

## Use of Coconut Shell as an Aggregate in Concrete: a Review

Sourav Ghosal and S.C.Moulik

Department of Civil Engineering, KIIT University, Bhubaneswar, Odisha-751024, India

Corresponding E mail: mkghosal1@rediffmail.com

**Abstract:** *Now-a-days, the rising cost of building materials for construction purposes is a factor of great concern. The price of building materials is rising day by day. Now, most of the researchers are paying much attention on the suitable materials which can reduce the cost of construction as well as increase the strength properties of concrete. Mainly gravel and sand are used in the preparation of conventional concrete. While the use of an agricultural by-product i.e. coconut shell as a partial replacement with conventional coarse aggregates is expected to serve the purpose of encouraging housing developers in building construction. Environmental impact can also be reduced by making sustainable use of this waste. The coconut shell aims to prepare light weight concrete which may reduce considerably the self-load of a structure and permits large precast units to be handled. The coconut shell is more resistant to acidic, salty and alkaline attack. The characteristic properties of concrete such as compressive strength, split tensile strength, flexural strength, impact resistance, bond strength using the mix made by replacing coarse aggregates with coconut shell were reviewed in this paper.*

**Keywords:** Civil Engineering, Natural Resources utilization, Agricultural By-product, Coconut shell, Light Weight concrete

### I. INTRODUCTION

Concrete is the premier civil engineering material. Concrete manufacturing involves consumption of ingredients like cement, aggregates, water and admixtures. Today's infrastructure development across the world has created demands for construction materials. In light of this, the non-availability of natural resources to future generations has also been realized. Now, time has come to think of some alternative materials for sustainable use in concrete production.

Following a rapid growth in population, the amount and type of waste materials have increased accordingly creating environmental problems. Different alternative waste materials and industrial by-products such as fly ash, bottom ash, recycled aggregates, foundry sand, china clay sand, crumb rubber etc were replaced with natural aggregates. Apart from the above mentioned waste materials, coconut shell can also be used as aggregates in concrete due following reasons:-

- i. Large scale cultivation of coconut in coastal regions of India including Kerala, Andhra Pradesh, Goa, Tamil Nadu, Odisha etc.
- ii. After the kernel is consumed, the shell is thrown away here and there causing environmental pollution.
- iii. Due to its tough made tissue, the shell is not decomposed easily and remains as solid waste for years. Hence utilizing it in a proper manner reduces environmental problems.

Very little percentage of shells are used in ornamental preparations, making fancy items, household utensils etc. but majority of it are discarded as waste.

Helpful in cost effective housing and low rise buildings

Serves as an environment-friendly construction material.

Coconuts trees are widely cultivated in southern India, especially Kerala. The name Kerala is derived from a word "kera" meaning 'coconut tree'. The Kerala state is densely populated and major population uses coconut or its by-products in their daily activities. The tough coconut shells accumulated in the mainland get degraded in around 100-120 years. Therefore, there is a serious environmental issue of disposal of these coconut shells. If the waste cannot be disposed properly it will lead to social and environmental problems. With the quest for affordable housing system for both the rural and urban population of India and other developing countries, various proposals focusing on cutting down conventional building material costs have been put forward. Finding a substitute for the aggregates used today is a task that is worth studying because the quarrying of aggregates from rivers and mountains harms the environment.

### II. REVIEW OF LITERATURES

The literatures regarding the potential uses of coconut shell as one of the suitable aggregates for concrete have been reviewed and are presented below.

Olanipekun et al; (2006) have investigated the cost analysis and strength characteristics of concrete using coconut shell as aggregates. They concluded that the compressive strength of concrete decreased with increasing percentage of coconut shells and the cost of concrete per m<sup>3</sup> using coconut shell aggregates is lower as compared to conventional concrete.

Tukiman Siti AminahBt and Mohd Sabarudin Bin (2009) have investigated the combination of coconut shell and grained palm kernel to replace aggregate in concrete. They found that combination of coconut shell (maximum percentage) and few percentage of grained palm kernel shell have the potential for light weight aggregate in concrete. Also the combination would reduce the material cost in construction due to the cheap and abundant availability of suitable agricultural waste for concrete preparation.

YerramalaAmarnath and C Ramachandrudu (2012) have studied the properties of concrete with coconut shells as aggregate replacement and in their study they observed that permeable voids increased with increase in percentage of coconut shells. Sorptivity of concrete using coconut shell was higher than conventional concrete. Particles with decreased size may avoid problems associated with shape and thus improve bond between the aggregate particles and cement paste. The reduced particle size may increase surface area and may lead to increase in water demand and at the same time causing strength reduction in

concrete. Similarly, the reduction in water cement ratio may increase the strength of coconut shell concrete.

Kulkarni P. Vishwas and Gaikwad Sanjay kumar B. (2013) have made a comparative study on coconut shell aggregate with conventional concrete and concluded that coconut shell aggregate concrete has a low modulus of elasticity. The flexural behaviour of reinforced coconut shell concrete beams is similar in comparison to other light weight concrete. Minimum probability of bond failure occurs between steel bars and coconut shell aggregates. Density of concrete is reduced using coconut shell as compared to conventional concrete. Coconut shell when dried contains cellulose, lignin and ash in varying percentage.

Shelke et al; (2014) have reviewed coconut shell as partial replacement for coarse aggregate and they made the following inference that the increase in percentage of coconut shell decreased with density of concrete. With the increase in the percentage of coconut shell, the strength of 7 days curing increased with the corresponding 28 days curing strength. Coconut shell is most suitable and compatible with the cement. The 28 days air dry density of coconut shell aggregates is less than  $2000 \text{ kg/m}^3$  and this is within the structural light weight concrete. Coconut shell aggregates satisfies the requirements of ASTM C 330.

Dandagala et al;(2014) have made laboratory investigation on coconut shell in concrete, an alternative low cost building material and reached at following findings that coconut shell can be used as full replacement with crushed granite in concrete construction. There is no need to treat coconut shells before use as an aggregate except for water absorption. The possibility exists for the partial replacement of coarse aggregates with coconut shell to produce light weight concrete. Also coconut shell exhibits more resistance against crushing, impact and abrasion when compared to normal concrete.

Kambli Parag S. and Mathapati Sandhya R. (2014) have studied the application of coconut shell in concrete and arrived at the following conclusions i.e. coconut shell has potential as light weight aggregate in concrete. It can be used where conventional aggregates are costly. Also coconut shell is more suitable as low strength giving light weight aggregate when used to replace common coarse aggregate in concrete production.

Kalkade S.A. and Dr. Dhawale A.W. (2015) have used coconut shell aggregates in concrete productions and hence concluded that coconut shell as aggregates have high water absorption because of high porosity in its shell structure. The aggregate impact value of coconut shell are much lower as compared to crushed stone aggregate which indicates that the aggregates have good absorbance to shock.

Rao et al; (2015) have studied the strength properties of coconut shell concrete and arrived at the following conclusions that addition of coconut shell aggregate alone decreases the workability of concrete. Increase in coconut shell percentage decreased densities of concrete. As the percentage of coconut shell is increased, the compressive strength and split tensile strength of concrete using coconut shell also are decreased as compared to conventional concrete.

### III. CONCLUSIONS

From the review of the above research work undertaken by the various researchers, it can be concluded that coconut shell can be used as coarse aggregates in light weight concrete preparation.

Sustainable utilization of this agricultural by-product would preserve the conventional aggregates for future. India is the third highest producer of coconut after Philippines and Sri Lanka. Hence this waste should not be dumped here and there; rather it should be utilized in a proper manner so as to eradicate environmental hazards and an effective substitute of concrete aggregate. To opt for green construction, use of coconut shell as coarse aggregates is a right choice, since coconut shell aims to produce light weight concrete and would definitely help in increasing the speed of construction. Till now, only the study regarding coconut shell as aggregate in concrete is studied. But research regarding the use of green coconut (tender coconut) shell and matured coconut husk as fine or coarse aggregates in concrete preparation should be done so as to utilize these vast and under- utilized agricultural wastes in mass construction in infrastructural sector. It is so, because after the consumption of sweet water, the green coconut shells are simply thrown and dumped here and there causing favourable conditions for methane emissions, the most potent green house gases for the atmosphere. Effective utilization these agricultural wastes will not only solve their disposal problem but also protects the local environment. Hence, there is the need to study the feasibility of green coconut shells and matured coconut fibre as the aggregates for concrete preparation in the future research programme.

### REFERENCES

- i. Olanipekun, E.A., Olusola, K.O. and Ata O, "A comparative study of concrete properties using coconut shell and palm kernel shell as coarse aggregates". *Building and Environment* 41: pp: 297-301, 2006.
- ii. Tukiman Siti Aminah Bt and Mohd Bin Sabarudin, "Investigation of the combination of coconut shell and grained palm kernel to replace aggregate in concrete-A technical Review". *National Conference on Postgraduate Research (NCON-PGR)-2009*; pp: 49-57, 2009.
- iii. Yerramala Amarnath and C Ramachandradu, "Properties of concrete with coconut shell as aggregate replacement". *International Journal of Engineering Inventions*; Volume 1, Issue 6 (October 2012) pp: 21-31, 2012.
- iv. Kulkarni P. Vishwas and Gaikwad Sanjay kumar B, "Comparative study on coconut shell aggregate with conventional concrete". *International Journal of Engineering and Innovative Technology (IJEIT)*; volume 2, Issue 12, June 2013; pp: 67-70, 2013.
- v. Shelke Akshay S., Ninghot Kalyani R., Kunjekar Pooja P and Gaikwad Shradha P, "Coconut shell as partial replacement for coarse aggregate-A Review". *International Journal of Civil Engineering Research*, Volume 5, Number 3 (2014), pp: 211-214, 2014.
- vi. Dandagala Sreenivasulu, K Praveen, K Satish, K Sri Harsha, P Mahesh and V Anil Kumar, "Laboratory Investigation on Coconut Shell in Concrete: An alternative low cost building material". *Journal of Chemical and Pharmaceutical Sciences-2014*, pp: 41-43.
- vii. Kambli Parag S. and Mathapati Sandhya R, "Application of coconut shell as coarse aggregates in concrete: A Technical Review". *International Journal of Engineering Research and Applications*, Volume 4, Issue 3 (version 1)-2014; pp: 498-501, 2014.
- viii. Kalkade S.A. and Dr. Dhawale A. W, "Light Weight Aggregate Concrete By Using Coconut Shell". *International Journal of Technical Research and Applications*, Volume 3, Issue 3-2015 pp: 127-129, 2015.
- ix. Rao Kalyanapu Venkateswara, Swaroop A. H. L. And Dr. Rao P. Kodanda Rama, Bharath Ch. Naga, "Study on strength properties of coconut shell concrete". *International Journal of Civil Engineering and Technology (IJCEIT)*, Volume 6, Issue 3-2015; pp: 42-61, 2015.