

Performance of Rice Husk Ash in Geopolymer Concrete

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Abstract

Environmental issues resulted from cement production have become a major concern today. To develop a sustainable future it is encourage to limit the use of this construction material that can affect the environment. Geopolymer is the best solution reduce the use of cement in concrete. Geopolymer is the hardened cementitious paste made from fly ash, alkaline solution and geological source material. Fly ash is finely divided powder produced by coal and fired power station. RHA is the by-product of paddy industry. RHA is rich in silica about 90%, 5% carbon and 2% K₂O. The specific surface area of RHA is about 40-100 m²/g. As per study it is found that incorporation of RHA upto 30% replacement level reduces the chloride penetration, decreases permeability and strength and corrosion resistance properties.

Keywords: Physio-Chemical Analysis, Groundwater samples, Land use and Salem

I. INTRODUCTION

Geopolymer are inorganic materials that form long range, covalently bonded, non-crystalline networks. Commercially produced geopolymers may be used for fire and heat resistant coatings and adhesives. According to T.F.Yen, geopolymers can be classified in to two major groups: pure inorganic geopolymers and organic containing geopolymers of naturally occurring macromolecules. The main constituents of geopolymers, namely source material and the alkaline liquids. The source materials for geopolymers based on alumino-silicate should be rich in silicon(Si) and Aluminium(Al). Usually it would be by-products such as fly ash, silica fume, rice husk ash, GGBS, red mud etc., The choice of source material for making geopolymer depends on factors such as availability, cost, type, application and specific demand of the end users. The most common alkaline liquids used in geopolymerisation is a combination of sodium hydroxide (NaOH) or potassium hydroxide (KOH) and sodium silicate or potassium silicate. Geopolymer concrete can be produced from ground granulated blast furnace slag (GGBS) and alkaline liquids. Water is added to the concrete only for workability and easiness in placing the concrete. On the other hand, in Portland cement, water is necessary for the hydration of cement. The fundamental unit within a geopolymer structure is tetrahedral complex consisting of Si or Al coordinated through covalent bonds of four oxygens. The geopolymeric framework results from the cross-linking between these tetrahedral, which leads to a 3-dimensional alumino-silicate network where the negative charge associated with tetrahedral aluminium is balanced by a small cationic species, most commonly an alkali metal cation.

II. COLLECTION OF LITERATURE

Greenhouse effect is a natural phenomenon. It refers to the atmosphere capability to prevent part of sun radiance to go back into space. The mechanism insures that earth average temperature is kept between -18°C and 15°C. Gases which allow this phenomenon are not naturally highly concentrated in the atmosphere but human activities have been increasing those concentrations. Therefore atmosphere characteristics and greenhouse effect has been altered. This alteration often considered as the main cause of global warming. Over the last century, carbon dioxide concentration in the atmosphere has increased of 30% and it is estimated that in 2013, CO₂, with approximately 467 million tonnes (Mt), represented 83% of UK's greenhouse emissions. In general, this report will not deal with other gas but when CO₂e will be considered, they are considered to be included. It is this massive participation

that makes of CO₂ the priority of any policy aiming a reduction of greenhouse emissions. However, because their global warming potential is greater than the one of CO₂, these other gas must be kept in mind and further studies might be carried out.

Increasing economic growth demands more effective utilization of both renewable and non-renewable resources. If not carefully targeted, this will lead to production of an increased amount of waste. Additionally, waste handling companies treat numerous waste flows generated in different industrial areas which have not yet found major industrial applications. Legislation and taxation are becoming more stringent, and consequently, waste disposal costs are increasing. This has resulted in increasing interest in the search for novel utilization possibilities for the waste flows generated.

III. NUMERICAL ANALYSIS

The various mix combinations that are to be casted are F₉₀R₁₀, F₈₀R₂₀, F₇₀R₃₀ using three different samples of rice husk ash. In this research work the compressive strength of Geopolymer concrete is examined for the mixes of 10 Molarity of sodium hydroxide. The molecular weight of sodium hydroxide is 40. To prepare 10 Molarity of solution 400 g of sodium hydroxide flakes are weighed and they can be dissolved in distilled water to form 1 litre solution. Volumetric flask of 1 liter capacity is taken, sodium hydroxide flakes are added slowly to distilled water to prepare 1liter solution.

IV. THEORETICAL ANALYSIS

As there are no code provisions for the mix design of geopolymer concrete, the density of geo-polymer concrete is assumed as 2400 Kg/m³. The rest of the calculations are done by considering the density of concrete. The total volume occupied by fine and coarse aggregate is adopted as 77%. The alkaline liquid to fly ash and GGBS ratio is kept as 0.4. The ratio of sodium hydroxide to sodium silicate is kept as 2.5. The conventional method used in the making of normal concrete is adopted to prepare geopolymer concrete.

V. EXPERIMENTAL TEST

Firstly, the fine aggregate, coarse aggregate, fly ash and GGBS are mixed in dry condition for 3-4minutes and then the alkaline solution which is a combination of Sodium hydroxide solution and Sodium silicate solution with super-plasticizer is added to the dry mix. Water is taken as 10 % of the cementitious material (fly ash and GGBS). The super plasticizer is taken as 3% of the cementitious material. The mixing is done for about 6- 8 mins for proper bonding of all the materials. After the mixing is done, cubes are casted by giving proper compaction in three layers. The specimen is to be left undisturbed for about 48 hours because of longer setting time. The following are the materials required for 1m³ of concrete:

Table – 1
Mix Design

<i>Fly ash +RHA</i>	<i>Sodium hydroxide</i>	<i>Sodium silicate</i>	<i>Fine aggregate</i>	<i>Coarse aggregate</i>
394.28 kg	45.06 kg	112.65 kg	554.4 kg	1293.6 kg
<i>Distilled Water : 15% of cementitious material</i>				
<i>Super-plasticizer : 3% of cementitious material</i>				



Fig. 1: Mixing of binders and aggregates



Fig. 2: Mixing of chemicals



Fig. 3: Casting of cubes



Fig. 4: Compressive strength test

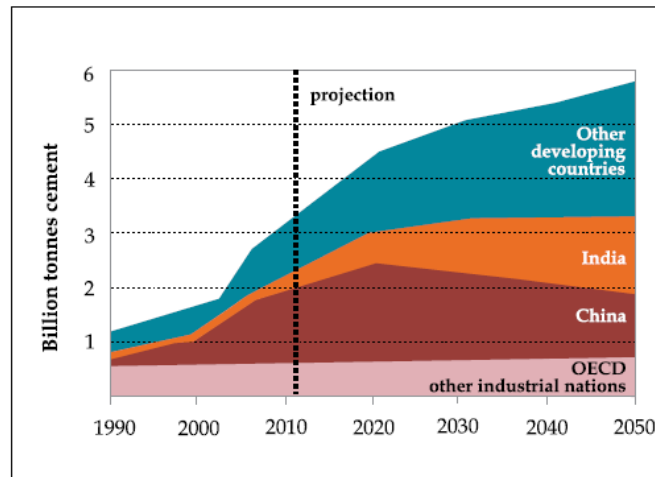


Fig. 5: Cement production of various countries

VI. CHEMICAL COPOSITION OF BINDER MATERIAL

Table – 2

Materials	Fly ash	Rice husk ash	GGBS
Silica	40	81.68	40
Fe ₂ O ₃	6	0.78	1.8
Al ₂ O ₃	25	4.40	13.5
CaO	20	0.55	39.2
MgO	3.71	0.35	3.6
Na ₂ O ₃	0.96	-	-
SO ₃	1.74	0.20	0.2
K ₂ O	0.8	5.50	0.2
LOI	3.0	7.54	0.0

VII. RESULTS AND DISCUSSION

A. Compressive Strength:

Table – 3

Compressive Strength

S.no	Mix ID	7 days	28 days
1.	F ₉₀ R ₁₀	5.3	12.6
2	F ₈₀ R ₂₀	5.1	11.4
3.	F ₇₀ R ₃₀	3.4	10.4
4.	R ₁₀ G ₁₀ F ₈₀	6.7	15.8
5.	R ₂₀ G ₁₀ F ₇₀	7.3	17.4
6.	R ₃₀ G ₁₀ F ₆₀	8.1	18.8

VIII. CONCLUSION

The use of RHA as partial replacement of cement in mortar and concrete has been extensively investigated in this paper. The following are the conclusions that are drawn from this study:

- 1) Concrete requires approximate increase in water cement ratio due to increase in percentage of RHA. Because RHA is highly porous material.
- 2) The workability of RHA concrete has been found to decrease with increase in RHA replacement.
- 3) It was found that rice husk when burnt produced amount of silica (more than 80%).For this reason it provides excellent thermal insulation.
- 4) Rice husk ash contains more silica, and hence we prefer rice husk ash use in concrete than silica fume to increase the strength.
- 5) Though Rice husk ash is harmful for human being, but the cost of rice husk ash is zero and thus we prefer RHA use in concrete as compared to silica fumes.
- 6) The workability of RHA concrete has been found to decrease but fly ash(FA) increases the workability of concrete so RHA and FA mix together in concrete to improve the workability of concrete.
- 7) Fly ash and rice husk based concrete shows lower compressive strength while addition of GGBS for about 10%, shows the reasonable increase in strength.

- 8) Due to high specific surface area of the RHA, the dosage of super-plasticizer has to be increased along with RHA fineness to maintain the desirable workability. Also, the amount of water is increased as the amount of RHA increases.

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