Interlock Using Geopolymer Concrete

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Abstract

This review paper provides an in-depth analysis of geopolymer concrete, a novel and sustainable construction material that has garnered significant attention in recent years. The paper aims to present an unbiased and comprehensive overview of the key aspects of geopolymer concrete, including its chemistry, mechanical properties, environmental benefits, and potential applications.

***Keywords-** Geopolymer concrete, GPC, fly ash, GGBS , Alkali.*

INTRODUCTION

With rapid progress across the world there is vast demand of infrastructure. This has resulted in increased demand for concrete and ingredients of concrete and so as the demand for ordinary portland cement. Currently, OPC is the essential ingredient for concrete. Portland cement is the main constituent of concrete, it's not advised environment favourable and absorbs natural raw materials like limestone, sand. High temperatures required to make Portland concrete, the amount of energy used for the production is very high Carbon dioxide (CO2) is responsible of around 65% of worldwide temperature rise. Cement industry from all over the world contributes around 6% of all CO2 emissions in light of the fact that the generation of Portland concrete of a.ton discharges roughly a ton of carbon dioxide into the atmosphere.

The growing toxic environment caused by CO2 have advanced the improvement of inorganic polymer cover called "geopolymer" The utilization of geopolymer not only reduces emission of toxic gas level, but also uses the waste material for example, fly ash, metakaolin.

The geopolymer could fundamentally mitigate the expulsion of CO2 to the climate brought about by the concrete production as the investigations carried out by Gartner. Geopolymer concrete (GPC), that include fly ash, Aggregates, and a soluble combination of sodium hydroxide and sodium silicate, can decrease the rise of toxic gases. As the carbon dioxide discharge from concrete generation decreases, it will directly lead to the reduction in temperature.

Importance of Geopolymer concrete

Geopolymer concrete, which is made up of inorganic material, which has come out as the feasible low cost and green material is a substitute for the portland cement based concrete, which has quality properties such as high strength, low creep, acid resistance to a higher level and low shrinkage, Geopolymer holds together aggregates and other unreacted material together to form geopolymer concrete, Geopolymer cement is produced using modern waste materials like fly ash, GGBS and so forth which contain alumina-silicate by their antacid initiation.

Geopolymer not just reduces the emission of toxic gases but also upgrades its mechanical properties, it is a alkali activated binding material produced by polymerisation process between the alkali liquids and the silicon and aluminium oxides of the source materials like metakaolinite or industrial waste products like Fly ash, Rice husk ash, Bagasse ash etc.

Type of Source Material

The good source material is the one which possess following properties, The source material should be rich in Si and Al. These materials are naturally available like clay etc or it can be a by-product, of some materials like fly ash. bagasse ash etc. The selection of the source materials for the production geopolymers be dependent on the availability, cost, kind of utilization and the particular request of the end client.

Chemical Activator

Generally from Na and K based dissolvable salt metals alkaline liquids are made. Most used basic fluids for geopolymerisation are the combination of sodium hydroxide(NaOH) or potassium hydroxide(KOH) and sodium silicate(Na_2SiO_3) or potassium silicate(K_2SiO_3).

The molarity of the alkaline liquids is the very important factor that effects the strength properties of the geopolymer concrete.

Curing Regime

Generally Curing for geopolymer concrete can be done in 2 ways, ambient curing and forced temperature curing, in some cases ambient curing will not be much effective since the geopolymer concrete will not set soon, since the polymerisation reaction will occur in a slower manner. If hot curing is done then the chemical reaction or polymerisation will be boosted and the mortar will set quickly and high early compressive strength will be achieved.

SCOPE OF PRESENT STUDY

General

This chapter deals with the aim and scope of the present study, which deals with the study of properties of the geopolymer concrete with the addition of Calcium Carbonate, Bagasse ash to fly ash based geopolymer concrete.

Scope

From the literatures available it is clear that a lot of research has been carried out on geopolymer concrete, but there is no literatures on fly ash based geopolymer concrete with the addition of Calcium carbonate, GGBS by using sodium silicate as alkaline activator, in the available literature sodium hydroxide and sodium silicate is used as the alkaline activator, in the present study sodium silicate alone is being used as the alkaline activator. Hence it becomes necessary to study the properties like strength, bonding, setting time, micro structure etc.

Methodology

An Experimental analysis were carried out to understand the properties of the geopolymer concrete by the addition of calcium carbonate using sodium hydroxide as alkaline activator. At the starting of the research work, the trial mix cubes were cast by keeping the molarity of the alkaline solution constant. After the trial mix, the combination which gave highest strength was taken and geopolymer concrete cubes were cast using the filler materials. The tests on fresh concrete were carried out which means like compressive strength.

Materials used in the Present Study

Fly Ash

Based on the chemical combination fly ash is classified into two classes namely F and C. Fly ash collected from Adani Udupi Power Corporation Ltd, India is used as the main component material. The fly ash was stored appropriately for the entire span of the study. As fly ash contains 3.2%of lime, it is categorized as Class F fly ash. The specific gravity of the flyash sample is 2.61.The fineness modulus is 2.98

Ground Granulated Blast Furnace Slag (GGBS)

GGBS is acquired from blast furnace, which is glassy, granular material, dried initially and finely powdered.

Fineness modulus – 3% ,

Specific gravity – 2.4

Calcium Carbonate ($CaCO_3$)

Calcium Carbonate ($CaCO_3$) is a chemical compound and is the main constituent of slag, seashell and eggshells. The addition of calcium carbonate to the Geopolymer concrete increases strength properties and results in high early strength, therefore calcium carbonate is being used in this project.

Recycled course aggregate

Recycled aggregates are mainly obtained from demolished structure rubbles, roads, crushed bricks or stones which can replace natural coarse aggregates. The rubbles were crushed manually to separate the material. The aggregates passing 20 mm I.S sieve and retaining in 8 mm I.S sieve were used

Fineness modulus R C A = 2.4

Specific gravity of R C A = 2.33

Fine aggregate

The quarry dust were obtained from the locally available sources. The fine aggregate should not react with other components of the mix. In this experiment along with M-sand passing 4.75 mm I.S sieve is carried out. Fine aggregate confirming to IS 383:2016 has been utilized in the experiment

Fineness modulus = 2.36

Specific gravity of Fine aggregate is 2.62

Alkaline Activator

Alkali solutions are most commonly used the alkaline activators , it will be either Sodium Hydroxide and Sodium Silicate or Potassium Hydroxide and Potassium Silicate solution of a known molar. In the present research work Sodium silicate alone is used as the alkaline activator.

Mix Design

Trial mixes with different binders are carried out the geopolymer paste cubes of size 70x70x70mm are cast and tested after a curing periods of 7, 14 and 28 days. The results are tabulated and analyzed. The mortar cubes which produce highest strength is taken for further study on Geopolymer Concrete.

- 0%CaCO3 +20%GGBS +80%FA
- 2%CaCO3 + 20%GGBS + 78%FA
- 4%CaCO3 + 20%GGBS + 76%FA
- 6%CaCO3 + 20%GGBS + 74%FA
- 8%CaCO3 + 20%GGBS + 72 %FA
- 0%CaCO3 + 30%GGBS +70%FA
- 2%CaCO3 + 30%GGBS + 68 %FA
- 4%CaCO3 + 30%GGBS + 66%FA
- 6%CaCO3 + 30%GGBS + 64%FA
- 8% CaCO3+30%GGBS +62%FA

Fig. 1 Geopolymer concrete materials

Binder - Fly ash, Calcium Carbonate.

Alkaline Solution – Sodium silicate solution (10M)

F/B ratio - 0.42, Flow test = 600 mm,

To cast cube, Standard cast iron metal moulds of size 100 × 100 × 100mm, respectively are used. The moulds are cleaned properly and oiled on all the sides before the moulds are filled with concrete. The Geopolymer concrete is filled in the mould in three layers, after each layer the mix will tamped properly, it will be vibrated for a shorter duration and then the excess concrete will be trimmed off and the top will be given smooth finishing. The mix that produces highest strength namely optimum mix is considered to cast Geopolymer Concrete cubes.

Fig.2 Concrete mix

Fig.3 Specimen of trial mix

Fig 4 sun drying of speciemen

Fig.5 Testing of specimen in machine.

Mix:9 Was used for casting interlock

FA(64%) +CaCO3(6%) +GGBS (30%)

Fig .6 Geopolymer conrcete in interlock mould

Fig 7 Geopolymer conrcete in mould after 24hrs

Fig 8 Demoulding after 24hrs

Fig 9 Curing of interlock in ambient temperature

RESULTS AND DISCUSSION

This test is carried out according to IS1565.2006.

The maximum load is noted and the compressive strength is computed.

Compressive strength = P/A Where, P= Load

A= Area of application of loa = 29580 mm^2.

Compressive strength = P/A= (560*1000/29580) = 18.93 N/mm^2

Fig 10 Compression test machine with inter lock.

Fig 11 Cracks on the side of the interlock after compaction

Fig 12 SIDE VIEW of the interlock after compression.

CONCLUSIONS

The following conclusions are made from the analysis of results.

- Incorporation of moderate amount of calcium carbonate to the Geopolymer concrete shows positive impact on the strength properties of Geopolymer concrete.
- The addition of calcium carbonate to the fly ash based Geopolymer concrete reduces the setting time.
- Geopolymer concrete can be used in construction material as a substitute to conventional concrete and its reduced impact on the environment.

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