicated greater scope for their utilization as construction material (1-4). Greater utilization of sea shells and coconut shells will lead to not only saving such construction material but also assists in solving the problem of disposal of these waste products.

Sea shell is also known as shell which possess hard, protective outer layer created by an animal that lives in the sea. The sea shell is a part of the body of the animal. Empty seashells are often found washed up on beaches. The shells are found empty because of the animals are died in the shells and the soft part of the shell is eaten by another animal or have rotted out.

Seashells are found large quantities in the Asian ocean and Pacific Ocean. There is large quantities of calcium carbonate is present in shells such as oyster shells are sometimes used as soil conditioners in horticulture in some areas(2). The shells are broken or ground into small pieces in order to have the desired effect of raising the pH and increasing the calcium content in the soil.

Coconut shell waste is an agricultural biodegradable waste found in most of tropical countries especially in Asia India manufactures 15,730 million nuts annually, which is next to Indonesia with 16,498 million coconut shells dumped improperly to the environment provide breeding places for disease vectors such as rats and mosquitoes(3). It is a light-weight material which is becoming much popular nowadays because of its easy handling and low dead loads. It is a good alternative to wood and helps to prevent deforestation and also inexpensive.

II. PREPARATION AND PROPERTIES OF COCONUT SHELLS AND SEA SHELLS

Sea shells have higher amount of CaCO3 (91.18%) slightly greater than lime stone. The physical properties of sea shells were Specific gravity (2810 kg/m3) and Water absorption (0.80%). Disadvantageous reactions at the interface between cement and OS or formation of new materials were not found, and cement hydrates and OS are independently detected (2).

Durability of an aggregate is a measure of its resistance to wear, moisture penetration, decay and disintegration. The

hardness of the CSs and SSs was measured by the durability test using the Los Angeles abrasion method. The test results were 3.65% and 27.18% % respectively. The test results of impact value test of CSs and SSs were found 2.22% and 25.44% respectively. The test results of crushing value test of CSs and SSs were found 6.38% and 29.87% respectively. This implies that concrete made from these types of aggregate will possess a high degree of resistance to wear and can be used in the production of concrete intended for floors and pavements expected to be subject to heavy human traffic(3). In all cases the density of the concrete produced decreased with increase in the percentage replacement of conventional coarse aggregate (gravel) with CSs (3).

The moisture contents of the coconut were found to be 5.13% .The water absorption capacity of CS was found to be 6.17% (8). Absorption capacity is a measure of the porosity of an aggregate. Since the values obtained are low, it is reasonable to conclude that the shells absorb very little amount of mixing water during concrete production (8). These values are also within the range of absorption capacity of lightweight aggregates which have been put at 5–20% (Portland Cement Association). The unit weight (density) and the specific gravity of the shells are 1738 kg/m3for CSs. These figures fall below the 2.5–3.0 range of specific gravity for normal weight aggregates. The CSs can therefore be classified as lightweight aggregates, the CSs having higher density and specific gravity (9).

III. TEST RESULTS OF SEA SHELLS AND COCONUT SHELLS CONCRETE

A. Fresh Concrete Properties

1) Slump

Workability of fresh concrete can be determined through a slump test. Sea shell concrete probably has better workability due to the smooth surface on outer side of the shells and also due to smaller size of SS used in the study. The test results are shown in figure1.

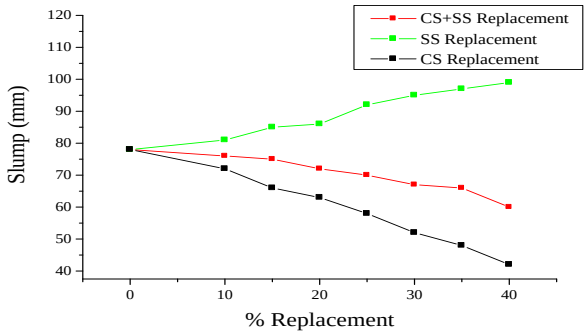

Figure :1 Workability test result

As shown figure 1, workability of concrete slightly decreases as the percentage of CS+SS replacement increases. With only replacement of sea shell there is increase in workability as the percentage replacement increases. The test results show that the workability is decreases as the percentage replacement of coconut shell increases.

B. Hardened Concrete Properties

1) 7- days Compressive Strength

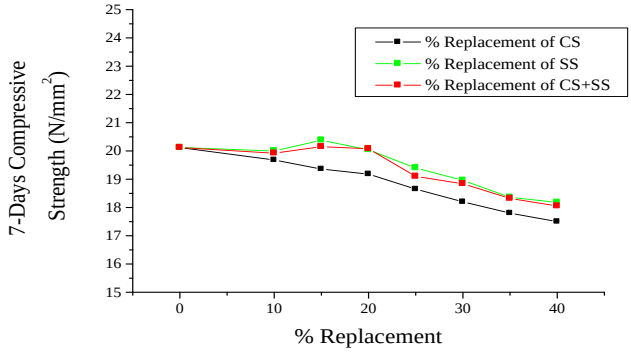

Figure 2 Compressive strength test result at 7-days

From figure 2 it is observed that the strength is gradually increases up to 20% replacement of CS+SS. With only use of SS, strength is increases up to 15% replacement as compare to CS. But after addition of coconut shell with sea shell there is slight reduction in strength as compare to SS replacement with coarse aggregate.

2) 28-Days Compressive strength

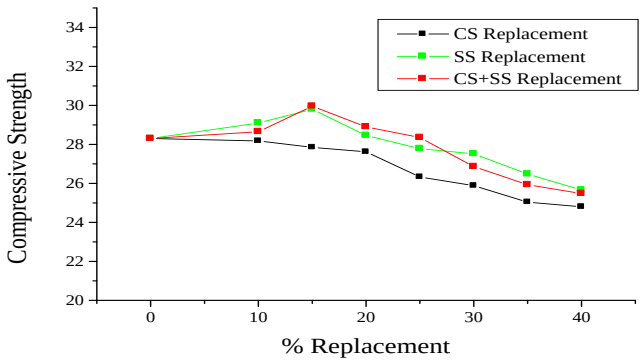

Figure 3 Compressive strength test result at 28-days

The compressive strength of concrete at 28 days was maximum with 15% CS and SS replacement. At 28 days, compressive strength with SS replacement is more than 28 days compressive strength with CS replacement.

3) Flexural Strength

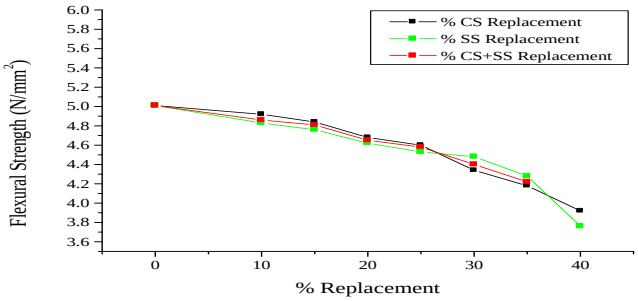

Figure 4: Flexural strength test result at 28- days

For the selected mixes, cement: Fine: aggregate. The splitting tensile strength of coconut shell concrete at 28-days was as shown in figure 4. There is maximum flexural strength found using 15% CS and SS replacement. Flexural strength is slightly greater with CS replacement as compare to SS replacement.

5) Split tensile strength

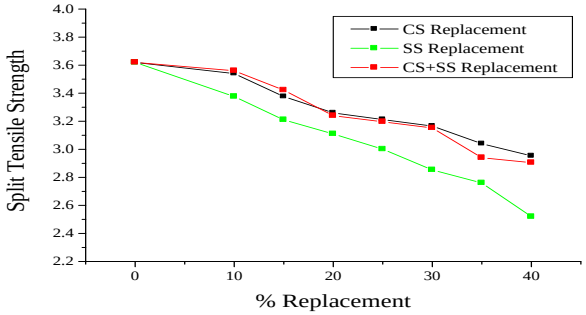

Figure 5: Split tensile strength test result at 28- days

From figure 5 it is observed that split tensile strength at 10% CS+SS replacement is nearby same as split tensile strength of conventional concrete.Split tensile strength is decreases as percentage replacement of CS and SS increases.

6) Water absorption test

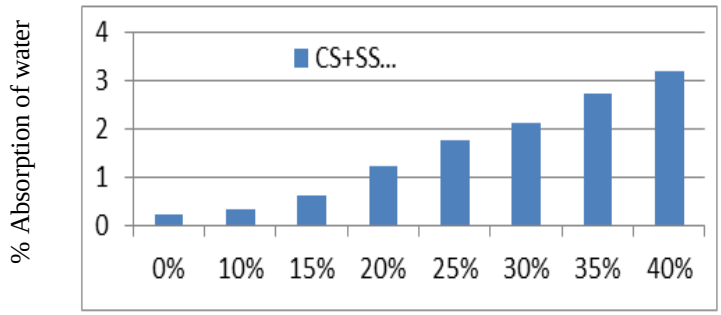

Figure 6: Water absorption test result

Percentage of water absorption is increases as percentage replacement of CS and SS increases. Figure 6 shows an increase in the water absorption of the block when the replacement dosage increases. Statical analysis of the result reveled that control, 10% replacement dosage is slightly or no difference in their water absorption value after 28 days. At the higher replacement level of 20%, 30%, and 40%, the absorption increased 4.04%, 7.48%, and 11.88%, after 28 days. The increase in water absorption is attributed to the increase in porosity of the block containing sea shells and coconut shells concrete.

7) Sulphuric acid attack test

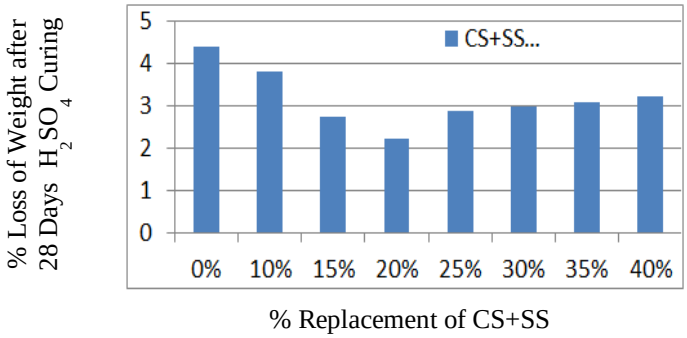

Figure 7: Sulphuric acid attack test result

From figure 7 it is observed that At 28 days sulphuric acid curing percentage loss of weight is decreases up to 20% replacement with CS+SS aggregate with conventional aggregate after furthermore replacement the weight loss is slightly increases. Percentage loss of compressive strength is decreases up to 20% replacement with CS and SS.

7) Packing Density Test Results (15% CS+SS Replacement)

Packing density of sea shell and coconut shell concrete was found as total Packing Density = 0. 9965 gm/cm^3 and Void Content =0.35%.

8) Water permeability test result

Conventional Concrete	2.2×10^{-6} mm/s
Concrete with 15% CS+SS Replacement	2.8×10^{-6} mm/s

Table 1: Water permeability test results

At 15% replacement of coarse aggregate with CS and SS concrete, water permeability is greater than that of the control concrete.

IV. APPLICATIONS OF SEA SHELLS AND COCONUT SHELL CONCRETE

Sea shells and Coconut shells found large in quantities at coastal areas. Coconut shell waste is an agricultural biodegradable waste found in most of tropical countries especially in Asia. India manufactures 15,730 million nuts annually, which is next to Indonesia with 16,498 million. It is a light weight material which is becoming much popular now a day because of its easy handling and low dead loads.

Sea shells are found large quantities in Asian and Pacific Ocean. There is large quantities of calcium carbonate is present in shells such as oyster shells are sometimes used as soil conditioners in horticulture in some areas.

Sea shells and Coconut shell can be used as Coarse aggregate in place of conventional aggregate in concrete. The sea shell and coconut shell concrete can be used as non-structural works such as road pavement design, minor bridges, slab, foundation where heavy loading is not expected.

V. CONCLUSION

Use of sea shells and coconut shells as aggregate in concrete Instead of conventional aggregate becomes appealing to Scientists and concrete industries. This paper has presented the current state of knowledge of using sea shells and coconut shells in concrete.

The major conclusions drawn from the study are:

- There is decrease in workability as the replacement level of CS and SS increases, and hence water consumption will be more for higher replacements.
- Relative to replacement of 15% CS and SS with Coarse aggregate, the maximum compressive strength is obtained at 28 days.
- There is in Reduction in flexural strength is observed after use of 15% CS and SS.
- Split tensile strength is slightly gradually decreases as percentage replacement of CS and SS increases.
- Water absorption is increases as percentage replacement of CS and SS increases.
- Sulphuric acid attack is improved with percentage replacement of CS and SS increases at 28 days.
- Sodium chloride attack is not much more affected to concrete with CS and SS.
- Good packing density is found at 15% replacement of CS and SS with coarse aggregate.
- At 15% replacement of coarse aggregate with CS and SS concrete, water permeability is greater than that of the control concrete.

From the above study we conclude that from economical view 15% (7.5%CS + 7.5%SS) replacement is preferable in the perspective of strength and durability.

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