GEOPOLYMER CONCRETE: A REVIEW IN INDIAN CONTEXT

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ABSTRACT

Concrete is the world most consumed construction material. Since it is more versatile, durable and reliable. Due to increase of infrastructure the demand of concrete has increased vastly. There are many ways to reduce environment pollution mainly carbon dioxide (CO2) which is produced by the production of portland cement. One of the best ways is to reduce the production of cement, geopolymer concrete is a kind in which cement is totally replaced by pozzolanic material that is rich in silicon and aluminium like flyash. Flyash is a by-product of coal obtained from the thermal power plant and is available in bulk quantities world wide. It is rich in silica and alumina on reacting with alkaline solution produce alumino silicate gel that act as binding material for concrete. Research is shifting from the chemistry domain to engineering applications and commercial production of geopolymer concrete.

This paper briefly reviews the proportions and behaviour of Geopolymer concrete.

INTRODUCTION

Construction is one of the fast growing fields worldwide. As per the present world statistics, annual global production of Ordinary Portland Cement (OPC) is over 4.1 Billion Metric tons, The amount of the carbon dioxide released during the manufacture of cement due to the calcinations of limestone and combustion of fossil fuel is in the order of one ton for every ton of cement produced.Hence, it is imminent to find an alternative material to the existing most expensive most resource consuming Portland cement.Geopolymer concrete is a type of concrete that is made by reacting aluminate and silicate bearing materials with a caustic activator. Commonly, waste materials such as fly ash or slag from iron and metal production are used which helps lead to a cleaner environment. geopolymer concrete is nothing but composite material resulting from the mixing and hardening of cement with water and stone aggregates.120 million tons of flyash is generated/year at the themal power plants of INDIA .10 tons of CO2 is liberated per 10 tons of production of opc.

LITERATURE REVIEW:

P. K. Jamdade and U. R. Kawade studied the strength of Geopolymer concrete by using oven curing. In this study Geopolymer concrete is prepared by mixing sodium silicate and sodium hydroxide with processed fly ash. The concrete is cured at different condition and different temperatures i.e; 600 C, 900 C and 1200 C so as to increase the strength of concrete. It was observed that higher curing temperature resulted in larger compressive strength of Geopolymer concrete, even though an increase in the curing temperature beyond 600 C did not increase the compressive strength substantially. Also longer curing time improved the polymerization process resulting in higher compressive strength of Geopolymer concrete

Shankar H. Sanni and R. B. Khadiranaikar carried out investigation on the variation of alkaline solution on mechanical properties of geopolymer concrete. The grades preferred for the investigation were M30, M40, M50 and M60; the mixes were designed for 8 molar. The alkaline solution used was the combination of sodium silicate and sodium hydroxide solution with the varying ratio of 2, 2.5, 3 and 3.5. The test specimens were 150x150x150 mm cubes

and 100x200 mm cylinders heat-cured at 60°C in an oven. The results revealed that the workable flow of geopolymer concrete was in the range of 85 to 145mm and was dependent on the ratio by mass of sodium hydroxide and sodium silicate solution. The freshly prepared geopolymer mixes were cohesive and their workability increased with the increase in the ratio of alkaline solution. It was concluded that the strength of geopolymer concrete can be improved by decreasing the water/ binding and aggregate/binding ratios. Compressive strength and split tensile strength obtained were in the range of 20.64-60N/ mm2 and 3-4.9 N/mm2

Benny Joseph and **George Mathew:-** carried out the influence of aggregate content on the engineering properties of Geopolymer concrete. Influence of other parameters such as curing temperature, period of curing, ratio of sodium silicate to sodium hydroxide, ratio of alkali to fly ash and molarities of sodium hydroxide were also discussed. Based on the study carried out, it can be concluded that a geopolymer concrete with proper proportioning of total aggregate content and ratio of fine aggregate to total aggregate, along with the optimum values of other parameters, have better engineering properties than the corresponding properties of ordinary cement concrete. Compared to ordinary cement superplasticizer below the critical value of molar strength. It was also observed that there is a good correlation between the rheological parameters and slump for fly ash based geop concrete, 14.4% enhancement in modulus of elasticity and 19.2% enhancement in Poisson's ratio could be achieved in geopolymer concrete

Aminul Islam Laskar and **Rajan sedBhattacharjee:-** investigated the variation of workability of fly ash ba Geopolymer concrete with the variation of lignin based plasticizer and poly-carboxylic ether based superplasticizer. It has been observed that there exists a critical value of molar strength of sodium hydroxide beyond which superplasticizer and plasticizer have adverse effect on workability of fly ash based geopolymer concrete. There is an increase in slump below the critical molar strength of sodium hydroxide. Lignin based first generation plasticizer shows better performance in terms of workability over third generation

MATERIALS USED

- **Fly ash-**a by-product from thermal power stations which is found to have rich in silica and alumina is used in Geopolymer concrete which further helps in reducing global warming.
- **Ground granulated blast furnace slag (GGBS):-** is a by-product of iron and steel-making industry obtained from a blast furnace and is a fine powder. GGBS is a glassy, granular, non-metallic material consisting essentially of silicates and aluminates of calcium and other bases. GGBS has been widely used in Europe, United States and in Asia (particularly in Japan and Singapore) for its superiority in concrete durability.
- **Alkaline Solutions:-** Sodium or Potassium based hydroxide and silicate can be used as alkaline used which on reacting with silica and alumina of fly ash will result into production of binder material. Sodium silicate/sodium hydroxide =2.5
  (water/Geopolymer) = 0.17 to 0.18
- **Aggregates:-**
- Natural sand obtained from river bed
- Coarse aggregates are greater than 10 mm obtained from hard rock
- **Compressive Strength**

Compressive strength is one of the most essential properties of concrete. Anuar et. al, (2011) explained that the higher concentration of sodium hydroxide solution inside the Geopolymer concrete will produce higher compressive strength of ; because NaOH will make the good bonding between aggregate and paste of the concrete. The compressive strength of Geopolymer concrete is about 1.5 times more than that of the compressive strength with the ordinary Portland cement concrete, for the same mix.

Duability

Rangan, B.V. (2008) stated that Geopolymer concrete is more resistant to heat, sulphate attack, water ingress & alkali-aggregate reaction. The role of calcium in Geopolymer concrete made up of fly ash is very prominent since it may cause flash setting.

Wallah et. al, (2006) Explained that, heat-cured fly ash-based Geopolymer concrete undergoes low creep and very little drying shrinkage in the order of about 100 micro strains after one year. And it has an excellent resistance to sulphate attack.

INFLUENCING FACTORS

- Higher fly ash with higher alkali content gives a high compressive strength.
- rest period = 24 hours
- As the water content increase workability increase and so the porosity.
- As the amount of Sodium hydroxide and sodium silicate trioxide increases the workability decreases
- The geopolymer concrete behave same as normal concrete aggregate.
- The size of aggregates to be used in geopolymer concrete should be greater than 10mm.
- Higher the curing temperature greater is the strength
- It requires three days for complete setting without leaving an nail operation
- Higher concentration of sodium hydroxide solution [by mass] results in higher compressive strength in geopolymer concrete
- High 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. Super plasticizers may assist in improving workability.
- As the H2O-to-Na2O molar ratio increases, the compressive strength of geopolymer concrete decreases. The main interesting characteristics of geopolymer concrete

ADVANTAGES

- Fly ash is cheaper than cement
- Geopolymer concrete has better compressive strength
- It has greater resistance towards fire and hence can be used as fire proofing
- It has lower permeability
- It is eco friendly
- Magnificent properties within both acid and salt environment**,** leeding free.
- It has a higher compressive strength of about 1.5 times than a normal OPC concrete mix.
- It's impermeable like normal OPC concrete.
- It shows a higher resistance to sulphate attack after full immersion for 15 weeks in different % of magnesium sulphate solution.
- Geo-polymer mortar shows a higher resistance to sulphuric acid solution and fire resistant.
- It can set at room temperature without any elevated temperature.
- It's highly resistant to chemical action, its non-toxic and

LIMITATIONS:

- Geopolymer concrete did not harden immediately at room temperature as in conventional concrete.
- Geopolymer concrete specimens took a minimum of 3 days for complete setting without leaving a nail impression on the hardened surface.
- These two limitations of geopolymer concrete mix was eliminated by replacing 10% of fly ash by OPC on mass basis with alkaline liquids resulted in Geopolymer Concrete Composite and are considered as drawbacks of this concrete to be used for practical applications

Conclusions:-

Fly ash-based Geopolymer is better than normal concrete in many aspects such as compressive strength, exposure to aggressive environment, workability and exposure to high temperature.

Geopolymer cement produces a substance that is comparable to or better than traditional cements with respect to most properties. Higher concentration of sodium hydroxide solution results in higher compressive strength of geopolymer concrete.

Geopolymer concrete has excellent properties within both acid and salt environments.

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