COCONUT SHELL AS A REPLACEMENT FOR COARSE AGGREGATE IN CONCRETE

The project report Submitted in partial fulfillment of the requirements for the

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BACHELOR OF TECHNOLOGY

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INTRODUCTION

Infrastructure development across the world created demands for construction materials. Concrete is the premier civil engineering material used in the structure. Concrete manufacturing involves the consumption of ingredients like cement, aggregates, water, and admixtures. Among all the ingredients, aggregates form the major parts. Production is expected to increase to more than a billion tons per year by the year. The use of natural aggregates at such a rate leads to a question about the preservation of natural aggregate sources. Using alternative materials in place of natural aggregates in concrete production makes concrete sustainable and environmentally friendly construction material. The chemical composition of the coconut shell is similar to wood and it contains 33.61% cellulose, 36.51 % lignin, and 0.61% ash.

Lightweight aggregate concrete can be used produced using a variety of lightweight aggregate. Lightweight aggregate can be originated from natural materials like pumice, the thermal treatment of natural raw materials like clay-slate or shale. The other by-product may include flying ash. The required properties will have bearing on the best type of lightweight aggregate used. the benefits of using lightweight aggregate concrete include reduction in dead load, improved thermal properties, improved fire resistance, and reduction in formword

EXPERIMENTAL MATERIALS

Cement

Commercially available Ordinary Portland Cement of 43 grades cement confirming to IS 8112:1989 was used in the field [8] (Specification, Bureau of Indian Standards, New Delhi). The physical properties of OPC 43 grade cement

TABLE 1. Properties of Cement

S. No.	Test conducted	Observed values
1	Specific gravity of cement	3.15
2	Consistency	28%
3	Initial setting time	60 min
4	Final setting time	310 min

Fine aggregate

Fine aggregate normally consists of natural, crushed, or manufactured sand. Natural sand is the usual component for normal-weight concrete. In some cases, manufactured lightweight particles are used for lightweight concrete and mortar. The maximum grain size and size distribution of the fine aggregate depend on the type of product being made. Fractions below 4.75 mm to 150 microns are termed fine aggregate. Locally available Narmada river sand passed through a 4.75mm IS sieve is applied as fine aggregate conforming to the requirements of IS 383:1970 [9]. The physical properties of fine aggregate as shown in table 2.

TABLE 2. Properties of Sand

S. No.	Parameters	Results
1	Specific Gravity	2.6
2	Fineness Modulus	3.3
3	Water absorption (%)	1.05
	Bulk density kg/cm^3	
4	Loose	1580
	Compacted	1750

Coarse Aggregate

Coarse Aggregate in concrete occupies 35% to 70% of the volume of the concrete. Smaller-sized aggregates produce higher concrete strength. Particle shape and texture affect the workability of fresh concrete. Usually, an aggregate with a specific gravity of more than 2.55 and absorption of less than 1.5% can be regarded as being of good quality. Where aggregates strength is higher, concrete strength is also higher. Fractions from 20 mm to 4.75 mm are used as coarse aggregate. The Coarse aggregate is obtained from a local quarry (Maneri), conforming to IS 383:1970 is used [9]. The physical properties of coarse aggregate as shown in table 3

TABLE 3. Properties of Coarse Aggregate

S. No.	Parameters	Results
1	Specific Gravity	2.76
2	Fineness Modulus	6.5
3	Water absorption (%)	1.35
	Bulk density kg/cm^3	
4	Loose	1600
	Compacted	1790

Coconut Shell

Coconut shell particles are used as reinforcing material for investigation. Shell particles of sizes between 20 mm to 600 μ are prepared in a grinding machine. The coconut shell has high strength and modulus properties. Coconut shells were collected from various temples at Jabalpur to analyze their properties as shown in The physical properties of coconut shells is shown in table 4.

TABLE 4. Properties of Coarse Aggregate

S. No.	Parameters	Results
1	Specific Gravity	1.25
2	Water absorption (%)Bulk density kg/cm^3	20
3	Loose	600
	Compacted	790
4	Shell thickness (mm)	2- 6

Water

Water is an important factor of concrete as it actually participates in the chemical reaction with cement. Potable water is employed in using concrete.

EXPERIMENTAL METHODOLOGIES

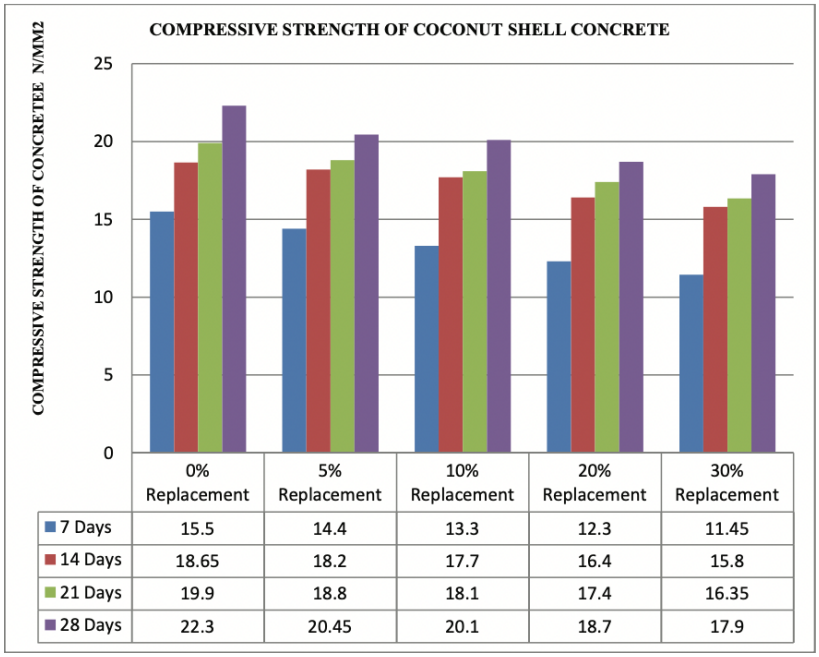
The study is conducted to analyze the compressive strength of concrete when the natural coarse aggregate is partially replaced with waste coconut shell respectively. Concrete mix is designed as per IS: 10262-1982 [10], IS: 456-2000 [11] for the nominal concrete. The grade of concrete, which we adopted, is M-20. The concrete mix proportion (cement: fine aggregate: coarse aggregate) is 1:1.5: 3 by volume and a water-cement ratio of 0.50. The Compressive strength tests were done on a compression testing machine using cube samples. Three samples per batch were tested with the average strength values reported in this paper. The natural coarse aggregates were replaced withcoconut shells as 0%, 5%, 10%, 20%, and 30% by weight of M-20 grade concrete. Cubes of OPC (150mm × 150mm) were examined

and results were analyzed after curing for 7days, 14days, 21 days, and 28 days. Due to the high water absorption of coconut shells, they were presoaked in water for 24 hours, prior to mixing. Results obtained from the replacement are compared with data from Conventional concrete. The compressive strength of coconut shell concrete for 7 days, 14 days, 21 days, and 28 days are shown in table 5 to table 8, whereas the comparison compressive strength of all these concrete specimens is shown in table 9 and in figure 2. Lab performances for the determination of coconut shell concrete

S.No	Specimen	7 days	14 days	21 days	28 days
1	0% Aggregate Replaced with Coconut Shell	15.50	18.65	19.90	22.30
2	5% Aggregate Replaced with Coconut Shell	14.40	18.20	18.80	20.45
3	10% Aggregate Replaced with Coconut Shell	13.30	17.70	18.10	20.10
4	20% Aggregate Replaced with Coconut Shell	12.30	16.40	17.40	18.70
5	30% Aggregate Replaced with Coconut Shell	11.45	15.80	16.35	17.90




RESULTS AND DISCUSSIONS



	0% Replacement	5% Replacement	10% Replacement	20% Replacement	30% Replacement
7 Days	15.5	14.4	13.3	12.3	11.45
14 Days	18.65	18.2	17.7	16.4	15.8
21 Days	19.9	18.8	18.1	17.4	16.35
28 Days	22.3	20.45	20.1	18.7	17.9

The compressive strength of coconut shell concrete has been determined by partial replacement of natural coarse aggregate with waste coconut shell. A laboratory test has been performed for 5 % to 30% replacement of coarse aggregate with coconut shell for M-20 grade concrete. Varying strength of concrete was observed, which is measured in N/mm2. The results obtained for 7 days to 28 days of compressive strength confirms the optimal percentage requirement for substitute of natural coarse aggregate with waste coconut shell are shown in figure 2 (Bar Graph).

LITERATURE SURVEY

Olanipekun (2006) carried out the comparative cost analysis and strength characteristics of concrete produced using crushed, granular coconut, and palm kernel shells as substitutes for conventional coarse aggregate. The main objective is to encourage the use of waste products as construction materials in low-cost housing. Crushed granular coconut and palm kernel were used as a substitute for conventional coarse aggregate in the following ratios: 0%, 25%, 50%, 75%, and 100% for preparing mix ratios 1:1:2 and 1:2:4. A total of 320 cubes were cast and tested and their physical and mechanical properties were determined. The result showed that the compressive strength of the concrete decreased as the percentage of the coconut shell increased in the two mix ratios, Coconut shell exhibited higher compressive strength than the palm kernel shell in the test. Moreover, there is a cost reduction of 30% and 42% for concrete produced from coconut shells and palm kernel shells respectively.

Siti Aminah Bt Tukiman and Sabarudin Bin Mohd (2009) replaced the coarse aggregate with coconut shell and grained palm kernel in their study. Percentage of replacement by coconut shell were 0%, 25%, 50%, 75% and 100% respectively. The conclusion is that the combination of these materials has the potential of being used as lightweight aggregate in concrete and also has reduced the material cost in construction.

Olutoge (2010) studied sawdust and palm kernel shells (PKS). Fine aggregates are replaced by sawdust and coarse aggregates by palm kernel shells in reinforced concrete slabs casting. Conventional aggregates were replaced by sawdust and PKS in the same ratios of 0%, 25%, 50%,75%, and 100%. Compressive and flexural strengths were noted at different IJSER International Journal of Scientific & Engineering Research, Volume 7, Issue 8, August-2016 1804 ISSN 2229-5518 IJSER © 2016 http://www.ijser.org time intervals. It was seen that at 25% sawdust and PKS can produce lightweight reinforced concrete slabs that can be used where low stress is required at a reduced cost. 7.43% reduction can be achieved.

J. P. Ries (2011) observed that Lightweight aggregate plays important role in today's move towards sustainable concrete. Lightweight aggregates contribute to sustainable development by lowering transportation requirements, optimizing structural efficiency that results in a reduction in the amount of overall building material being used, conserving energy, reducing labor demand, and increasing the life of structural concrete.

Abubakar and Muhammed Saleh Abubakar (2011) compared the physical and mechanical properties of coconut shell and crushed granite rock also a total of 72 concrete cubes of size 150x150x150mm with different mix ratios of 1:2:4, 1:1.5 :3 and 1:3:6 were cast and tested for evaluating different properties. Aggregate crushing value (ACV) for coarse aggregate was 21.84 and 4.71 for coconut shells. Elongation and flakiness index were 58.54 and 15.69 respectively for gravels, while for coconut shells, it was 50.56 and 99.19 respectively. Compressive strength of

concrete cubes in N/mm2 of coconut shell at 7,14,21 and 28 days with mix ratios of 1:2:4, 1:1.5:3, and 1:3:6 are (8.6, 8.9 ,6.4,), (9.6, 11.2, 8.7), (13.6, 13.1, 10.7) and (15.1, 16.5, 11) respectively, likewise (19.1, 18.5, 9.6), (22.5, 23.0, 10.4), (26.7, 24.9, 12.9) and (28.1, 30.0, 15) respectively for gravel. Since the concrete strength of coconut shell with mix ratio 1:1.5:3, attained 16.5 N/mm2 compressive strength at 28 days it can be used in plain concrete works, and cost reduction of 48% will be achieved [14].

Maninder Kaur & Manpreet Kaur (2012) published a review paper in which it is concluded that the use of coconut shells in cement concrete can help in waste reduction and pollution reduction. It is also expected to serve the purpose of encouraging housing developers in investing these materials in house construction. It is also concluded that the Coconut Shells are more suitable as low strength-giving lightweight aggregate when used to replace common coarse aggregate in concrete production.

Vishwas P. Kulkarni et al (2013) studied that Aggregates provide volume at low cost, comprising 66 percent to 78 percent of the concrete. M20 Concrete is produced by 0%, 10%, 20%, 30% replacement of coarse aggregate by coconut shell. There is no need to treat the coconut shell before use as an aggregate except for water absorption. No bond failure was observed, confirming that there was adequate bonding between the coconut shell aggregate concrete and the steel bars.

Daniel Yaw Osei (2013) in this experimental study coarse aggregate is partially replaced by coconut shell. Percentages of replacement by coconut shell were – 0%, 20%, 30%, 40%, 50%, 100%. He concluded that CS can be used to produce lightweight concrete and an 18.5% replacement of crushed granite with coconut shells can be used to produce structural concrete.

Parag S. Kambli & Sandhya R. Mathapati. (2014) prepared three different Mix Designs for M20, M35, and M50 grades of concrete. Percentage replacement by coconut shell varied as 0%, 10%, 20%, 30%, 40% respectively. It is concluded in this study that M20 grade concrete cubes with 30% replacement of CS aggregates had given a strength of 23 MPa at 28 days. Concrete cubes with 30% replacement of CS aggregates had given a strength of 42 MPa at 28 days for M35. For M50 grade concrete cubes with 30% replacement of CS aggregates had given the strength of 51 MPa at 28 days.

Dewanshu Ahlawat & L.G.Kalurkar (2014) explored the possibility of producing M20 grade concrete by replacing conventional aggregate of granite with coconut shell. Forty-five cubes were cast. Percentage of replacement of conventional coarse aggregate by coconut shell were 2.5%, 5%, 7.5%, 10%. Compressive strength were 19.71, 19.53, 19.08, 18.91 N/mm2 respectively at 28 days. Workability and compressive strength had been evaluated at 7, 14, and 28 days. The compressive strength of concrete reduced as the percentage replacement increased. By these results, it can be concluded that coconut shell concrete can be used in reinforced concrete

CONCLUSION

The purpose of this research is to compare and find out the characteristic strength of M-20 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 experimental investigations concerning the compressive strength of concrete, the following observations are drawn:

1. On 10% partial replacement of natural coarse aggregate with Waste Coconut Shell, the Compressive Strength of coconut shell concrete has obtained at 20.10 N/mm2 at 28 days. Thus, making the replacement both technically and economically feasible and viable. On further replacement, a decrease in the compressive strength of Coconut Shell Concrete has been observed.
2. Coconut shells can be grouped under lightweight aggregate because 28-day air dry densities of coconut shell aggregate concrete are less than 2000 kg/m3. The actual density of coconut shells is in the range of 600-800 kg/m^3.
3. Experimental results and discussions of research on coconut shells confirm that the coconut shell has potential as a lightweight aggregate in concrete. Also, using the coconut shell as aggregate in concrete can reduce the material cost in construction because of the low cost and its abundant agricultural waste.
4. Coconut Shell Concrete can also be for non-structural members e.g. partition walls, hollow concrete brick, floor tiles, etc. Even after more than 10% partial replacement of coconut shell with aggregate.

The use of coconut shell waste as an aggregate will reduce the depletion of natural sources of conventional aggregate and will also be helpful to make eco – a friendly.

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