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A study on Strength of Cement Mortar with Partial Replacement of Groundnut Shell Ash

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***Abstract*- Groundnut ash is the one of the waste material used for replacement of cement. The ground nut shell ash contains 11% CaO and 34% Sio2 which can be considered as good pozzolona only next to fly ash. Therefore an experimental program is evolved to determine experimentally optimum the percentage of cement can be replaced with ground nut shell ash pozzolona without sacrificing the strength mortar cubes 70.6 X 70.6mm size of mortar cubes were cast with no replacement of cement and other cubes with 15%, 20%, 30% and 40% replacement. From the results of experimental study it can be concluded that the strength increases and reach optimum value at 15% replacement of cement by Groundnut shell ash on the comparison of 7 days strength. It is found that the strength had increased by 8.5% and its percentage of increase in strength on 28th day need to be studied. The extension of this, in concrete is also proposed to be studied.**

Key words – Groundnut Shell Ash, Cement mortar, Cement Concrete Cubes, Compressive strength.

I. INTRODUCTION

The construction industry is based heavily on cement for its functions in the development of shelters and other infrastructural amenities and facilities. It then becomes extremely complicated for common people to own their own houses or several collapse structures in endeavour to reduce cost. A way out is moreover by reducing the energy expenditures in the burning of clinker or by escalating the manufacture of the composite cement.

The later on engages replacing a fraction of the clinker manufactured high calorie consuming portion by available other by-products that are suitable and do not needs further heat treatment.

Several researchers in the recent past had investigated the use of agricultural wastes that are identified to be pozzolona to partly substitute cement that is the main component of concrete. The use of Rice Husk Ash (RHA) and Ordinary Portland Cement (OPC) concrete in minimizing thermally tempted expansion cracks has been acknowledged. This is for the reason that the OPC-RHA paste hydrates gradually and therefore evolved low heat bringing in their worthy for use in concrete in the tropicals.

The partial replacement of OPC/PPC with GSA in concrete production is a welcome progress. The cost of GSA when compared with PPC is especially low due to the accessibility of Groundnut shell in huge quantities as agricultural farm wastes in our Tamil Nadu. The consumption of Groundnut shell to partial replacement of cement will promote waste management at modest cost, diminish pollution by these waste and enhance the financial base of the farmer when these waste are traded thereby ropes more production. The major cause to use of GSA in concrete as its production involves less energy demand likened with cement production and safe and sound the required foreign exchange trade depleted on importation of cement or its ingredients.

II. RESEARCH OBJECTIVES

The objectives of the study is

- **i.** To recognize and assess various supplementary materials obtained as by-products for partial replacement of cement.
- **ii.** To develop an green and economical substitute to cement by using groundnut shell ash
- **iii.** To minimize the overall environmental effects of cement production using these resources as partial replacement.

III. MATERIAL PROPERTIES

Groundnut Shell Ash

India is one of the largest producers for oil seeds in the world and occupies an important position in the Indian agricultural economy. It is estimated that area of 23.44 million hectares with the production of 25.14 million tonnes ground nut. It is one of the most important food and cash crops of our country. While being a valuable source of all the nutrients, it is a low price commodity. Ground nut is also called as wonder nut and poor means cashew nut. It is a low a price commodity but valuable source of all the nutrients.

Ground nut is grown on 26.4 million hectares worldwide with a total production of 37.1 million metric tonne and an average productivity on 1.4metric tonne per hectares. Over 100 countries worldwide grow groundnut. Developing countries constitute 97 percentage of the global area and 94 percentage of the global production of this crop.

The chief groundnut producing countries in the world are India, China, Senegal, Nigeria, Sudan, Burma and the USA. India takes the first place, both in consideration to the area and the production in regard the whole world. Around 7.5 million hectares are set under it annually and the production is concerning six million tonnes. 70% of the area and 75% of the production has been concentrated in the four states of Tamil Nadu, Andhra Pradesh, Gujarat and Karnataka. Tamil Nadu, Andhra Pradesh, Gujarat and Karnataka have irrigated areas primarily during the rabi season. The irrigated areas are about 6% of the groundnut cultivated area in India.

At present time, issues related to environmental preservation have gained significance; hence the make use of these waste materials that are available in our environment is now essential. In related works, Fly ash, RHA and volcanic ash etc., have been used as partial replacement to cement in concrete work.

IV. RESEARCH METHODOLOGY

From the study of literatures and previously made researches, Compressive Strength test was adopted to experiment the strength and mechanical properties of cement mortar using groundnut shell ash. Cement mortar cubes made up of various proportions were tested and analysed for finding the effect of using groundnut shell ash.

In this study M20 grade cement mortar was casted. Total number of 21 cubes was casted and tested for compressive strength as test. Out of which totally three are control specimen made up of ordinary cement mortar and the remaining specimens were casted using 0.8% of Humic Acid, 15% of GSA, 15% of GSA+0.8% of Humic Acid, 20% of GSA, 30% of GSA and 40% of GSA by cement weight at the same time as three cube specimens for each volume fractions.

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 the enviable 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 mould 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 moulds 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 moulds and instantly stored in clean fresh water. After 7 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 is shown in Table II and Table III.

Let,

P = maximum bear load of the cube prior to the failure
A = area normal to the load = 70.6 × 70.6 mm^2
= 4984.36 mm^2
σ = maximum compressive stress (N/mm^2)

Therefore,

$$\sigma = (P/A)\ N/mm^2 \quad (1)$$

V. RESULTS AND DISCUSSIONS

A. Chemical Analysis of Ground Shell Ash (GSA)

Chemical analysis was carried out on samples of GSA by SEM plus EDAX and result shown in Table I. The results show that GSA contains most of the compounds known to have binding properties necessary for concrete work. The percentage composition of CaO found in the GSA was found to be less than that in the PPC. The total percentage of iron oxide (Fe_2O_3) silicon dioxide (SiO_2) and aluminium oxide (Al_2O_3) is found to be less than the minimum of 70% specified for pozzolanas. However, the percentage content of magnesium oxide was found to be much higher than the minimum recommended.

TABLE I: COMPOSITION OF GROUNDNUT SHELL ASH

Constituent	**% Composition (GSA)**
Silica (SiO_2)	34.21
Ferrous oxide (Fe_2O_3)	1.80
Calcium Oxide (CaO)	11.53
Magnesium Oxide (MgO)	6.04
Aluminum Oxide (Al_2O_3)	5.93
Potassium Oxide (K_2O)	9.74
Sulphite (SO_3^2)	6.21
Sodium Oxide (Na_2O)	9.02

B. Tests on Cubes

From the above comparative table it is found that GSA can be used to replace PPC since their constituents match and when used together will not sacrifice the strength and performance of concrete, various proportions are adopted to find the optimum replacing percentage of GSA to PPC. Therefore cement cubes were casted and tested and found 15% GSA replacement with PPC in cement mortar cubes contributed best results compared to others proportions.

1) Test Results for GSA and Humic Acid Proportions

Cases:

I. M20 - Control specimen
II. M20 - 0.8% of Humic Acid
III. M20 - 15% GSA replacement of cement
IV. M20 - 15%GSA + 0.8% of Humic Acid

TABLE II: 7days Compressive Strength of cement mortar cubes made using GSA and Humic Acid

Case	**Cube (No's)**	**Compressive strength (N/mm^2)**	**Average Strength(N/mm^2)**
I (CONTROL)	1	15.22	15.4
	2	16.05	
	3	15.04	
II (0.8% Humic Acid)	1	14.04	14.04
	2	14.04	
	3	14.04	
III (15%GSA)	1	17.05	16.71
	2	17.05	
	3	16.05	
IV (15%GSA + 0.8% Humic)	1	12.03	12.37
	2	13.04	
	3	12.03	

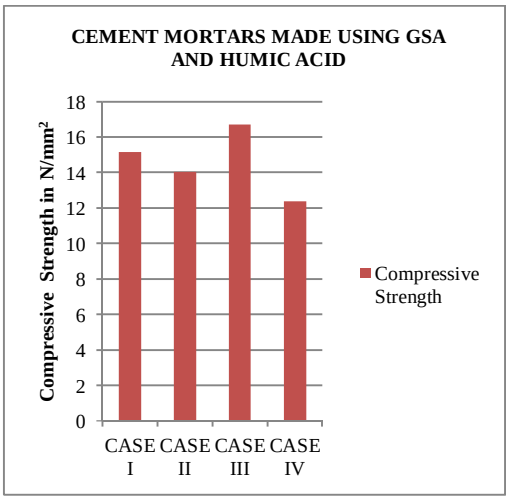

CHART I. 7DAYS COMPRESSIVE STRENGTH OF CEMENT MORTAR CUBES MADE USING GSA AND HUMIC ACID

The above table states as the 15% GSA replaced to PPC gives us good result about 8.5% more strength when compared with PPC cement mortar cube. Whereas the combination of Portland Pozzolona Cement with and without GSA, and 0.8% humic acid did not pass the required strength of 7 days compressive test.

2) Test Results for Various Proportions of GSA

Cases:

I. M20 - Control specimen
II. M20 - 15% GSA replaced to cement
III. M20 - 20% GSA replaced to cement
IV. M20 - 30% GSA replaced to cement
V. M20 - 40% GSA replaced to cement

TABLE II: 7days Compressive Strength of various proportions of GSA

Case	Cube (No's)	Compressive strength (N/mm^2)	Average Strength(N/mm^2)
I (CONTROL)	1	15.22	15.4
	2	16.05	
	3	15.04	
II (15%GSA)	1	17.05	16.71
	2	17.05	
	3	16.05	
III (20%GSA)	1	10.03	9.79
	2	9.03	
	3	10.03	
IV (30%GSA)	1	8.02	7.35
	2	8.02	
	3	6.02	
V (40%GSA)	1	5.01	5.35
	2	5.01	
	3	6.02	

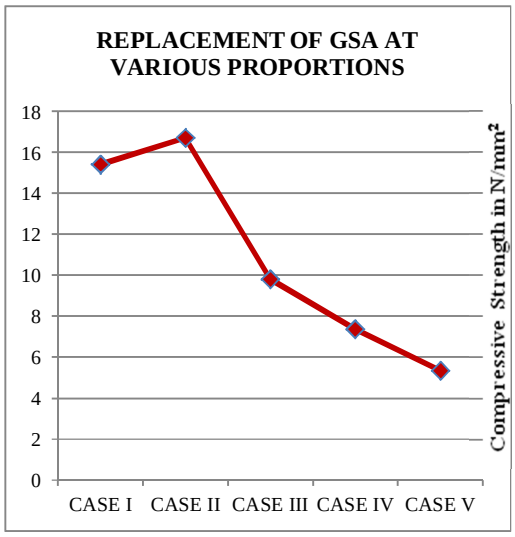

CHART II. 7DAYS COMPRESSIVE STRENGTH OF CEMENT MORTAR CUBES MADE USING GSA AT VARIOUS PROPORTIONS

From the previous discussions we found that 15% GSA replacement gave good strength, hence we attempted to increase the GSA replacement proportion to 20%, 30% and 40% which showed linear decrease in the 7 days compression test results, when plotted. Hence we conclude to prefer with 15% GSA replacement with PPC for further progression.

VI. CONCLUSION

The cement is becoming costlier and cleaner as it uses non-renewable materials for its production. Therefore attempts are being made to reduce the cement consumption by blending pozzolonic materials partially without losing its strength.

The groundnut is grown abundantly in the states Gujarat, Tamilnadu, Andhra and Maharashtra. The shell of pods is used as fuel to fry grams to get fried gram. The ground nut shell ash (GSA) contain good amount of CaO and Sio2 which give strength and hence it can be used as pozzolonic materials to replace cement partially without losing its characteristics and strength.

Experiments were conducted with various proportions of cement: mortar and using mortar cubes their compressive strength on 7th day after curing was observed and plotted in the form of graph. This preliminary study reveals that 15% replacement of cement by GSA results to attain more than targeted strength by 8.5%.

Therefore it is now planned to extend this study to analysing the characteristics of concrete using this blend cement.

It is also planned to develop a building material without the addition of cement.

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