Utilization of Coconut Shell in Different Forms in Concrete

Neetesh Kumar[1] Dilip Kumar[2]
[1]PG Student [2]Assistant Professor
[1,2] Department of Civil Engineering
[1,2]Madan Mohan Malviya University of Technology, Gorakhpur

Abstract— The rising cost of material is a matter of concern in this developing construction environment. The prices of building material such as cement, sand, gravel etc. are increasing day by day. The reason for increase in cost is high demand and less availability of material. Nowadays, most of the researchers are doing research on the 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 water demolished building material 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. Coconut shell used as coarse aggregate in concrete encouraged sustainable and environmentally helpful material in the construction field. Since cement rate increases day per day and its availability is decreasing as per time so it can be useful to use coconut shell ash used as substitute of cement in concrete. Coconut shell can be used in the form of powder with epoxy resins or epoxy matrixes in concrete also. Composites are made by combining two or more natural or artificial materials to maximize their useful properties and minimize their weaknesses.

Keywords: coconut shell, coconut shell ash, epoxy matrixes or composites, coconut shell powder, cement, coarse aggregate

I. INTRODUCTION

Many of the non-decaying waste materials will remain in the environment for hundreds, perhaps thousands of years. The non-decaying waste materials cause a waste disposal crisis, thereby contributing to the environmental problems. However, the environmental impact can be reduced by making more sustainable use of this waste. This is known as the Waste Hierarchy. Its aim is to reduce, reuse, or recycle waste, the latter being the preferred option of waste disposal. There were many experimental work conducted to improve the properties of the concrete by putting new materials, whether it is natural materials or recycle materials or synthetic materials in the concrete mix. Concrete is an artificial material similar in appearance and properties to some natural lime stone rock. It is a man made composite, the major constituent being natural aggregate such as gravel, or crushed rock, sand and fine particles of cement powder all mixed with water. The concrete as time goes on through a process of hydration of the cement paste, producing a required strength to withstand the load. The use of coconut shell in concrete has never been a usual practice among the average citizens, particularly in areas where light weight concrete is required for non-load bearing walls, non-structural floors, and strip footings. The chemical composition of the coconut shell is similar to wood. Coconut is grown in more than 93 countries. South East Asia is regarded as the origin of coconut. India is the third largest, having cultivation on an area of about 2.60 million hectares. Annual production is about 7562 million nuts with an average of 5295 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. Coconut shell represents more than 60% of the domestic waste volume.

II. OBJECTIVES

- To find economical and environmental helpful solution for high cost of concrete.
- To discuss the use of coconut shell in the form of ash as partial replacement of cement.
- To discuss the use of coconut shell powder with epoxy resins/epoxy matrixes/composites in concrete.
- To discuss the use of coconut shell as coarse aggregate in concrete.

A. Chemical Properties of Coconut Shell Ash

Oxide	CSA
SiO_2	37.97
Al_2O_3	24.12
Fe_2O_3	15.48
CaO	4.98
MgO	1.89
MnO	0.81
Na_2O	0.95
K_2O	0.83
P_2O_5	0.32
SO_3	0.71
LOI	11.94

B. Physical Properties of Coconut Shell

S.N.	Physical property	Test result
1.	Maximum Size (mm)	20
2.	Fineness modulus	6.48
3.	Specific Gravity	1.56

4.	Bulk Density(kg/m^3)	510-600
5.	Water Absorption (%)	23
6.	Aggregate Crushing Value (%)	2.49
7.	Aggregate Impact Value (%)	8.55
8.	Moisture Content (%)	4.2
9.	Shell Thickness(mm)	3-6

C. Coconut shell and crushed coconut shell


D. Use of Coconut Shell Ash as Replacement Of Cement

The cost of cement used in concrete works is on the increase and unaffordable, thus the need to find alternative binding materials that can be used solely or in partial replacement of cement. One of the agricultural waste materials, coconut shells are collected and burnt .in the open air (uncontrolled combustion) for three hours to produce coconut shell ash (CSA), which in turn was used as pozzolana in partial replacement of cement in concrete production. The studies showed that the density of concrete cubes for 10-15% replacement was above 2400 Kg/m^3. The average density decreases from 2525.5 Kg/m^3 for OPC to 2314 Kg/m^3 at 30% replacement. The density of cement is higher than that of the CSA. The compressive strength meets the requirement for use in both heavy weight and light weight concreting. CSA meets the requirement for a pozzolana. The setting times increases with increase in the amount of CSA. The initial setting time increases from 1 hr 5 min at 0% replacement to 3 hrs 26 min at 30% replacement while the final setting time increases from 1 hr 26 min at 0% replacement to 4 hrs 22 min at 30% replacement. The pozzolanic activity index decreases with increasing percentage replacement of OPC with CSA. The compressive strength decreases with increasing percentage replacement of OPC with CSA. The optimal 28 days strength for OPC-CSA mix is recorded at 10% replacement is 31.78 N/mm^2.

E. Use Of Coconut Shell Powder With Epoxyresins/ Epoxy Matrixes/ Composites In Concrete

The chemical composition of coconut shell powder having Lignin (29.4%), Cellulose (26.6%), Pentosans (27.7%), Solvent Extractives (4.2%), Moisture (8%), Uronic Anhydrides (3.5%) and Ash (0.6%).The coconut shells collected from local resoureces were crushed into small pieces manually by using hammer. Then small pieces converted into powder by same method. The collected powder was then sieved to different sieve sizes.

Mechanical properties of coconut shell powder epoxy resin are greatly affected by the how much volume filled by coconut shell powder. Samples provided are on the 20 %, 30 %, 40 % coconut shell powder filled, from density point of view it is observed that density of 20% CSP filled is less than the other filled. When we go from 20% to 30 % density curve increases gradually and when it goes to 40% from 30%, it increases more rapidly than other so from 30-40% rate of increase in density is maximum.

Maximum tensile strength is obtained at 20% CSP filed and it decreases as further increment in the ratio. Rate of decreasing tensile strength is approximately constant from 20% to 30% and from 30% to 40%.

Flexural strength of CSP composites increases from 20 % to the 30 % of CSP filled and further it is decreased for the 40 %. Flexural strength is minimum for the 40% and rate of decrement in strength for 30-40% is greater than rate of increment in flexural strength for the 20-30%.

The composite prepared with 20% to 30% CSP filled volume fraction is suitable for the application in the interior part of an aircraft, motor car and automobilewhere materials with good tensile strength, low density andlow hydrophilic characteristic are required.

F. Use of Coconut Shell as Coarse Aggregate In Concrete

Using 1:2:4 proportions it is found that the density and strength characteristics of concrete produced by volume replacement of 20%, 30%, 40%, 50% and 100% replacement of crushed granite with coconut shells were investigated. It was concluded that

- Increase in percentage replacements by coconut shells reduced the strength and density of concrete.
- With the exception of complete replacement, 20%, 30%, 40%, and 50% replacement of crushed granite by coconut shells can be used in producing lightweight concrete.
- 18.5% replacement of crushed granite with coconut shells can be used to produce structural concrete per the requirements.
- Coconut shells can be used as partial replacement of crushed granite or other conventional aggregates in reinforced concrete construction.
- Coconut shell can be used as partial replacement of coarse aggregate in concrete.

At M-25 mix design it was reported development of the mix design of lightweight aggregate concrete using Coconut shell aggregate (CSA) as coarse aggregate together with cement and river sand. The compressive strength after 28 days was found to be in the ranges between 4.9 N/mm^2 - 23.5 N /mm^2 under water curing. The test results shows that concrete using coconut shell aggregate has resulted in acceptable strength required for structural lightweight concrete. It is concluded that the lightweight concrete developed from CSA aggregate can be used for both structural and non-structural applications. This study was carried out to determine the possibilities of using coconut shell as aggregate in concrete. They concluded water absorption of the coconut shell aggregate was high about 24 % but the crushing value and impact value was comparable

to that of other lightweight aggregates. The average fresh concrete density and 28-day cube compressive strength of the concrete using coconut shell aggregate were 1975 kg/m^3 and 19.1 N/mm^2 respectively.

` At the different proportions, the compressive strength of concrete cubes produced with gravel and coconut shells, for seven (7) days curing, the average compressive strength for concrete cubes produced with coconut shell of mix ratio 1:2:4, 1:1$^{1/2}$:3, 1:3:6 were 8.6, 8.9, 6.4 N/mm^2 respectively and 15.1, 16.5, 11N/mm^2 respectively for 28 days. The 7 days cured concrete cubes produced with gravel have an average compressive strength of 19.6, 18.5, and 9.6 N/mm^2 and 28.1, 30.0 and 15.6 N/mm^2 at 28days with mix ratios of 1:2:4, 1:1$^{1/2}$:3, 1:3:6. From the research, mix ratio 1:1$^{1/2}$:3 of coconut shell with strength 16.5N/mm^2 at 28 days can be used as plain concrete.

III. Conclusions

There are several conclusions from above study:

(1) Coconut shell can be used in concrete to solve environmental and economical problem.
(2) Coconut shell can be as coarse aggregate in concrete and it give enough strength to concrete as its crushing value and impact value is better than coarse aggregate. It can be grouped as light weight aggregate and used at different proportion as per required strength.
(3) Coconut shell ash can e used as the partial replacement of cement in concrete and proportion depends upon the strength required and quality of coconut shell (property of coconut shell).
(4) Coconut shell powder with epoxy resin/matrixes can be used in concrete.

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References

[1] Utsev J. T, Taku J. K. (2012), "Coconut Shell Ash as Partial Replacement of Ordinary Portland Cement in Concrete Production", International Journal of Scientific & Technology Research Vol. 1, Issue 8, pp. 86-89.
[2] V.K.Nagarajan, 2014, "Experimental Study on Partial Replacement ofCement with Coconut Shell Ash in Concrete", International Journal of Science and Research, Volume 3 Issue 3, March.
[3] Alok Singh et al. (2013), "Study of mechanical properties and absorption behavior of coconut shell powder-epoxy composites", International Journal of Materials Science and Applications, August 30.
[4] Abdulfatah Abubakar, Muhammed Saleh Abubakar (2011), "exploratory study of coconut shell as coarse aggregate in concrete", Journal of Engineering and Applied Sciences, Vol 3, Dec.
[5] Daniel Yaw Osei. (2013), "Experimental assessment on coconut shells as aggregate in concrete", International Journal of Engineering Science Invention, Vol. 2, Issue 5, pp. 07-11.
[6] Gunasekaran, K., Annadurai, R. & Kumar, P. S.,2012 " Long term study on compressive and bond strength of coconut shell aggregate concrete" Construction and Building Materials 28 (1) 208-215.
[7] K.Gunasekaran, P.S.Kumar et al 2008, Proceedings of International Conference on Advances in Concrete and Construction, ICACC-2008", Hyderabad, India pp 450-459

