iJRASET
International Journal For Research in Applied Science and Engineering Technology



INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 10 **Issue:** V **Month of publication:** May 2022

DOI: https://doi.org/10.22214/ijraset.2022.42137

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 10 Issue V May 2022- Available at www.ijraset.com

An Overview on the Development and Research Work on Coconut Shell as an Aggregate

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Abstract: ***Different waste materials such as fly ash, silica flumes, blast furnaces slag are used in concreting. Aggregate is a major ingredient for making concrete, occupy almost 70 - 80% part of concrete[1]. Conventionally crushed rocks are used as coarse aggregate and river sand used as fine aggregate. Due to rapid growth of construction activities, conventional aggregate sources are depleting very fast leading to significant increase in cost of Construction. This has necessitated research for alternative cost effective materials in construction. The paper aims about the partial replacement of crushed coconut shells as a substitute of conventional aggregate. It may help to produce concrete economically and at the same time also will help to reduce its disposal problem.***

Keywords: coconut shell, concrete, coarse aggregate, compressive strength, waste disposal.

I. INTRODUCTION

Infrastructure development across the world created demands for construction material. Concrete is the premier civil engineering material. Concrete manufacturing involve consumption of ingredients like cement, aggregates, water & admixtures. Among all the ingredients, aggregates form the major parts. In addition, concrete is the 2nd most consumed substance in the world-behind water. About 7.23 billion tons of concrete is produced every year. Annual production represents one ton for every person on the planet [2].
The large scale production of concrete in construction activities using conventional coarse aggregate such as granite immoderately reduces the natural stone deposits and affecting the environment hence causing ecology imbalance. Increasing demand of natural aggregates show that crushed stone demand will be 2050 million metric tones in 2020[2]. In this contemporary world civil engineering construction, using alternative materials in place of natural aggregate in concrete production makes concrete as sustainable and environmentally friendly construction material.

II. COCONUT SHELL AS AN AGGREGATE

Coconut is grown in more than 93 countries. 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[3]. The chemical composition of the coconut shell is similar to wood 4248 nuts per hectare[3]. The chemical composition of the coconut shell is similar to wood. The chemical composition of the coconut shell is similar to wood. It contains 33.61% cellulose, 36.51% lignin, 29.27% and ash at 0.61%. Concrete obtained using coconut shell as a coarse aggregate satisfies the minimum requirements of concrete. Coconut shell aggregate resulted acceptable strength which is required for structural concrete. Coconut shell may present itself as a potential material in the field of construction industries. The coconut shell is compatible with cement and no need to pre-treatment for using it as an aggregate. Because of the smooth surface on one side of the shells presents better workability and also shows good impact resistance. As compared to conventional aggregate water absorbing and moisture retaining capacity of coconut shell is more. The presence of sugar in the coconut shell, does not affect the setting and strength of concrete because it is not in a free sugar form. It is found that wood based materials being hard and of organic origin, will not contaminate or leach to produce toxic substances once they are bound in concrete matrix.

III. RESEARCH FINDINGS

A few studies are done on coconut shells and the outcomes of the researches are as following:-
Olanipekun (2006) carried out the comparative cost analysis and strength characteristics of concrete produced using crushed, granular coconut and palm kernel shell 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 was used as substitute for conventional coarse aggregate in the following ratios: 0%, 25%, 50%, 75% and 100% for preparing of mix ratios 1:1:2 and 1:2:4. Total 320 cubes were casted, tested and their physical and mechanical properties were determined.

The result showed that the compressive strength of the concrete decrease as the percentage of the coconut shell increases in the two mix ratios, Coconut shell exhibited a higher compressive strength than kernel shell in the test and the cost reduction of 30% and 42% for concrete produced from coconut shell and palm kernel shell respectively[4,5].

Olutoge (2010) studied the saw dust and palm kernel shells (PKS). Fine aggregates are replaced by saw dust and coarse aggregates by palm kernel shells in reinforced concrete slabs casting. Conventional aggregates were replaced by saw dust and PKS in same ratios of 0%, 25%, 50%,75% and 100%. Compressive and flexural strengths were noted at different 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 reduced cost. 7.43% reduction can be achieved in terms of cost for every cubic meter of slab [6].

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 casted and tested for evaluating different properties. Aggregate crushing value (ACV) for coarse aggregate was 21.84 and 4.71 for coconut shell. Elongation and flakiness index were 58.54 and 15.69 respectively for gravels, while for coconut shell, 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, cost reduction of 48% will be achieved[7].

Maninder Kaur & Manpreet Kaur (2012) published a review paper in which it is concluded that 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 [9].

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 [10].

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 18.5% replacement of crushed granite with coconut shells can be used to produce structural concrete [11].

Tomas U. Ganiron Jr (2013) used coconut shells and fibre as substitute for aggregates in developing concrete hollow block. The study was carried out for various percentage of coconut shell content as partial replacement of conventional aggregate. Results showed that replacement of appropriate coconut shell content produces workable concrete with satisfactory strength. Integration of coconut shell enhanced the strength of concrete [12].

Parag S. Kambli & Sandhya R. Mathapati(2014) prepared three different Mix Designs for M20, M35, M50 grades of concrete. Percentage replacement by coconut shell varied as 0%, 10%, 20%, 30%, 40% respectively. It is concluded in this study that for M20 grade concrete cubes with 30% replacement of CS aggregates had given strength of 23 MPa at 28 days. Concrete cubes with 30% replacement of CS aggregates had given strength of 42 MPa at 28 days for M35. For M50 grade concrete cubes with 30% replacement of CS aggregates had given strength of 51 MPa at 28 days [13].

Gopal Charan Behera, Ranjan Kumar Behera presented the comparative cost analysis and strength characteristics of concrete produced using crushed coconut shell as substitutes for conventional coarse aggregate. The main objective was to encourage the use of coconut shell waste as construction materials in low-cost housing.

Damre Shraddha and Shrikant Varpe (2014) replaced conventional coarse aggregate with coconut shell and concluded that- with 50% replacement of coarse aggregates by coconut shells, the strength attained reduces invariably from 10%-20% as compared to the conventional coarse aggregate concrete. With 50% replacement of coarse aggregates by coconut shells, the flexural strength attained reduces invariably from 10%-15% as compared to the coarse aggregate concrete [14].

Anjali S. Kattire, Priyanka A. Bhujugade and Shashirajs.chougule(2015) When the tests are carried out for CSC, it shows that 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 [15].

IV. CONCLUSION

This review focuses on production of concrete using coconut shell as an ingredients replacing fast depleting conventional aggregate sources construction material and introducing a new light weight aggregate.

1) Coconut shell can be grouped under lightweight aggregate because 28-day air-dry densities of coconut shell aggregate concrete are less than 2000 kg/m3. Actual Density of coconut shell is in the range of 550 - 650kg/m3 [10].

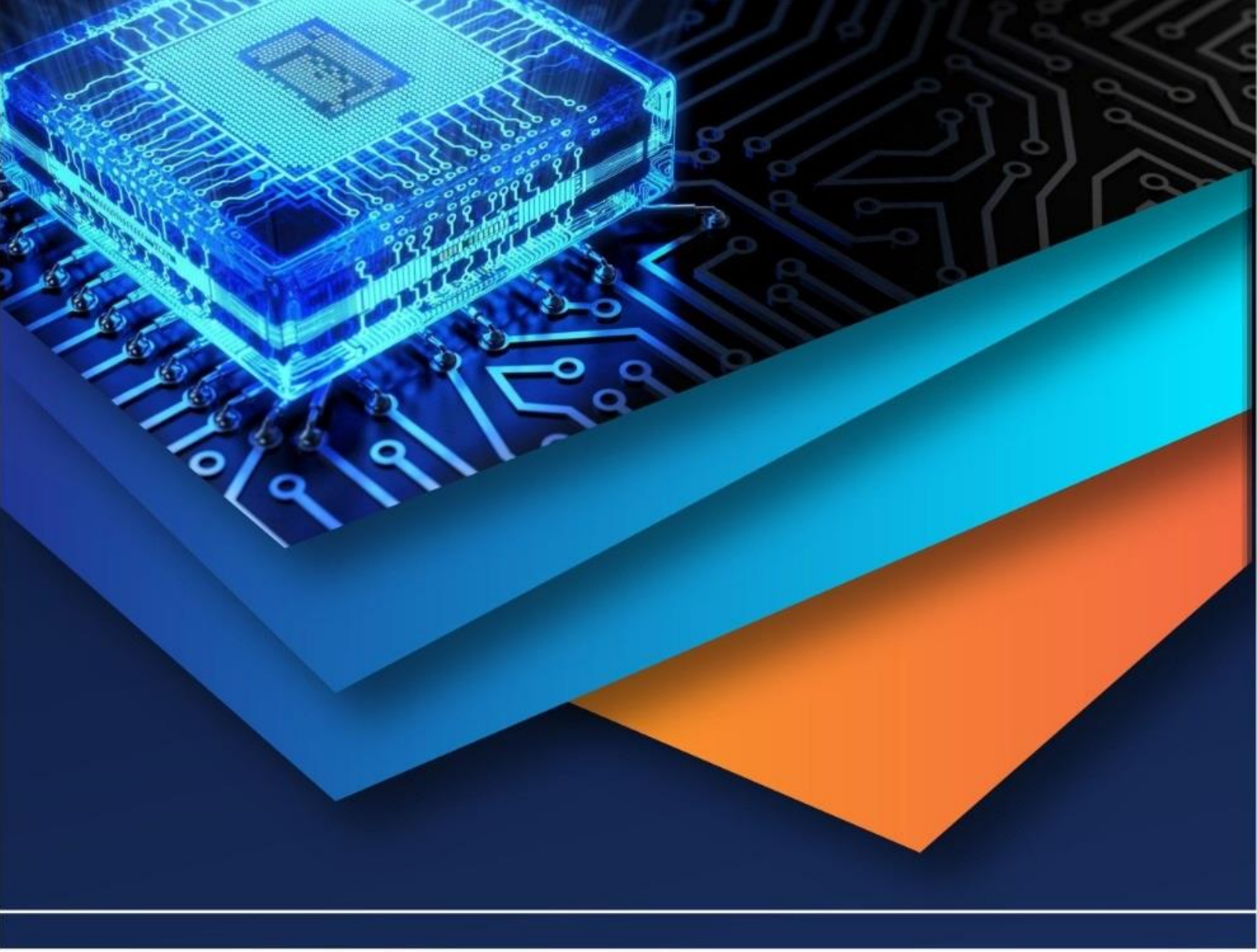
2) From the experimental results and discussions of above researches on coconut shell, the coconut shell has potential as lightweight aggregate in concrete. Also, using the coconut shell as aggregate in concrete can reduce the material cost in construction because of the low cost and its availability is abundance.

3) Coconut shell exhibits more resistance against crushing, impact and abrasion, compared to crushed granite aggregate. There is no need to treat the coconut shell before use as an aggregate except for water absorption.

4) From the above researches it also found that the addition of CS decreases workability and addition of fly ash either as cement replacement or aggregate replacement increases workability of CS concrete. We can also use fly ash to improve workability of CS concrete.

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