

REPLACEMENT OF COARSE AGGREGATE BY COCONUT SHELL IN LIGHT WEIGHT CONCRETE

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Abstract-Coconut shell is one of the main contributors of pollution problem as a solid waste and people burn it for fire purposes which pollute air. Coconut shell used as coarse aggregate in concrete encouraged sustainable and environment friendly material in the construction field. Composites are made by combining two or more natural or artificial materials to maximize their useful properties and minimize their weaknesses and make this material useful. The Material such as cement, sand, gravel etc are using in construction is going to be out of reach day by day. First one it is a natural non-renewable material and second one it is going to be costly. Its natural abundance is decreasing on the other hand constructions are increasing. It is not easily available according to requirements. It is a matter of concern in this developing construction area. Nowadays, most of the researchers are doing on some renewable material which can reduce the cost of construction as well as increase the strength. Research on waste material such as fly ash, rice husk, slag and sludge from treatment of industrial and domestic waste is being done. Use of coconut shell in concrete is not only useful economically but also environmentally useful for human being. Coconut shell is one of the main contributors of pollution problem as a solid waste and people burn it for fire purposes which pollute air. Coconut shell used as coarse aggregate in concrete encouraged sustainable and environment friendly material in the construction field. Composites are made by combining two or more natural or artificial materials to maximize their useful properties and minimize their weaknesses and make this material useful.

Index Terms-light weight, cement, coarse aggregate, Mix Design, Compressive strength, flexural strength,coconut shell.

1. INTRODUCTION

Concrete is the premier civil engineering construction material. Concrete manufacturing involve consumption of ingredients, aggregates, water and admixture(s). Constructions across the world increased the demand for construction materials. Aggregates are the major civil engineering construction material. It makes main mass of concrete. The main Concrete ingredients are aggregates, water and admixture(s). Among all the ingredients, aggregates form the major part. The high demand for concrete in the construction using normal aggregates such as gravel and granite drastically reduces the natural stone deposits and this has damaged the environment which cause ecological imbalance. There is a need to find out suitable replacement material to substitute the natural stone. In developed countries, many natural materials like Pumice, Scoria and Volcanic debris and manmade materials like blast-furnace slag, vermiculite and clinker are used in construction works as substitutes for natural aggregates. Infrastructure development across the world created demand for construction materials.. Among all the ingredients, aggregates form the major part. Two billion tons of aggregate are produced each year the United States. Production is expected to increase to more than 2.5 billion tons per by the year 2020. Similarly, the consumption of the primary aggregate was 110 million tonnes in U.K in the year 1960 and reached nearly 275 million tonnes by 2006. 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 byproducts 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 byproducts, few studies identified that coconut shells, the agricultural by product can also be used as aggregate in concrete. According to a report, coconut is grown in more than 86 countries worldwide, with a total production of 54 billion nuts per annum. India occupies the premier position in the world with an annual production of 13 billion nuts, followed by Indonesia and the Philippines. Limited research has been conducted on mechanical properties of concrete with coconut shells as aggregate replacement. However, further research is needed for better understanding of the behavior of coconut shells as aggregate in concrete. Furthermore, there is no study available in the literature on the transport properties which determine durability of the concrete. Thus, the aim of this work is to provide more data on the strengths coconut shell concretes at different coconuts shells (CS) replacements and study the transport properties of concrete with CS as coarse aggregate replacement.

2. Literature Review

Maninder Kaur, Manpreet Kaur et al, an investigation carried out on the comparative cost analysis and strength characteristics of concrete produced using crushed, granular coconut shells as substitutes for conventional coarse aggregate. The results of the tests showed that the compressive strength of the concrete is acceptable on 25% replacement of coconut shells but this strength is decreased as the percentage of the shells increased. The results also indicated cost reduction of 30% and 42% for concrete produced from coconut shells.

B. Damodhara Reddy, et al, demonstrated the coconut shell is used as light weight aggregate in concrete. The project paper aims at analyzing flexural and compressive strength characteristics of with partial replacement using M30 grade concrete. The project also aims to show that coconut shell aggregate is a potential construction material and simultaneously reduces the environment problem of solid. The conclusions for the result are, CSC where 25% of the coarse aggregate is replaced, shows properties similar to the nominal mix and 50% replaced CSC shows properties similar to light weight concrete which can be used as filler materials in framed structures, flooring tiles, thermal insulating concrete etc.

Damre Shraddha, Firake Hitali et al recommends that The Coconut shell as partial replacement of coarse aggregate in concrete. The aim of this research is to spread awareness of using coconut shell partial replacement of coarse aggregate in concrete and determining its compressive strength, density and research on it's to another properties. The conclusions for the research are the compressive strength of the concrete decreased as the percentage shell substitution increased. Also increased in percentage replacement by coconut shell increase workability of concrete. Coconut shell can be used as partial replacement of coarse aggregate in R.C.C. concrete.

M. Lakshmi pathy, et al investigated that the properties of concrete using coconut shell as coarse aggregate were investigated in an experimental study. Compressive, flexural, splitting tensile strengths, impact resistance and bond strength were measured and compared with the theoretical values as recommended by the standards. For the selected mix, two different water-cement ratios have been considered to study the effect on the flexural and splitting tensile strengths and impact resistance of coconut shell concrete. The bond properties were determined through pull-out test. The results showed that coconut shell concrete can be classified under structural lightweight concrete.

("Mechanical and bond properties of coconut shell concrete")

3. MATERIALS AND METHODS

The materials used in this experiment were locally available and these were Ordinary Portland Cement (O.P.C), sand as fine aggregate, crushed granite and coconut shell both as coarse aggregate. Potable water was used for mixing and curing. The constituent materials used in this investigation were produced from local sources. Ordinary Portland cement of OPC 53 grade conforming to both the requirements of IS: 12269 and ASTM C 642-82 type I was used. Normal aggregate, that is, crushed blue granite of maximum size 20mm was used as coarse aggregate. Well graded river sand passing through 4.75mm was used as fine aggregate. The specific gravities of coarse and fine aggregates were 2.65 and 2.63 respectively. The freshly discarded Coconut shells were

collected from a local oil mill. The coconut shells were crushed using concrete hammers to a size such that it passes through a 20mm sieve and retained on 4.75mm sieve. Crushed shells were washed to remove fibers, mud, etc from them. The washed shells were dried in sunlight for 2 days. The crushed edges were rough and spiky. The surface texture of the shell was fairly smooth on concave and rough on convex faces. Coconut shell aggregates used were in saturated surface dry (SSD) condition. Further broken the shells into small chips manually using hammer and sieved through 12mm sieve. The material passed through 12mm sieve was used to replace coarse aggregate with coconut shells.

Batching and Mixing:

Weigh Batching was accomplished with the help of electronic weighing balance. Batching was done as for each the mix proportions. Mixing was done in tray. It was mixed for 2-3 minutes, later than addition of water.

Placing and Compaction:

Cubes and prism are cleaned and oiled to avoid the formation of bond between concrete and iron moulds. Place the fresh concrete in moulds in 3 layers, tamping each layer with temper 25 times. The air which is entrapped in concrete is removed by table vibrator.

Details of Specimens:

Cube: For Compressive test: 150mm x 150mm x 150mm

Rectangle (beam): For Flexural test: 150mm x 150mm x 300mm

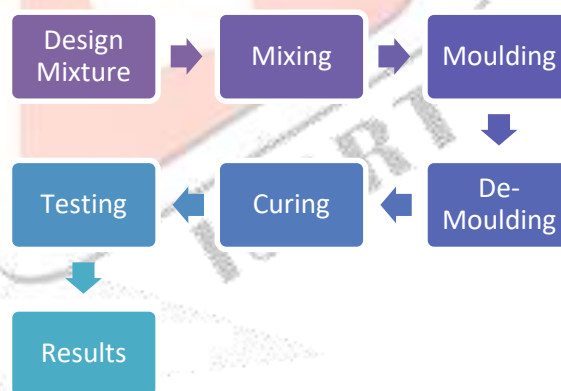


FIGURE 1 :PREPARTION OF SPECIMEN

4. METHODOLOGY

The ingredients of concrete i.e. cement, fine aggregate, coarse aggregate, coconut shells are tested before producing concrete. As per Indian standard codes various test are conducted on ingredients materials of the concrete. Firstly the dry ingredients cement, coarse aggregate, fine aggregate and coconut shells are fed in mixer and thoroughly mixed to ensure even distribution. Then the Water is added and the mix is continued. Production of mix (normal concrete of grade M-20) in the laboratory is carried out by IS method of concrete mix design (IS 10262-1982).Coconut shell concrete is produced by

adding coconut shells in different percentage (i.e. 25%, 50% and 75%) replacement for coarse aggregate.

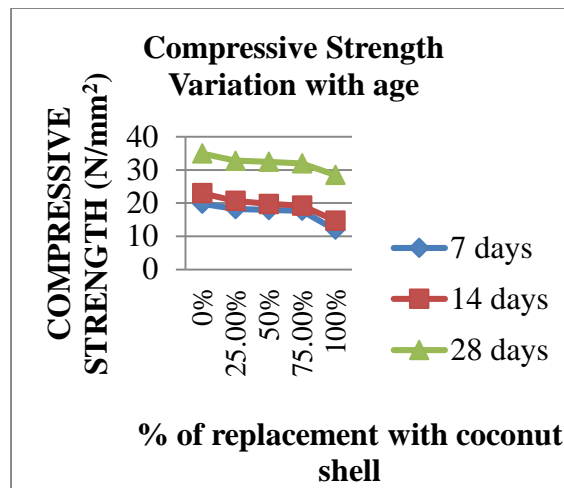
5. RESULT AND DISCUSSIONS

4.1 COMPRESSIVE STRENGTH OF COCONUT SHELL CONCRETE (N/MM2) :-

The 25% replacement mix got an average compressive strength of 32.81 MPa which is about 94.25% strength of normal concrete(24MPa). Likewise ,we got a compressive strength of 31.96 MPa and 28.52 MPa for 75% and 100% replacement respectively. The result shows that coconut shell concrete can be even used in high strength applications with replacements within or around 25%. Further we can use higher percentage replacement for non load bearing structures. An examination of the failure surfaces showed the breakage of the Coconut shell aggregate, indicating shell strength had a strong influence on the resultant concrete strength. The flexural strength was found to be (4.44MPa) of normal concrete flexural strength and 80.6% (4.19 MPa) and 76%(4.02MPa) for 25% and 50% replacement mixes respectively. The 100% replacement concrete mix showed negligible flexural and compressive strength. The beam cast with 100% replacement concrete mix showed negligible flexural strength. The beam cast with 100% coarse aggregate replaced with coconut shells broke under its self weight itself. The flexural strength percentages are slightly lower than compressive strength percentages. In concrete with conventional aggregates, the failure in tension occurs as result of breaking of bond between the matrix and the surface of the aggregate used or by fracture of the concrete matrix itself. Thus the surface properties of coconut shells also pay an important role in determining the flexural properties of concrete. The reduction in self weight was found to be 9.56%, 19.16%, 38.32% when 25%, 50% and 100% of coarse aggregate was replaced by coconut shell respectively.

Results are discussed through table and graphical view is given below:-

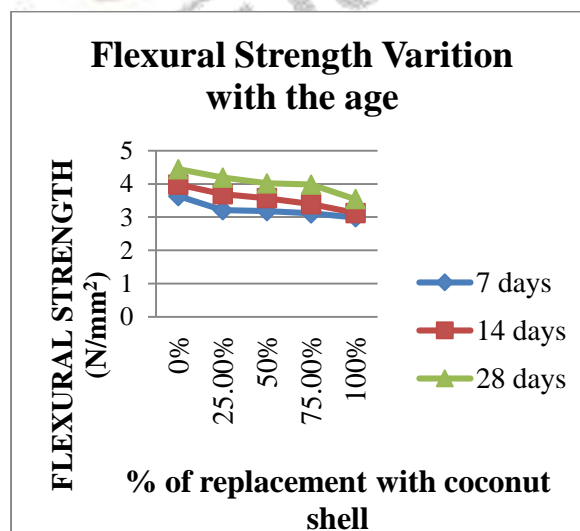
Days	0%	25%	50%	75%	100%
7	19.83	18.25	17.95	17.68	11.98
14	22.98	20.70	19.78	19.22	14.75
28	34..95	32.81	32.44	31.96	28.52



4.2 FLEXURAL STRENGTH OF COCONUT SHELL CONCRETE (N/MM2)

The maximum flexural strength of 4.44 N/mm² was attained at 0% replacement, while the minimum strength of 3.54 N/mm² was attained at 100% replacement. At 100% replacement, concrete attained 3.54 N/mm² marginally less than 4.44 N/mm². Variations of flexural strength with the ages are given below by the help of graph.

Days	0%	25%	50%	75%	100%
7	3.63	3.21	3.18	3.11	2.99
14	3.98	3.69	3.57	3.39	3.12
28	4.44	4.19	4.02	3.98	3.54



4.3 WORKABILITY OF COCONUT SHELL CONCRETE:

The word ‘workability’ signifies much wider and deeper meaning than the other terminology “consistency” often used loosely for workability. Consistency is to indicate the degree

of fluidity or degree of mobility. Two tests basically have done for workability namely slump test and compaction factor test with fresh mix.

Test	0%	25%	50%	75%	100%
Slump (mm)	38	35	31	29	24
Compaction Factor	0.85	0.85	0.85	0.85	0.85

6. CONCLUSIONS

1. 25% replacement mixture may used in strength required constructions but above this percentage like 50% or 75% replacement concrete may not be used in loaded buildings.
2. 50% and 75% replacement concrete may used in light weight constructions like partition walls, retaining walls, park chairs, tables, gutter lids, slabs and foundations because coconut shells have higher crushing strength and more fire retaining than rock aggregate.
3. It is analyzed that in the replacement of coarse aggregate with coconut shell if increase in the percent of replacement it reduced the compressive strength of the concrete.
4. It is observed in this study that flexural strength of concrete reduces as the percent of replacement is increases.
5. Density reduced at the increment of percent replacement.
6. Workability increases as the percent of replacement increases as the slump factor and compaction factor increases.
7. Coconut shell concrete has better workability because of the smooth surface on one side of the shells and the smaller size of coconut shells. So we could possibly use coconut shell concrete in concretes where high workability is desirable.

So coconut shell can be used as partial replacement of coarse aggregate as there is marginal difference in strength between coconut shell and convention aggregate. Because of it is a waste material and abundantly available in the area of its production and near the industry used coconut, one can reduce the effective cost of the concrete and it is also helpful for the environmental point of view.

7. FUTURE SCOPE OF THE PROJECT

My study had many limitations, of which the time was a major concern. The durability properties of coconut shell concrete are to be rested before practically applying our project. Durability tests on CSC which may take around a year to complete can be conducted as a future work. The strength properties of CSC depend on the aggregate properties of coconut shells and its individual strength characteristics. Experiments on impact value, crushing value etc can be done in order to analyze the strength properties of coconut shells. When CSC is used along with reinforcement, the surface bonding between coconut shell aggregates and steel comes into play. Therefore study about bond properties of these can be useful. Furthermore the action of coconut shell aggregates in cement matrix is also an area

requiring future research. We can also study about the use of coconut shell aggregates along with other non-conventional aggregates like palm kernel shells, coir pith, volcanic debris, etc.

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