INTERNATIONAL JOURNAL OF ADVANCE RESEARCH AND DEVELOPMENT

(Volume3, Issue3)
Available online at: www.ijarnd.com

Experimental Study on Strength of Concrete by Partial Replacement of Cement by Cashew Nut Shell Ash (CNSA) and Chicken Feather Fiber (CFF) as Fiber Reinforcement

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ABSTRACT

In this project, to reduce the cement content in the concrete to use the cashew net shell ash (CNSA). Most ashes have pozzolanic activity and may be used as a cement replacement material, resulting in less energy waste and low-cost composite. And also increase the strength of concrete to add the chicken feathers as a fiber. The CFF has the presence of more void space in its cross-section, so it has good resilient property. By using the CFF will save cost, eco-friendly environment and also help the fiber industry sustainable. Combination of CNSA and CFF is cost-efficient and improve the strength of the concrete block.

Keywords: *Cashew Nut Shell Ash, Chicken Feather Fiber, Pozzolanic, Energy Waste, Calcareous, Argillaceous, Compression, Plain Rigid Bearing Block.*

1. INTRODUCTION

Cashew nut shell Ash (CSNA) is obtained from Cashew nut shell and is combusted to very high temperature. Cashew is an important evergreen tropical crop. India is the largest producer, processor, exporter and second largest consumer of cashew in the world. In India, cashew cultivation is about 8, 54,000 hectare with annual production of 6, 20,000 tones giving average productivity 820 kg/ha. In Tamilnadu, Cuddalore district has ranked first in cashew production with 24,302 tons and had the highest cashew productivity of 810 kg/ha among the cashew growing districts in the state. In this study, CNSA was replaced for cement in various proportions 20% and 30%its compressive strength was studied.

Fibers are hair-like materials that are continuous filaments or discrete elongated pieces. They are of two types: natural fiber and synthetic fiber. Natural fibers are a class of hair-like materials that are obtained from vegetables, animals, or minerals. Some of them can be spun into filaments, thread, or rope. They can be used as reinforcements in composites. Natural organic fibers can be derived from either plant or animal sources. The main chemical structures are based on cellulose for plant fibers and proteins for animal fibers. Cellulose-based fibers from plants are of most interest for composite materials because they tend to be stronger and stiffer than their animal counterparts. CFF has added 2% in the mix proportion.

2. RESEARCH OBJECTIVES

The following are the objective of this study

- To reduce the cement content for concrete.
- To increase the compressive strength of concrete.
- To recognize and assess various supplementary materials obtained as by-products for partial replacement of cement.
- To increase the compressive strength of concrete by using chicken feather fiber.
- To develop a green and economical substitute to cement by using cashew nut shell ash.
- To minimize the overall environmental effects of cement production using these resources as partial replacement of cement.
- To determine the performance of concrete by partial replacement of cement by cashew nut shell ash(CSNA) slag in 20%, 30%variants.
- To determine the most optimized mix of CSNA- based concrete.

- To study the physical and chemical properties of industrial waste and are the ingredients in concrete.
- To provide economical construction material for all construction projects.
- To provide a safeguard to the environment by utilizing solid wastes properly.

3. MATERIAL PROPERTIES

CASHEW NUT SHELL ASH

The cashew tree belongs to the Anacardiaceae family, genus Anacardium L., species Anacardiumoccidentale L. The cashew tree occupies an important position among the tropical fructiferous trees on account of the growing commercialization of its main products: the cashew nut shell. The plant is found in Central America, Africa, Asia and India, Vietnam and Brazil stand out as the largest producers of cashew nut. Most of the production of the cashew nut and CNSL is destined for exportation. The rinds of cashew nut are burned again during the heating process, and in boilers, they'll generate heat for shelling other nuts. The CNSA is the waste collected from the boiler grid, resulted from burning of the rind of nuts. This waste is used as composts in plantings of cashew and a little part of it is dumped in landfills.

CHICKEN FEATHER FIBRE

CFF is natural material from the chicken and it is possible to find in nature an almost unlimited source of high-performance materials which remain to be critically studied to establish them as the basis for innovative technologies and useful raw materials. This is the case of keratin fiber from chicken feathers. Chicken feather comprises more than 90% protein, the major part being beta-keratin, a fibrous and insoluble structural protein broadly cross-linked by disulfide bonds. The CFF has the presence of more void space in its cross-section, so it has good resilient property. By using the CFF will save cost, eco-friendly environment and also help the fiber industry sustainable.

4. RESEARCH METHODOLOGY

From the study of literature, CSNA is a by-product from agricultural waste cheaper than Ordinary Portland cement and available in large quantities, the utilization of this product in concrete work would reduce the effect of this agricultural waste an agent of environmental pollution. This CSNA also has the product such as the Sio2, Al2o3, Fe2o3, Cao which is also a byproduct of the cement, so the ash can be used for the replacement of the cement. The Youngs modulus of chicken feather fibers was found to be in the range of 3 - 50 GPa and the tensile strength of oven-dried chicken feather fibers in the range of 41-130 Mpa.

Compression test: It is the most recognized test conducted as it is an easy test to perform on hardened cement mortar and also most of theenviable characteristic properties of cement mortar are qualitatively associated to its compressive potency. The compression test is experimented out on cubical specimens of the size 70.6 × 70.6 × 70.6 mm. The test is carried out in the following steps: Firstly the mold made up of cast iron is used to make the specimen of size 70.6 × 70.6 × 70.6 mm. At the time of placing concrete in the molds it is well compacted with the tamping bar with not less than 35 strokes per layer. After 24 hours the specimens are carefully removed from the molds and instantly stored in clean fresh water. After 7, 14 and 28 days the specimens are made to test under the load in a compression testing setup.

The results from the compression test are the maximum load that the cube can bear before it ultimately fails. The compressive stress can be computed by dividing the maximum load by the area normal to it. The findings of compression test and the corresponding compressive stress are shown in Table II, III, IV.
Let,
P = maximum bear load of the cube prior to the failure
A = area normal to the load = 70.6 × 70.6 mm2
= 4984.36 mm2
σ = maximum compressive stress (N/mm 2)
Therefore,

$$\sigma = (P/A)\ N/mm^2$$

5. RESULTS AND DISCUSSIONS

Chemical Analysis of CNSA Chemical analysis was carried out on samples of CNSA by SEM plus EDAX and result shown in Table I. The results show that CNSA contains most of the compounds known to have binding properties necessary for concrete work. Sio_2 and Fe_2o_3 are having a higher percentage of the Cashew nut shell ash compare to the PPC. So that the cashew nut shell as used partial replacement by cement.

Table 1

Oxides	CNSA	PPC
Sio_2	54.85%	20.98%
Al_2o_3	2.01%	5.42%
Fe_2o_3	4.20%	3.92%
Cao	35.58%	62.85%
Mgo	1.85%	2.57%
So_3	0.80%	2.36%
Loss in ignition	0.71%	1.9%

CHEMICAL COMPOSITION OF CNSA

B. Tests on Cubes

Cube Test of Concrete is one of the most important tests done on concrete. It is also known as a test to determine the Compressive Strength of Concrete. At the failing point, the compressive strength of Concrete is determined. The cube will be tested for finding compressive strength, by using the universal testing machine. It will be tested in the 7 days,14 days and 28 days strength of concrete. And the cubical moulds of size 15cm x 15cm x 15cm. In the mould, concrete is filled and by using the tamping rod to tamped properly so as not to have any voids. After 24 hours these moulds are removed.

Table II: 7 days Compressive Strength of cement mortar cubes

Partial replacement of cement with CNSA (%)	Adding of CFF	Cube No	Cube size ($mm^{3)}$)	Load in P (KN)	Average Load in (KN)	Compressive strength in N/mm^2
0%	0%	1	150×150	338		
		2	150×150	356	344	15.3
		3	150×150	338		
20%	2%	1	150×150	366		
		2	150×150	380	377	16.8
		3	150×150	385		
30%	2%	1	150×150	332		
		2	150×150	325	330	14.7
		3	150×150	333		

Table III: 14 days Compressive Strength of cement mortar cubes

Partial replacement of cement with CNSA (%)	Adding of CFF	Cube No	Cube size (mm$^{3)}$	Load in P (KN)	Average Load in (KN)	Compressive strength in N/mm^2
0%	0%	1	150×150	618		
		2	150×150	622	628	27.96
		3	150×150	646		
20%	2%	1	150×150	668		
		2	150×150	676	679	30.23
		3	150×150	694		
30%	2%	1	150×150	597		
		2	150×150	588	591	26.30
		3	150×150	590		

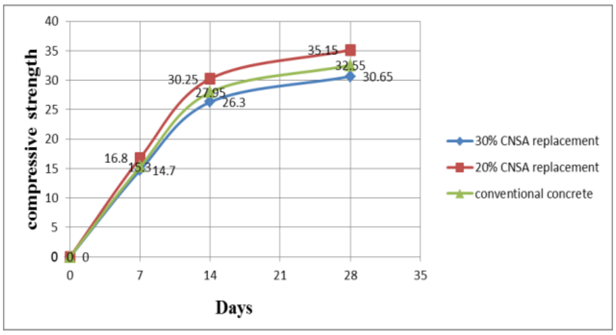
Table IV: 27 days Compressive Strength of cement mortar cubes

Partial replacement of cement with CNSA(%)	Adding of CFF (%)	Cube No	Cube size (mm$^{3)}$	Load in P (KN)	Average Load in (KN)	Compressive strength in N/mm^2
0%	0%	1	150× 150	725		
		2	150× 150	732	731	32.56
		3	150× 150	737		
20%	2%	1	150× 150	777		
		2	150× 150	791	790	35.16
		3	150× 150	802		
30%	2%	1	150× 150	692		
		2	150× 150	686	692	30.65
		3	150× 150	689		

The above table shows the 14 days compressive strength of the cube. In that 20% will achieve more strength compare to the conventional concrete and 30% replacement of CNSA & 2% of CFF.

GRAPH:

COMPRESSIVE STRENGTH OF CONCRETE WITH 7& 28 DAYS



From the previous discussions we found that 20% CNSA & 2% CFF replacement gave good strength, hence we attempted to increase the CNSA replacement proportion to 30% which showed a linear decrease in the 14 and 28 days compression test results when plotted. Hence we conclude to prefer with 20% CNSA AND 2% CFF replacement with PPC for further progression.

6. CONCLUSION

Based on the conducted experiment and according to the result obtained, it can be concluded that: Cashew nut shell ash can increase the overall strength of the concrete when used up to a 20% cement replacement and chicken feather fiber as 2% with w/c ratio of 0.45.when cashew nut shell ash is used up to 30%in concrete with w/c ratio of 0.45 it gives lower strength to the 20%of replacement. Cashew nut shell ash is a valuable material and it can potentially be used as a partial replacement for cement. This can reduce the environmental problems. Since Cashew nut shell ash is a by-product material, its use as a cement replacing material reduces the levels of co_2 emission by the cement industry and also saves a great deal of virgin materials. Compressive strength test confirmed the actual behavior of CNSA and CFF blended mortars and it suggested that up to 20% substitution of PPC with CNSA can make with better strength results than that with pure cement.

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