Experimental Study of RHA-FA based Geopolymer Composites

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Abstract— Rice husk ash is a waste generated by agricultural field than this is used for electricity generation than the byproduct is known as RHA, Fly ash is a waste generated by thermal power plants is as such a big environmental concern. The investigation reported in this paper is carried out to study the effect of RHA - FA based geopolymer composites on mechanical properties of RHA-FA based geopolymer composites, so as to provide an environmentally consistent way of its disposal and reuse. The RHA in geopolymer concrete matrix is replaced from 5 to 40 % by step in steps of 5 %. This provides an environmental friendly method of RHA-FA disposal.

Key words: Agricultural waste, Rice husk ash (RHA), Fly ash (FA), concrete and strength

I. INTRODUCTION

Rice husk ash (RHA) is a by-product from the burning of rice husk. The husk of the rice is removed in the farming process before it is sold and consumed. It has been found beneficial to burn this rice husk in kilns to make various things. The rice husk ash is then used as a substitute or admixture in concrete. Globally, approximately 675 million tonnes of rice harvest is produced each year out of which approximately 130 million ton is produced in India alone. On average 20 % of the rice paddy is husk, giving an annual total production of 130 million tonnes. This rice husk when burnt produces 26 million tonnes of rice husk ash (20 % approx.). Rice husk is unusually high in ash compared to other biomass fuels – close to 20%. The ash is 92 to 95% silica, highly porous and lightweight, with a very high external surface area. For every 1000 kg of paddy milled, about 200 kg (20%) of husk is produced, and when this husk is burnt in the boilers, about 50 kg (25%) of RHA is generated. Completely burnt rice-husk is grey to white in color, while partially burnt rice-husk ash is blackish.

In the present investigation, Fly ash which was containing low calcium less than 10% CaO as per American society for testing and material C618 class F from the Wanakbori power station, Gujarat- India, was used as a source material and rice husk ash from rice mill at orisa. The chemical compositions of the fly ash were determined by X-Ray Fluorescence (XRF) analysis are given in Table-2, the fly ash contained a very low percentage of carbon. In this composition, the molar Si-o-Al ratio was about 2, and the calcium oxide content was very low. The iron oxide (Fe_2O_3) contents are relatively high. Specific gravity of fly ash was 2.28.

II. EXPERIMENTAL WORK

A. *Properties of Rice husk ash:*

Sr.No.	Test	Sample : Rice Husk Ash	Unit
1	SiO2	97.01	% By wt.
2	Fe2O3	Absent	% By wt.
3	Al2O3	Absent	% By wt.
4	CaO	0.93	% By wt.
5	K2O	Absent	% By wt.
6	Carbon	0.04	% By wt.
7	TiO2	Absent	% By wt.

Table 1: Chemical properties of rice husk ash

B. *Properties of Fly ash:*

Various tests were done to find out the physical and chemical properties of fly ash which is illustrated in table 1.

Parameter	Observed value	Permissible value as per IS 3812-2003
Specific surface area	325 - 335 m²/kg	> 250 m²/kg
Soundness	0.025 to 0.032%	< 8%
Particle retained on 45 micron sieve	30%	< 35%
Silica + alumina + iron oxide content	87.20%	> 70%
Silica	54.78%	> 35%
Sulphur as SO3	0.63%	< 0.3%
MgO	0.30%	< 0.5%
Na2O as Sodium Oxide	0.33%	< 1.5%
Loss of ignition	1.32%	< 1.5%
Chlorides	0.011 - 0.02%	0.05%

Table 2: Physical & Chemical properties of fly ash

It can be seen that all parameters are within permissible limits.

C. *Concrete Mix Proportion:*

In present study, [NaOH = 16M], [Na_2/SiO_3 = 2], [Na_2SiO_3/NaOH = 3], [Alkaline Solution/Binding Material = 0.5], [Temp. = 80ºC, 24 hrs], [Specific gravity of sodium silicate = 1.62 g/cc, Viscosity at 20ºC = 400 cp], [naphthalene sulphonate super plasticizer used for workability purpose], [30% fine aggregate + 46% 10mm + 24% 20mm aggregate]. Used as per review.

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D. Compressive & Tensile Strength Determination:

For compressive strength test sample of concrete is filled in the mould of size 150mm x 150mm x 150mm and top of mould is strike off. For tensile strength test sample of concrete is filled in the cylinder of size 150mm x 300mm. A total number of 54 cubes were casted. Rice husk ash is added in place of Fly ash in geopolymer concrete in 9 different percentages starting from 0%, and raised mixing of rice husk ash upto 40%, at an interval of 5%. The moulds are covered with the cello tap for easy removal. Then the specimens are put in oven for curing at 80ºC temperature for 24 hrs. At the end of curing period sample is removed and keep in normal atmospheric temperature. At 7 & 28 days sample are tested. The testing is done under Digital Compressive Testing Machine, Amil Engineers make. The load is applied smoothly and gradually. The crushing loads are noted and average compressive strength for three specimens is determined for each which is given in figure 1.

III. Results and Discussion

A. Compressive strength of RHA-FA based Geopolymer Concrete:

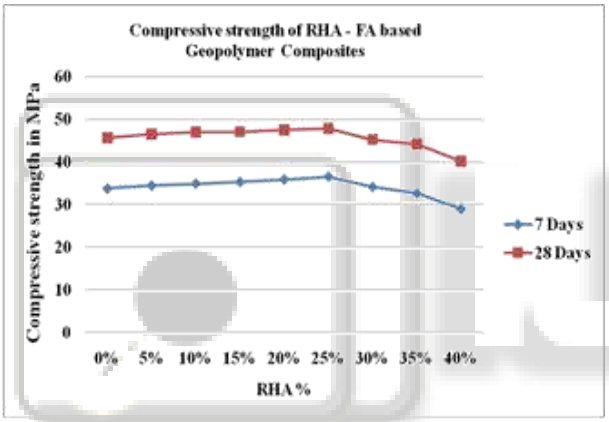

Fig. 1: Effect of Rice Husk Ash on Compressive Strength

By addition of rice husk ash in geopolymer concrete, the compressive strength was increase up to 25% and then after starts decreasing up to 40%. The percentages of replacement of rice husk ash was increases from 0% to 25%, compressive strength was increases from 2.24% to 1.78% in which maximum increase was observed at 25% as 5.40% compare to normal concrete test result.

B. Tensile Strength of RHA-FA based Geopolymer Concrete:

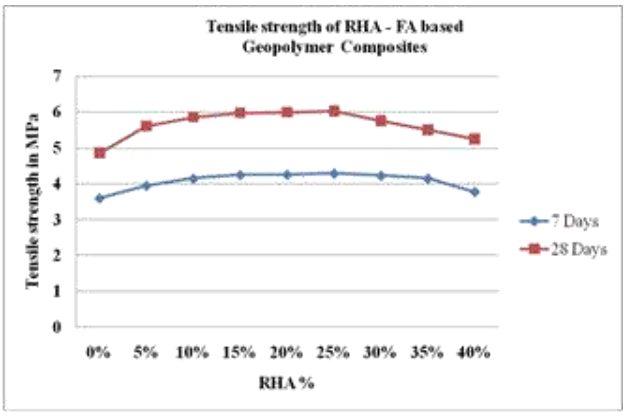

Fig. 2: Effect of Rice Husk Ash on Tensile Strength

By addition of rice husk ash in geopolymer concrete, the split tensile strength was increases up to 25% and then after starts decreasing up to 40%. The percentages of replacement of rice husk ash was increases from 0% to 40%, split tensile strength was increases from 2.91% to 9.39% in which maximum increase was observed at 10.2% as compare to normal concrete test result.

IV. Conclusion

From the graph we were observed that the geopolymer concrete was gave the better result in Compressive strength as compare to M25 grade concrete at 25% replacement of Fly ash with Rice husk ash.

From the graph we were observed that the geopolymer concrete was gave the better result in Tensile strength as compare to M25 grade concrete at 25% replacement of Fly ash with Rice husk ash.

So that up to 20-25% replacement of fly ash with rice husk ash can be successfully used in the geopolymer concrete in minor amount as an additive. Considering the intangible cost of disposal problem of fly ash and rice husk ash and hidden cost of environmental protection, the methodology appears to be indeed successful. Fly ash and rice husk Ash is actually a solid waste. So, it is priceless. If it can be used for any purpose then it will be good for both environment and economy. Use of this fly ash and rice husk ash as a raw material in geopolymer cement is an effective means for its management and leads to saving of cement and economy consequently. Hence it is a safe and environmentally consistent method of disposal of fly ash and rice husk ash. However the rate of strength development is less, Due to lesser rate of strength development, fly ash and rice husk ash finds specific application in precast, prestressed concreting and electrical accessories. It can be concluded that agricultural waste is extensively used in geopolymer concrete as a partial replacement for fly ash and an admixture.

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