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# Comparative Study on Coconut Shell Aggregate Concrete with Conventional Concrete

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***Abstract:*** **The rising cost of construction material is a matter of concern. The reason for increase in cost is high demand of concrete and scarcity of raw material. Hence the concrete technologists must search for some economical alternative to the coarse aggregate. In this study, M20 grade of concrete was produced by replacing coarse aggregate by coconut shell aggregate of 12mm-10mm. Thirty six cubes were casted and their compressive strength and density evaluated at 7 & 28 days. The compressive strength of concrete reduced as the percentage replacement increased. Concrete produced by 0% 20% 30% 40% 50% and 60% replacement attained 7 days compressive strength of 20.89, 16.89, 16.00, 14.74, 10.67, 9.19, and 28 days 24.89, 19.85, 18.07, 16.37, 13.78, 12.74 respectively. These results showed that Coconut shell concrete can be used in reinforced concrete construction. Its utilization is cost effective and eco friendly.**

***Keywords:*** **Coarse Aggregate, Coconut Shell, Compressive Strength, Density, Waste Utilization.**

## I. INTRODUCTION

Infrastructure development across the world created demand for construction materials. Concrete is the premier civil engineering construction material. Concrete manufacturing involve consumption of ingredients, aggregates, water and admixture. Among all the ingredients, aggregates form the major part. Use of natural aggregate in such a rate leads to a question about the preservation of natural aggregates sources. In addition, operations associated with aggregate extraction and processing are the principal causes of environmental concerns. In light of this, in the contemporary civil engineering construction, using alternative materials in place of natural aggregate in concrete production makes concrete as sustainable and environmentally friendly construction material. Different alternative waste materials and industrial by products such as fly ash, bottom ash, recycled aggregates, foundry sand, china clay sand, crumb rubber, glass were replaced with natural aggregate and investigated properties of the concretes. Apart from above mentioned waste materials and industrial by products, few studies identified that coconut shells, the agricultural by product can also be used as aggregate in concrete.

India is the third largest, having cultivation on an area of about 1.78 million hectares for coconut production. Annual production is about 7562 million nuts with an average of 4248 nuts per hectare. The coconut industry in India accounts for over a quarter of the world's total coconut oil output and is set to grow further with the global increase in demand. However, it is also the main contributor to the nation's pollution problem as a solid waste in the form of shells, which involves an annual production of approximately 3.18 million tones. It also presents serious disposal problems for local environment, is an abundantly available agricultural waste from local coconut industries. In developing countries, where abundant coconut shell waste is discharged, these wastes can be used as potential material or replacement material in the construction industry. This will have the double advantage of reduction in the cost of construction material and also as a means of disposal of wastes.

## II. METHODOLOGY

### A. Selection of materials and tests:

1. Cement
2. Fine aggregate
3. Coarse aggregate
4. Coconut shell

**TABLE.1: Tests on materials.**

| Sl. No | Material | Test | Apparatus | Result |
|---|---|---|---|---|
| 1 | Cement | Specific gravity | Le-Chatelier flask | 3.15 |
| | | Standard Consistency | Vicat's apparatus | 34% |
| | | Initial and final setting time | Vicats apparatus | 32min & 190min |
| | | Compression Test of Cement | Mechanical vibrating machine | 7 days= 23.5N/mm$^2$<br>28 days = 32.5N/mm$^2$ |
| 2 | Fine aggregate | Sieve Analysis of fine aggregate | Sieve shaker | Fine aggregate lies in Zone – 3 |
| | | Specific gravity of fine aggregate | Pycnometer | 2.7 |
| 3 | Coarse Aggregate | Aggregate crushing value | Compression testing machine | 27% |
| | | Aggregate impact test | Impact testing machine | 14.98% |
| | | Specific gravity | Wire Basket | 2.7 |
| 4 | Coconut shell Aggregate (12mm-10mm) | Coconut shell crushing value | Compression testing machine | 1.53% |
| | | Coconut shell aggregate impact test | Impact testing machine | 6.08% |
| | | Specific gravity | Wire Basket | 1.5 |

From practical tests (TABLE:1) it is observed that crushing value, impact value and specific gravity is less compared conventional coarse aggregates.

## III. MIX DESIGN FOR M20 CONCRETE

**TABLE.2: Mix design result of M20 concrete[10].**

| Grade | Cement | Fine Agg. | Course Agg. | Water |
|---|---|---|---|---|
| **M20** | | | | |
| **Proportion** | **1 : 1.65 : 2.95** | | | |

## IV. TEST AND RESULTS OF SPECIMENS

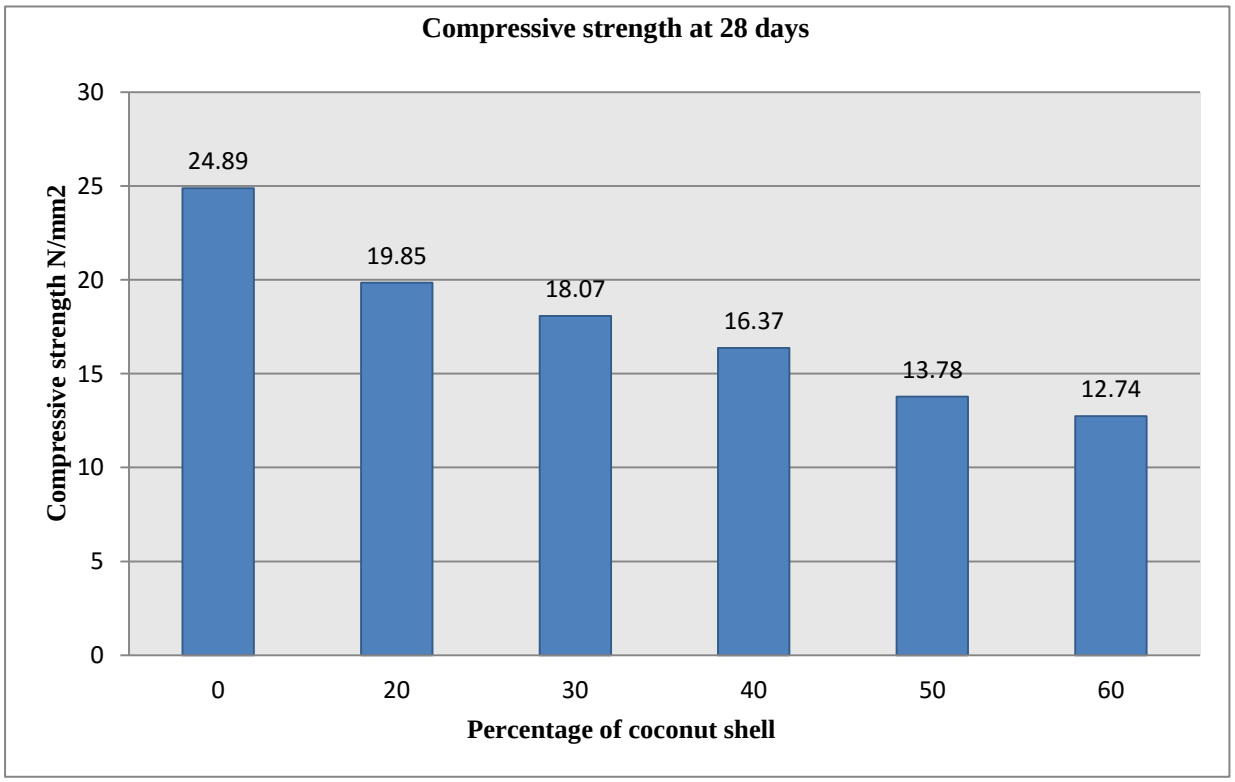
### A. Compressive strength:

Where

**TABLE.3: Compressive strength at different percentage of coconut shell aggregate**

| Sl No | % of coconut shell replaced | cubes | compressive strength ($f_c$) N/mm$^2$ | | | |
|---|---|---|---|---|---|---|
| | | | 7 day | Average $f_c$ | 28 days | Average $f_c$ |
| 1 | 0 | 1 | 21.556 | 20.89 | 24.889 | 24.89 |
| | | 2 | 20.667 | | 25.556 | |
| | | 3 | 20.444 | | 24.222 | |
| 2 | 20 | 1 | 17.556 | 16.89 | 19.333 | 19.85 |
| | | 2 | 16.889 | | 20.444 | |
| | | 3 | 16.222 | | 19.778 | |
| 3 | 30 | 1 | 15.556 | 16.00 | 17.778 | 18.07 |
| | | 2 | 16.667 | | 18.444 | |
| | | 3 | 15.778 | | 18.000 | |
| 4 | 40 | 1 | 14.889 | 14.74 | 16.667 | 16.37 |
| | | 2 | 15.111 | | 16.000 | |
| | | 3 | 14.222 | | 16.444 | |
| 5 | 50 | 1 | 10.222 | 10.67 | 13.333 | 13.78 |
| | | 2 | 10.889 | | 14.444 | |
| | | 3 | 10.889 | | 13.556 | |
| 6 | 60 | 1 | 9.333 | 9.19 | 13.111 | 12.74 |
| | | 2 | 9.556 | | 12.444 | |
| | | 3 | 8.667 | | 12.667 | |

From the TABLE:3 it is observed that as the percentage of coconut shell increases compressive strength decreases and 20% replacement gives the best compressive strength.

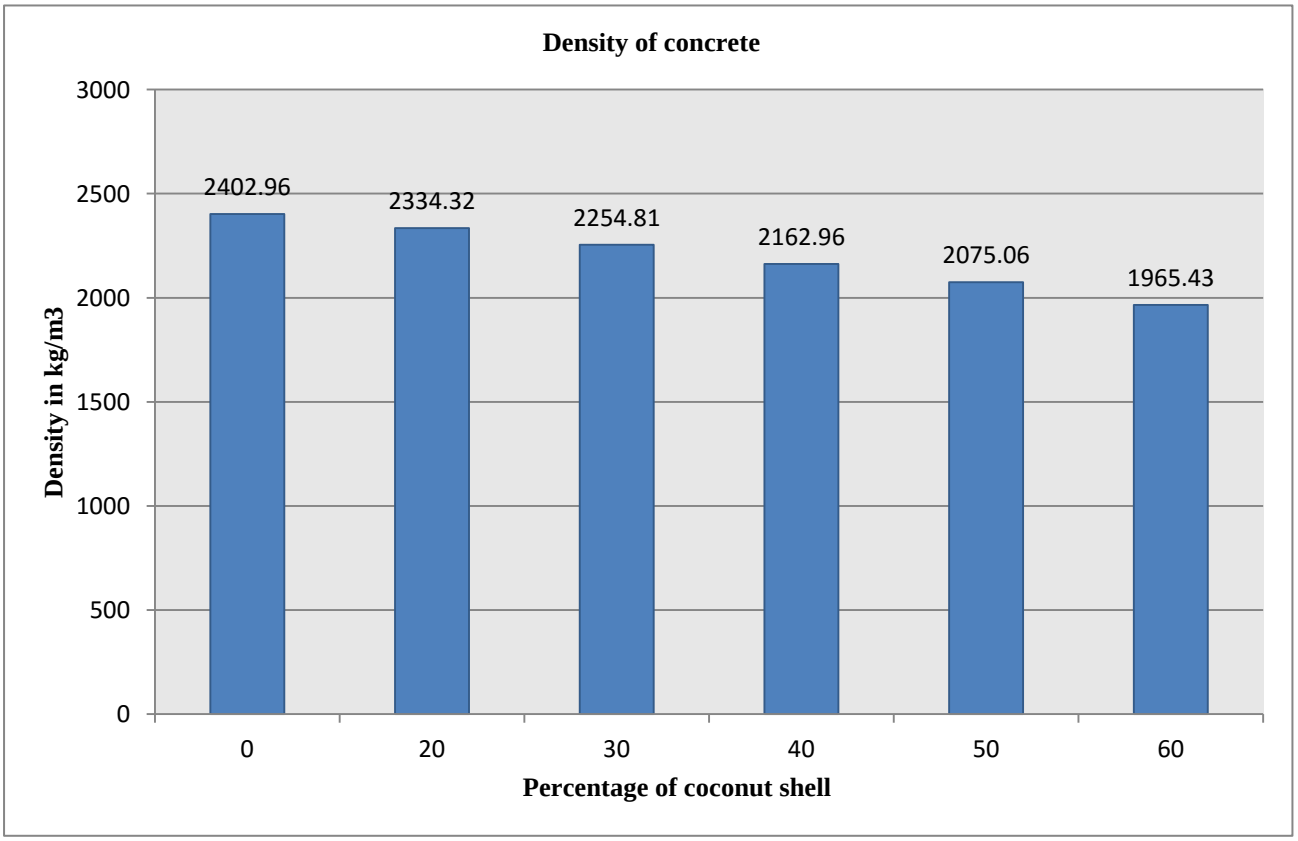


**B. Density of concrete:**

**TABLE.4: Density of concrete at different percentage of coconut shell aggregate**

| Sl No | % of coconut shell replaced | Cubes | Weight of cube in kg | Average weight in kg | Average density of cube in kg/m$^3$ |
|---|---|---|---|---|---|
| 1 | 0 | 1 | 8.01 | 8.11 | 2402.96 |
| | | 2 | 8.32 | | |
| | | 3 | 8.00 | | |
| 2 | 20 | 1 | 7.95 | 7.88 | 2334.32 |
| | | 2 | 7.84 | | |
| | | 3 | 7.845 | | |
| 3 | 30 | 1 | 7.61 | 7.61 | 2254.81 |
| | | 2 | 7.59 | | |
| | | 3 | 7.63 | | |
| 4 | 40 | 1 | 7.37 | 7.30 | 2162.96 |
| | | 2 | 7.14 | | |
| | | 3 | 7.39 | | |
| 5 | 50 | 1 | 7.03 | 7.00 | 2075.06 |
| | | 2 | 6.95 | | |
| | | 3 | 7.03 | | |
| 6 | 60 | 1 | 6.55 | 6.63 | 1965.43 |
| | | 2 | 6.75 | | |
| | | 3 | 6.60 | | |

It is seen that the maximum density, 2402.96 kg/m$^3$ was attained at 0% replacement while the minimum density, 1965.43 kg/m$^3$ was attained at 60% replacement. It is also seen that the density of concrete reduced as the percentage replacement with coconut shells increased



## V. CONCLUSION

- Concrete cubes with 20% replacement of coconut shell aggregate have given a good strength (19.85MPa) for M20 grade concrete.
- Increase in percentage replacement by coconut shell reduces compressive strength of concrete.
- Increase in percentage of coconut shell, decreases densities of concrete.
- Coconut Shell can be used as partial replacement of coarse aggregate in R.C.C concrete.
- Permeable voids and water absorption increases with increase in CS replacement.
- Using the combination of coconut shell as aggregate in concrete can reduce the material cost in construction because of the low cost and abundant agricultural waste.
- Coconut shell exhibits more resistance against crushing and impact (1.53%, 6.08%) compared to crushed granite aggregate (27%, 14.98%).

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