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# Experimental Study on Light Weight Concrete Using Coconut Shell and Fly Ash

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***Abstract:*** ***Aggregates provide volume at low cost, comprising 66% to 78% of the concrete. With increasing concern over the excessive exploitation of natural and quality aggregates, the aggregate produced from industrial wastes and agricultural wastes is the viable new source for building material. This study was carried out to determine the possibilities of using coconut shells as aggregate in concrete. Utilizing coconut shells as aggregate in concrete production not only solves the problem of disposing of this solid waste but also helps conserve natural resources. In this paper, the physical properties of crushed coconut shell aggregate were presented. The fresh concrete properties such as the density and slump and 28 days compressive strength of lightweight concrete made with coconut shell as coarse aggregate were also presented. The findings indicate that water absorption of the coconut shell aggregate was high about 24% but crushing value and impact value were comparable to that of other lightweight aggregates. The average fresh concrete density and 28days cube compressive strength of the concrete using coconut shell aggregate 1975kg/m$^3$ and 19.1 N/mm$^2$ respectively. It is concluded that crushed coconut shell is suitable when it is used as a substitute for conventional aggregates in lightweight concrete production.***

***Keywords: Coarse Aggregate, Cement, Concrete, Fly Ash, Coconut shell Aggregate, Water, Compressive Strength, Workability, Fine Aggregate.***

## I. INTRODUCTION

Concrete is a widely used construction material around the world. Different types of concrete have been developed to improve various properties of concrete. It has an important role to play in sustainable construction. Since it needless effort in its manufacture. These facts have not only led to many inventions in the field of concrete but have also led to many studies to improve its quality, reduce the cost of implementation and make the concrete environment friendly. This research work is conducted to judge the potential enhancement of compressive strength due to the addition of steel of fiber in structural lightweight concrete (LWC). The coconut shell was used as a partial replacement of coarse aggregates to develop lightweight concrete. Lightweight concrete blocks find a good range of applications within the development industry.

By using lightweight concrete can reduce the self-weight of the structure. It also reduces the worth of construction during this work to seek out some alternative replacement for coarse aggregate to avoid washing natural resources. The exponential growth rate of population (Loehr RC. 1984), development of industry and technology, and the growth of social civilization would be considered as the underlying factors that have caused the increased waste production. Recently the importance of countermeasures to deal with waste materials has been pointed out because such materials continue to increase every year. The use of alternative aggregate has become a necessity for the construction industry because of the economic, environmental, and technological benefits derived from their use. The high cost of conventional building materials is a major factor affecting housing delivery in India. In developing countries like India where large amounts of agricultural and industrial wastes are produced; these wastes can be used as potential material or replacement material in the construction industry. This will have the double advantage of the reduction in the cost of construction material and also a means of disposal of wastes.

It is at this the above approach is logical, worthy, and attributable. In India, about 960 million tonnes of solid wastes are being generated annually as waste products during industrial, mining, municipal, agricultural, and another process. Out of this 350 million tonnes are organic wastes from an agricultural source, 290 million tonnes are inorganic waste of industrial and mining sectors. However, it is reported that about 600 million tonnes of waste have been generated in India from agricultural sources alone.

### *A. Light Weight Concrete*

Lightweight aggregate concrete has gained popularity due to its lowered density and superior thermal insulation properties. One such alternation is a coconut shell, which is one of the most common agricultural solid wastes in many tropical countries. in India around 14000 million coconuts are being used every year. After the coconut is scraped out, the shell is usually discarded as waste. This was good potential to use in areas where coarse aggregate is costly.

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The bulk density of coconut shells is about 500 to 600 kg/m$^3$, which reduces the density of concretes by about less than 200 kg/m$^3$ in density, which marks them lightweight concrete has low density than the conventional concrete. The purpose of lightweight concrete in buildings is to reduce the self-weight of the building. It has been found that coconut shell concrete easily attains a strength of more than 17 Mpa.



Fig.1 Lightweight Concrete

## II. MATERIAL USED

### *A. Coconut Shell Aggregate*

Coconut shell is an abundantly available material that may waste material that can be used as potential or replacement material in the construction. Coconut shell passing through 20 mm IS sieve and retaining on 12.5 mm IS sieve. Coconut shells were soaked in water for 24 hours so utilized in concrete as coconut shells have more water absorption than the coarse aggregate. The properties of coconut shell aggregate as given in below table

TABLE- 2.1 PROPERTIES OF COCONUT SHELL

| S. No. | Properties | Results |
|---|---|---|
| 1 | Specific Gravity | 1.13 |
| 2 | Water Absorption (%) | 24 |
| 3 | Fineness modulus | 6.48 |
| 4 | Moisture Content (%) | 4.2 |

### *B. Fine Aggregate*

The sand helps the concrete to fill the voids between coarse aggregate and makes concrete more compact and dense, thus increasing the strength of concrete. The fine aggregates used in the investigation are confirmed to Indian standard specifications in table 2.2.

TABLE- 2.2 PROPERTIES OF FINE AGGREGATE

| S. No. | Properties | Results |
|---|---|---|
| 1 | Fineness Aggregate | 3.12 |
| 2 | Specific Gravity (%) | 7 |
| 3 | Consistency (%) | 32 |
| 4 | Initial Setting Time (minute) | 30 |
| 5 | Final Setting Time (minute) | 600 |

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*C. Coarse Aggregate*

Good-quality aggregate is clean, hard, strong, has durable particles, and be free from absorbed harmful chemicals, coatings of clay, or other contaminants which might affect the hydration of cement. The coarse aggregate shall conform to the requirement of IS 383 as shown in the below table.

TABLE- 2.3 PROPERTIES OF COARSE AGGREGATE

| S. No. | Properties | Result |
|---|---|---|
| 1 | Specific Gravity | 2.83 |
| 2 | Water Absorption | 0.195 |

*D. Cement*

Locally available 43 grades ordinary cement (PPC) of the Sankar brand has been employed during this investigation for all concrete mixes. The cement used was fresh and with no lumps. The physical properties of Cement are given below table.

TABLE 2.4 PHYSICAL PROPERTIES OF CEMENT

| S. No. | Property | Test Results |
|---|---|---|
| 1 | Specific gravity | 3.12 |
| 2 | Fineness modulus | 7 |
| 3 | Standard Consistency (%) | 32 |
| 4 | Initial setting time (minute) | 30 |
| 5 | Final setting time (minute) | 600 |

*E. Fly Ash*

Fly Ash is a heterogeneous by-product material produced in the combustion process of coal used in power stations. It is a fine grey colored powder having spherical glassy particles that rise with the flue gases. As fly ash contains pozzolanic materials components which reach with lime to form cementitious materials. Thus Fly ash is used in concrete, mines, landfills, and dams. Fly ash is a fine inorganic material with pozzolanic properties, which can be added to SCC to improve its properties.

TABLE- 2.5 PHYSICAL PROPERTIES OF FLY ASH

| S. No. | Characteristics | Results |
|---|---|---|
| 1 | Specific gravity | 2.07 |
| 2 | Fineness | 290 $m^2/kg$ |
| 3 | Bulk density | 1100-1200 $kg/m^3$ |
| 4 | Colour | Light grey |

## III. METHODOLOGY

The ratio of cement, sand, and aggregate in M20 concrete is 1:1.5:3. The natural coarse aggregate was replaced as 10%, 15%, and 20% by coconut shells, The Cement was replaced as 10%, 15%, and 20% by fly ash. The weight of materials is calculated accurately with the help of a weighing machine. All the mix was having the following proportion of cement, sand, aggregate coconut shell, Fly Ash and Coconut Fiber. The concrete was mixed in a tray of 50KG capacity. The samples are so made that the water-cement ratio is kept constant for all the samples for all tests.

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The mixing time kept 3-4 minutes. All the materials cement (OPC 43), sand, aggregate, water; fly ash, and coconut shell gently and compacted with the help of a tamping rod. Specimens were prepared and kept 24 hrs for the undisturbed condition. After 24 hrs the specimen was remolded and immersed in a curing tank which was filled with water. Curing was for 7 days for six cubes respectively.

TABLE- 3.1 SAMPLE NAME AND PROPORTION OF COCONUT SHELL AGGREGATE

| Sample | CSA % | Weight of CSA in Mix (kg) |
|---|---|---|
| CSA0 | 0 | 00 |
| CSA10 | 10 | 0.44 |
| CSA15 | 15 | 0.89 |
| CSA20 | 20 | 1.33 |

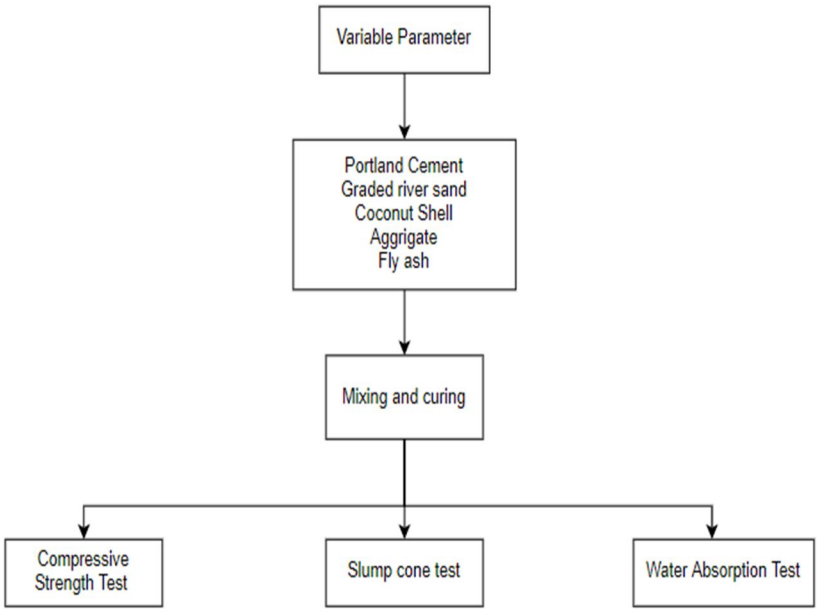



Fig. 2 Flow Chart of The Study

## IV. RESULT & DISCUSSION

Several Tests Have Been Conducted on both fresh and hardened concrete samples made for this experiment as described earlier in the methodology. For fresh concrete, workability tests have been conducted by the slump cone method. For each test, 3 samples were tested and an average of the 3 tests is used. For hardened concrete compressive strength tests have been done using CTM for all samples, after 7 days and 28 days of curing. For each test, 3 samples were tested and an average of the 3 tests is used.

### *A. Details Of Compressive Strength Test With Various % of CSA*

The 7 Days and 28 Days Average Compressive Strength test results of all samples are given in table 4.1.

TABLE - 4.1 COMPRESSIVE STRENGTH TEST

| Sample No. | 7 Days Compressive Strength ($N/mm^2$) | 28 Days Compressive Strength ($N/mm^2$) |
|---|---|---|
| CSA0 | 17.55 | 26.6 |
| CSA10 | 17.07 | 25.3 |
| CSA15 | 16.35 | 25.1 |
| CSA20 | 16.09 | 24.7 |

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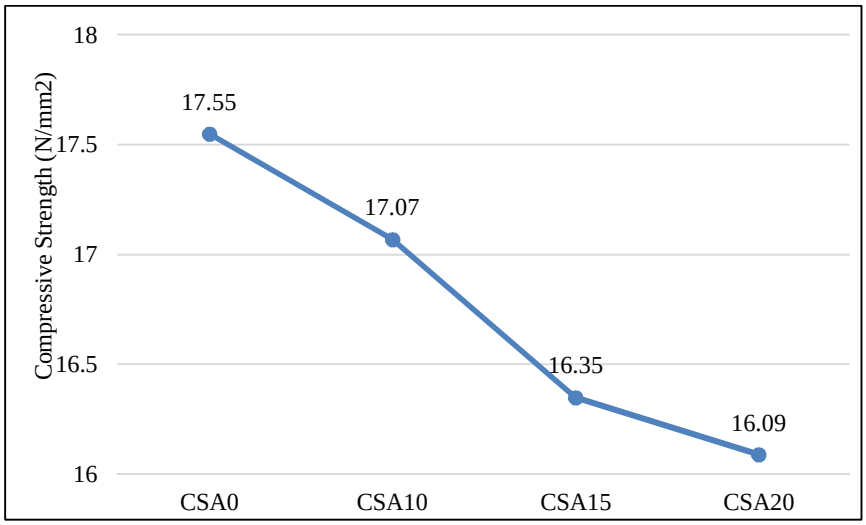


Fig 3 Compressive Strength (N/mm2) after 7 days of curing

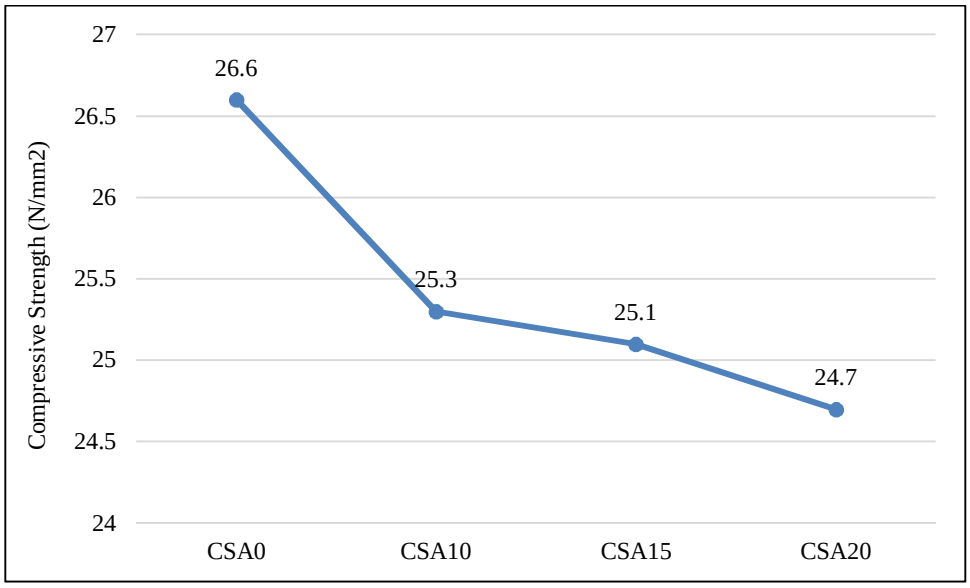


Fig 4 Compressive Strength (N/mm2) after 28 days of curing

*B. Workability Test Result*

The workability test results of all the samples are given in table 4.2. slump cone is used to test the workability of fresh concrete. The water-cement ratio is kept constant for each sample.

TABLE - 4.2 WORKABILITY TEST RESULT USING SLUMP CONE

| S. No. | Slump Value, mm |
|---|---|
| CSA0 | 78 |
| CSA10 | 69 |
| CSA15 | 64 |
| CSA20 | 60 |

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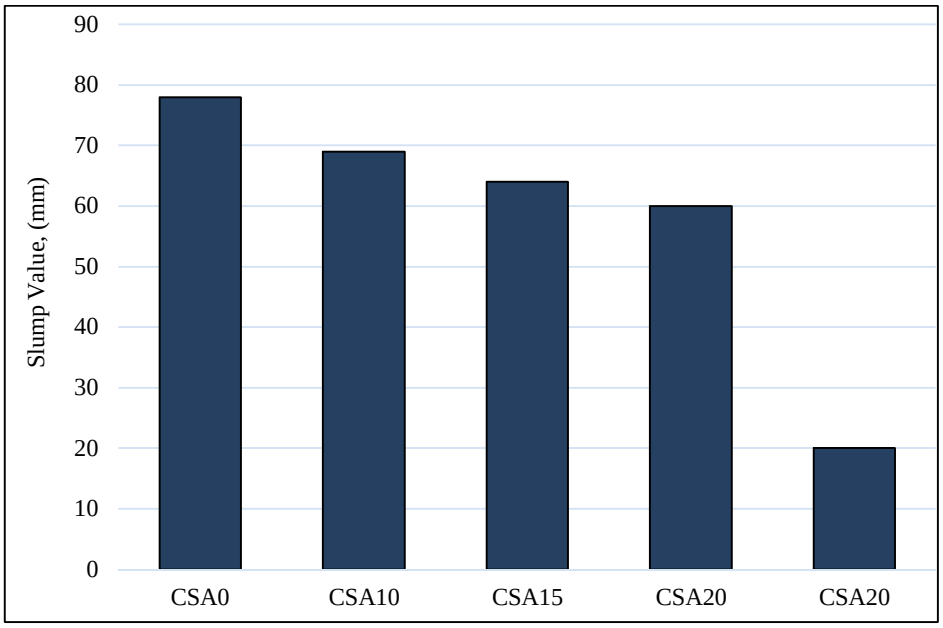



Fig 4 Graph of Workability Test Result Using Slump Cone

## V. CONCLUSION

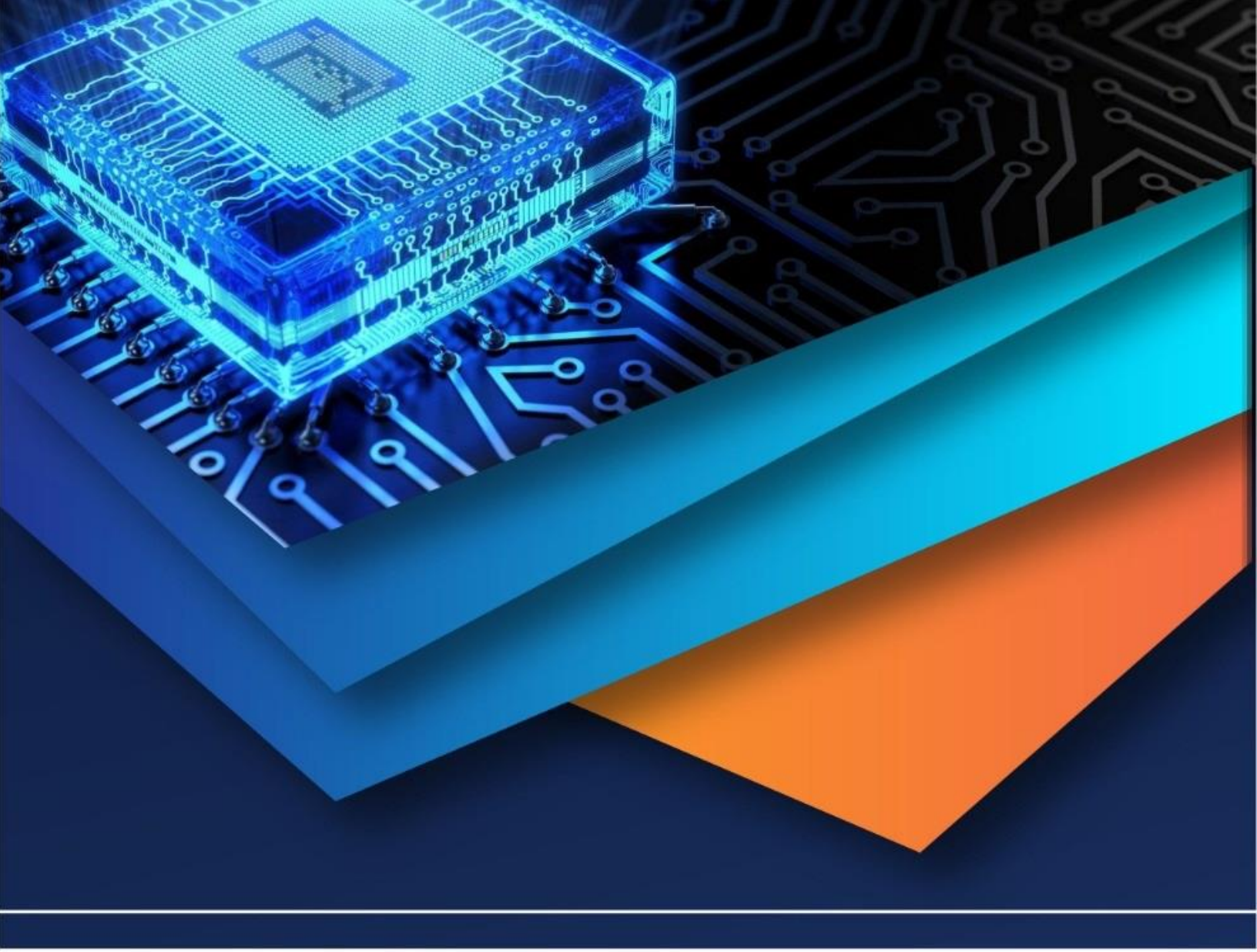
The purpose of this research is to compare and find out the characteristic strength of the M20 grade. Coconut shell concrete at the water-cement ratio of 0.50 Using the waste Coconut shell by replacing fast depleting conventional aggregate source construction material and thereby getting the solution for social and environmental issues. Based on an experimental investigation concerning the compressive strength of concrete, the following observation drew**:**

*1)* Concrete made of 10% partial replacement of natural waste coconut shell aggregate, compressive strength obtained is 26.60N/mm$^2$ at 28 days. Thus making the replacement both technically and economically feasible and viable. A decrease in the compressive strength of coconut shell concrete has been observed as we increase the percentage replacement.
*2)* Coconut shell can be grouped under lightweight aggregate because 28 days air-dry density of coconut shell aggregate concrete are less than 2000 kg/m$^3$. The actual density of the coconut shell is in the range of 550-650 kg/m$^3$.
*3)* The specific gravity of coconut shell is low as compared to the coarse aggregate and the water absorption is higher for coconut shell than coarse aggregate and hence the strength decreased in comparison with the conventional concrete.
*4)* Coconut shell Concrete can be used in rural areas and places where coconut can be collected in large amounts and may also be used where the conventional aggregate is costly.
*5)* Coconut shell concrete is also classified as structural lightweight concrete. It can be concluded that the coconut shell is more suitable for lightweight aggregate with low compressive strength when used to replace common coarse aggregate in concrete production.

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