Experimental Study on Concrete With Partial Replacement of Coarse Aggregate with Cashew Shells

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Abstract. Concrete is a mix of cement, fine aggregate and coarse aggregate with water in correct proportion. Many attempts had been to replace the fine aggregate, coarse aggregate and cement in concrete. In this row replacement of coarse aggregate by cashew shells was tried. Over 66% of the overall country export cashew kernels. The cashew seeds is well acclaimed for its good quality and appearance. Concrete cubes and beams had casted using cashew shell as a partial replacement of the coarse aggregate in the proportion of 10%, 20% and 30% replacement. the specific gravity of the shell was analyzed and 16mm shell were selected for the experiment. The characteristic of concrete was determined and the result showed that 10% replacement of shell with coarse aggregate gives the optimum strength.

Keywords: Concrete, Cashew shell, compressive strength, aggregates, replacements.

1. Introduction

Concrete matrix is a combination of cement, coarse aggregate and fine aggregate which is primarily derivative of the normal properties [1][2]. The existing sustainable green building Rating systems estimate the life of the buildings depends on the several groups in which the material used for construction is one such group in most of the systems. Problems similar to expulsion of Co2, sands and aggregate, demolished waste material in concrete look less well-suited with ecological condition of a modern sustainable construction industry [3]. Similarly, concrete also prepared using wastes from agriculture had shown good thermal property in investigates which result in improving as a green environment opinion in the energy and a proper atmosphere category of the Leadership in Energy and Environmental Design rating system [4][11].

The wastes that produced from the farming was used as a fine aggregate in concrete are sugarcane bagasse ash, peanut shell, tobacco waste, oyster shell, rice husk ash, cork and, sawdust. And the cost of quantity of coarse aggregate (natural resource) for making cement concrete is disturbing the development of building industry in many parts of the country. Some of the substitute materials previously had been used as a part of coarse aggregate. For example, coconut shell, palm kernel shell, seashell, cockle shell and recycled concrete were used in concrete mixture as a partial replacement of coarse aggregate [5] [6]. The main objective of the study is to develop a green and economical substitute to coarse aggregate by using these shells and to determine the performance of concrete by replacement of cashew shell slag in various percentage.
2. Materials and Methods

2.1 Cashew Shells
Cashew nut shells are biomass harsh environment that can offer energy through diverse ways. These are agro wastes formed from cashew nut. The cashew nut tree (Western Anacardium) raises from both naturally and through strategic agricultural performs in semitropic countries like Brazil, Nigeria and Ghana. The cashew includes of about 30 to 40% nut and 60 to 70% of shell. When the nut was taken by everyone, the shells of these nuts were very rigid, with a thickness of 1 to 2mm is normally waste. Cashew shells typically contain: 11% water and 3% ash shown in figure 2.1.

These cashew shells were used concrete with a replacement of coarse aggregates by varying the ration of 10%, 20% and 30%. The properties of the material used in the concrete were given below in table 2.1, 2.2 and 2.3.

![Fig 2.1 Cashew Shell](image)

| S.No | Property                  | Fine aggregate | Coarse aggregate |
|------|---------------------------|----------------|------------------|
| 1    | Specific Gravity          | 2.5            | 2.66             |
| 2    | Fineness Modulus (%)      | 2.7            | 5                |
| 3    | Grading                   | Zone II        | Zone II          |

**Table 2.1 Properties of Fine Aggregate**

| S.No | Property                  | Standard Value                      |
|------|---------------------------|-------------------------------------|
| 1    | Consistency (%)           | 36 IS:4031(part-4)- 1988            |
| 2    | Initial setting time      | 30min                               |
| 3    | Final setting time        | 600min                              |
| 4    | Specific gravity          | 3.10                                |
| 5    | Fineness of cement (%)    | 1.26 IS:4031(part-1) 1996           |

**Table 2.2 Properties of Cement**
Table 2.3 Properties of Cashew Shells

| SL.No | Description          | Value        |
|-------|----------------------|--------------|
| 1     | Specific gravity     | 1.57         |
| 2     | Size Classification  |              |
|       | Small                | 16 mm        |
|       | Medium               | 16 to 20 mm  |
|       | Large                | > 20 mm      |
| 3     | Surface area         | 2410 mm²     |
| 4     | Bulk Density         | 321.57 kg/m³ |
| 5     | Friction coefficient | 0.51         |
| 6     | Angle of repose      | 23.915       |
| 7     | Terminal velocity    | 4.91 m/s     |
| 8     | Thermal conductivity | 0.815 W/m°C  |
| 9     | Calorific value      | 4963.63 kcal/kg |

3. Result and Discussion

3.1 Casting of specimen
The cube was prepared by placing all the material such as cement, coarse aggregate and fine aggregate in a dry form and then water is added to the mixture. The cashew shell is added separately at percentage replacement of coarse aggregate at 10%, 20% and 30%. The concrete cube was casted in steel moulds and compacted by using the tamping rod. The test specimens were stored dried for a period of twenty four hours and marked specimens were put for curing process. Curing is done for all in 28 days evenly for all concrete mix. The specimens were subjected for the following tests compressive strength test (size of 150 x 150 x 150mm), shown in fig 3.1.

3.2 Testing on Concrete
The replacement of coarse aggregate by cashew shells by 10%, 20% and 30% was done and cubes and beams were tested for its flexural rigidity. 30% replacement by cashew shells gives lesser strength. 20% replacement of coarse aggregate gives higher strength when compared to the 30% replacement. Now, finally our successful concrete cube of replacement of coarse aggregate by cashew shells is 10%. It is better than the other replaced concrete cubes. The test result was shown in table 3.1 and 3.2. The figure 3.2 shows the optimum strength of the replacement of concrete.
Table 3.1 Result of Compression Strength

| Sl.No | Grade | Specimen trial | Partially replacement of coarse aggregate in (%) | Compressive strength (7 days) N/mm² |
|-------|-------|----------------|-----------------------------------------------|----------------------------------|
|       |       |                | Coarse Aggregate | Cashew Shell                      |                                  |
| 1     | M20   | 1              | 100              | -                                | 15.6                             |
| 2     |       | 2              | 90               | 10                               | 14.35                            |
| 3     |       | 3              | 80               | 20                               | 12.8                             |
| 4     |       | 4              | 70               | 30                               | 11.9                             |
|       |       |                |                  | Average of compression strength    | 13.66                            |

Table 3.2 Result of Flexural Strength

| Sl.No | Grade | Specimen trial | Partially replacement of coarse aggregate in (%) | Compressive strength (7 days) N/mm² |
|-------|-------|----------------|-----------------------------------------------|----------------------------------|
|       |       |                | Coarse Aggregate | Cashew Shell                      |                                  |
| 1     | M20   | 1              | 100              | -                                | 3.0 (as per std 3.13)            |
| 2     |       | 2              | 80               | 20                               | 2.7                              |
|       |       |                |                  | Average of flexural strength      | 4.55                             |

Fig 3.2 Optimum Level of Compression Strength
4. Conclusion
Cashew shell having 20% and 30% replacement of coarse aggregate shows less compressive strength when compare to M20. This can be used instead of sea shell also. So it can use the cube structure as temporary structure and if add some of the strengthening material alike chicken feather fiber, plasticizer etc., It gives strength to the replaced cubes. And the flexural strength of cashew shells concrete beam M20 which have 20% replacement of coarse aggregate shows higher strength compared to conventional specimen. In this case it can be used for beam as a permanent structure.

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