Strength Properties on Fly Ash based Geo Polymer Concrete with Admixtures

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Abstract— Environmental problems are increasing due to construction process of cement. An ordinary Portland cement is caused to five to seven percent of total greenhouse gases emission, so alternative of cement is must needed for construction of concrete. One such material is geopolymer concrete, the fly ash, fine aggregates and coarse aggregates are mixes then the alkaline solution was added to prepare the geopolymer concrete. Fly ash uses as binding material. Fly ash is by product of thermal power plant with goods percent of silicon and alumina. This study explained the performance properties of geopolymer concrete with fly ash. Geopolymer concrete can be used as an effective building material and it also helpful in an effective way to reduce to dump fly ash in environment.

Key words: Geopolymer Concrete, Fly Ash, Sodium Hudroxide, Potassium Hydroxide

I. INTRODUCTION

The most commonly used material for binding in concrete is ordinary Portland cement, but construction process of cement produces hazardous impact on environment so it is necessary to search an alternate for ordinary Portland cement. Geopolymer concrete is such a material which uses fly ash as binding material instead of cement. Fly ash is a by-product of coal-fired electric generating plants, Fly ash is one of the residues generated in combustion, and comprises the fine particles that rise with the flue gases. Alkaline liquids and source materials are the two main elements of geo polymers where source material are by-product materials such as fly ash, silica fume, slag, red mud, etc. The alkaline liquid used in polymerisation is a mixture of sodium hydroxide (NaOH) or potassium hydroxide (KOH) and sodium silicate. The objective of this paper is to review the styrength properties of fly ash based geopolymer concrete.

II. LITERATURE REVIEW

A. Geoplolymer Concrete

N. P. Rajamane et al (2009) Reported that Producing one tonne of cement requires about 2 tonnes of raw materials (shale and limestone) and releases 0.87 tonne (H" 1 tonne) of CO_2, about 3 kg of Nitrogen Oxide (NO_x), an air contaminant that contributes to ground level smog and 0.4 kg of PM10 (particulate matter of size 10 µm), an air borne particulate matter that is harmful to the respiratory tract when inhaled. The global release of CO_2 from all sources is estimated at 23 billion tonnes a year and the Portland cement production accounts for about 7% of total CO_2 emissions. The cement industry does not fit the contemporary picture of a sustainable industry because it uses raw materials and energy that are non-renewable; extracts its raw materials by mining and manufactures a product that cannot be recycled. Through waste management, by utilizing the waste by-products from thermal power plants, fertiliser units and steel factories, energy used in the production can be considerably reduced. This cuts energy bills, raw material costs as well as greenhouse gas emissions. In the process, it can turn abundantly available wastes, such as fly ash and slag into valuable products, such as geopolymer concretes.

'Geopolymer cement concretes' (GPCC) are Inorganic polymer composites, which are prospective concretes with the potential to form a substantial element of an environmentally sustainable construction by replacing/supplementing the conventional concretes. GPCC have high strength, with good resistance to chloride penetration, acid attack, etc.

Sofi et al, 2007; Chang, 2009, The elastic properties of hardened geopolymer concrete and the behavior and strength of reinforced geopolymer concrete structural members are similar to those observed in the case of Portland cement concrete.

Wallah and Rangan, 2006, Heat-cured low-calcium fly ash-based geopolymer concrete also shows excellent resistance to sulfate attack, good acid resistance, undergoes low creep, and suffers very little drying shrinkage.

Sumajouw et al, 2007, The behaviour and failure modes of reinforced geopolymer concrete columns and beams were similar to those observed in the case of reinforced Portland cement concrete columns

B. Fly Ash

Hardjito and Rangan, 2005, Reported that the compressive strength and the workability of geopolymer concrete are influenced by the proportions and properties of the constituent materials that make the geopolymer paste. Research results have shown the following:

Higher concentration (in terms of molar) of sodium hydroxide solution results in higher compressive strength of geopolymer concrete.

Higher ratio of sodium silicate solution-to-sodium hydroxide solution ratio by mass, results in higher compressive strength of geopolymer concrete.

The slump value of the fresh geopolymer concrete increases when the water content of the mixture increases. Superplasticizers may assist in improving workability.

C. Silica Fume

Debabrata Dutta et al 2010, Following conclusions were made on the basis of the results from the experimental investigation.

Addition of silica fume to fly ash based geopolymer mortar specimens improves the total porosity. However, it increases porosity in case of geopolymer pastes.

Incorporation of silica fume enhances the compressive strength of mortar specimens whereas it causes a significant drop for the paste specimens. This could be due to the notable variations of porosity between the specimens prepared with or without silica fume.

Water absorption values were found directly related to total porosity of specimens. For paste specimens, water absorption gradually increases with introduction of silica fume into mix. In contrast, mortar specimens showed a decreasing trend in water absorption with increasing silica fume content.

D. Alkaline Liquids

Ammar Motorwala et al, reported that the main objective of this study was to find the effect of varied concentrations of alkaline solutions on the strength characteristics of the concrete. We expect that the combined use of KOH and NaOH would help in achieving a more rigid structure and hence improve the strength characteristics. Based on the general finding, the following conclusions were drawn:

Higher concentration (in terms of molar) of sodium hydroxide solution results in higher compressive strength of fly-ash based geo-polymer concrete and higher the ratio of sodium silicate-to-sodium hydroxide ratio by mass, higher is the compressive strength of fly ash based geo-polymer concrete, as the curing temperature in the range of 30°C to 90°C increases, the compressive strength of fly ash-based geo polymer concrete also increases, longer curing time, in the range of 4 to 96 hours (4 days), produces higher compressive strength of fly ash-based geo-polymer concrete

Geopolymer concrete an innovative material that is characterized by long chains or networks of inorganic molecules is a potential alternative to conventional Portland cement concrete. The term 'geopolymer' was first introduced by Davidovits in 1978 to describe a family of mineral binders with chemical composition similar to zeolites but with an amorphous microstructure. It utilizes the polycondensation of silica and alumina precursors to attain structural strength. Two main constituents of geopolymers are: source materials and alkaline liquids. The source materials on alumino-silicate should be rich in silicon (Si) and aluminium (Al).

E. Curing

Hardjito and Rangan, 2005, Reported that heat-curing of low-calcium fly ash-based geopolymer concrete is generally recommended. Heat-curing substantially assists the chemical reaction that occurs in the geopolymer paste. Both curing time and curing temperature influence the compressive strength of geopolymer concrete.

Vijai k., et al 2010, It state that the compressive strength of hot cured concrete is much higher than that of ambient cured concrete. In ambient curing, the compressive strength increases as the age of concrete increases from 7 days to 28 days. The compressive strength of hot cured fly ash based geopolymer concrete has not increased substantially after 7 days. The average density of fly ash based geopolymer concrete is similar to that of OPC concrete. Geopolymer concrete is more environ-friendly and has the potential to replace ordinary portland cement concrete in many appliances such as precast units.

III. CONCLUSIONS

The paper presented information on fly ash-based geopolymer concrete. The Portland cement is replaced by fly ash as the source material, to make concrete. Fly ash-based geopolymer concrete has very effective compressive strength and is suitable for construction work. The elastic properties of hardened geopolymer concrete and the behavior and strength of reinforced geopolymer concrete structural members are similar to those observed in the case of Portland cement concrete. Heat-cured fly ash-based geopolymer concrete also shows good resistance to sulfate attack, good acid resistance, undergoes low creep, and suffers very little drying shrinkage. The paper has identified several benefits and environment friendly advantages of geopolymer concrete

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