Control of Environmental Pollution by Utilizing Wastes from Industry on Fly Ash Based Geopolymer Concrete

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Abstract. Geo-polymer Concrete is mainly hardened cementitious paste made from fly-ash and alkali solution. It helps to combines waste product into useful product. In this the major point is to investigate the solidity parameters of GPC utilize varying proportions of fly-ash, GGBS & Silica fume in addition to alkali solution (Na-OH and Na2SiO3), which reduces demand of OPC which leads to the emission of CO2 to the environment and to produce a more durable infrastructure. With various advantages of these materials as studied in detail in this project, better strength parameters for Geo-polymer concrete are expected by using varying proportions of Fly-ash, GGBS, Silica-fume along with an alkali solution (NaOH and Na2SiO3) than conventional concrete. Thus, Geo-polymer concrete helps in the complete replacement of Portland cement and act as an environmentally friendly material by the reduction of CO2 emission to the society which leads to control the environmental pollution. It is expected that centralizing over needs & examining in a way that includes a lot of careful detail in this area will help to materialize flue-ash based GPC as a trading & non-polluting material also set the seal on the sustainability of construction.

Keywords: Geo-polymer Concrete, Fly-ash, GGBS, Silica-fume.

1. Introduction

Expansion of construction shows to the usage of numerous method which sources, damaging reaction of discharge in the habitat. But the order of concrete is multiplying gradually for its development & manufacturing by entire types of suited forms. To avoid these issues, the concrete should be made with eco-friendly materials. To bring-up non-polluted concrete, the cement wanted to restore with some other binders which should not be creating any bad effect on the surroundings. The use of industrial byproducts as binders can reduce the problem. By the regard of the vanguard GPC is optimistic techniques. The GP’s were the division of the genealogy of dead polymers undergo synthesized configuration alike to essential zeolite materials, but the multilayers were un-structured. So that the Geo-polymer (GP) technology could bring down the CO2 outflow to the atmosphere. The main aim to investigate the hardness limit of flue-ash formed GPC by varying proportions of flue-ash, GGBS & silica fume along with an activator solution (NaOH & Na2SiO3).
(V. Gopi & K. Shyam Chamberlin 2019) come-up with an experimental investigation on the strength and durability of concrete incorporated with silica fume and fly-ash; in this study, the utility of concrete enlarges with the increase in the proportion of silica fume and fly ash in concrete. (M. G. Kamaldeep & K. Shyam Chamberlin 2019) carried out a paper on studies the production of concrete by using a mixture of fly-ash and GGBS as combined material. In this the representation of M40 by comparatively restore Fly ash and GGBS to cement were radiate and analyzed for Compressive strength at 7, 28 days. Flexural strength merited were also attained at 28 days and obtained results were compared with conventional concrete. (Akshatha K. B 2018) carried out an experimental study of concrete using silica fume. In this examination, the introduction of silica fume to the materials directed to reduce the resilience of OPC and the bulk of the material with silica fume is close to the OPC. But in the compressive strength in the concrete, the silica fume gets increases in it. And also, flexural strength & split tensile strength are also close variants where the silica fume was added. So, the modulus of elasticity in addition to with silica fume concrete there was no specific trend of dissimilarity. (V. Hariharan et al. 2017) studied on implementation in fly-ash & GGBS as an entire renewal of the cement in Geo-polymer concrete. The experimental investigations executed, the automatic resources of Geo-polymer concrete such that the compressive strength, split tensile strength & flexural strength expand with expansion in the GGBS gratified. By that absorption of NaOH solution rises and the energy will expand. Compressive strength of GP enlarges within the expansion of era in concrete.

1.1 Geo-polymer Concrete

Geo-polymer concrete is the combination of squandering substance for example fly-ash, silica fume and also GGBS; were they mixed with the binding compound. Portland cement is not mandatory for the fabrication of GPC. The manufacturing of the binder is by the synthesizing of alkaline liquid with the original matter loaded with silica & alumina. The principal fragment of GPC are industrial products such as the silicon & aluminium and also alkaline start up this polymerizes this medium into the molecular pattern and a webbing to invent a desensitized binder. And well known as the inanimate polymer cement. Also, the major polymerization take place in geo-polymer concrete occurs while the heat obtruded to throughout the healing span. Lengthy healing time will amplify the polymerization action and the outcome will be high-level compressive strength. GPC have a marvellous defiance with chemical strike and display the capability of hostile habitats where the toughness of Portland cement will be analysed. It will relevant in aquatic regions, the place where high-level CO2 soils. Thus geo-polymer concrete helps in the complete replacement of Portland cement . It is expected that centralizing over needs & examining in a way that includes a lot of careful detail in this area will help to materialized flue-ash based GPC as a trading & non-polluting material & set the seal on the sustainability of construction.

2. Materials and Objectives

The ingredients used for this work are same as those used in the conventional concrete. But here fly-ash, GGBS and silica fume are introduced as fully replacement for cement. The material used are cement, sand, coarse aggregate, fly-ash, GGBS, silica fume, super plasticizer and water.

The future developments of construction should be economy and environmental basis. Fly-ash based GPC is an economic alternative to ordinary concrete. The overall cost for geo-polymer concrete is under of conventional concretes, since it is utilizing easily and freely available for fly-ash, cheapest chemicals NaOH and Na2SiO3 solution.

Beyond such economic benefits, the major advantage of geo-polymer concrete is related to environment:

To construct a convenient thing and supply extreme level concrete besides OPC.

Mainly reduces CO2 emission and eco-friendly products.
2.1 General

This output is comparing the solidity parameters of geo-polymer concretes with Ordinary Portland Cement (OPC). These describes quantity calculation, properties of materials used and casting of specimens. The total number of cubes, beams and cylinder are shown in Table 1.

| Table 1. No. of cubes, beams and cylinders for GPC and OPC |
|---------------------------------|
| No. of cubes, beams, and cylinders for GPC | No. of cubes, beams, cylinders for OPC |
|---------------------------------|
| 7th day 70% flyash, 20% GGBS, 10% silica fume | 9 cubes |
| 60% flyash, 30% GGBS, 10% silica fume | |
| 50% flyash, 40% GGBS, 10% silica fume | |
| 28th day 70% flyash, 20% GGBS, 10% silica fume | 6 cylinders |
| 70% flyash, 20% GGBS, 10% silica fume | |
| 70% flyash, 20% GGBS, 10% silica fume | 4 beams |

3. Result and Discussion

Test outcome of the geo-polymer concretes specimens were emulated with the normal concrete specimens of same size & grade and the results were presented using tables and graphs. The function of concrete by fully renewal of cement by varying the percentage of pozzolanic materials; (70% flyash, 20% GGBS, 10% silica fume), (60% fly-ash, 30% GGBS, 10% silica fume), (50% fly-ash, 40% GGBS, 10% silica fume). Workability then the compressive strength, flexural strength & the split tensile strength of the test specimens. The strength parameters of ordinary concretes specimens and Geo-polymer Concrete specimens.

The sieve analysis is done to both fine & coarse aggregates to measure the percentage of sieves. Fine aggregates pass through 4.75mm IS sieve & in other-hand coarse aggregates retains through 4.75 mm. In Fig. 1.is shown the findings of sieve analysis of both, fine & coarse aggregates.

![Figure 1. Sieve Analysis Result](image-url)

Then the cast of specimens will takes-place through various test such as workability in the concrete, where the mixer material can be moulded into any shape. For maximum strength the compaction should be 100% in the concrete. In which slump & compaction tests were approved for inspect the workability of the concrete. After this test only the degree of workability will be finalized.

The conventional concrete specimens were prepared first & compressive strength tested for an age of seventh and twenty-eighth days after cast of the specimens. In this study, for conventional concrete, 150×150×150 mm cube specimens were developed. Three of these cubes are testing for compressive
strength at the span of seventh and twenty-eighth days after cast the specimens. Fig. 2. given below shows the compressive strengths of conventional concretes at seventh day and twenty-eighth day as a result.

Figure 2. Compressive strength of specimens

Split tensile strength are indirect practice that determinism the tensile strength of concretes used in a cylinder which splits over the vertical diameter. The length of the specimen must not be below than that of the diameter & not more than double the diameter. The cylindrical specimens of size 150mm diameter × 300mm height were prepared and tested for split tensile strength on conventional concrete. The fill-up must be enacted in need of upset & enlarges interminably at a nominal rate within the span of 1.2 N to 2.4 N. Fig. 3 given below shows the Split tensile strengths of conventional concrete at 28th day.

Figure 3. Split tensile strength of conventional concrete for 28th day

Flexural strength of a conventional concretes is deliberated by the load of 150×150 mm concrete beams with a width of three times. The flexural strength results were found in the span of 2.5N/mm² - 2.38 N/mm². Fig. 4. given below shows the Flexural strength on conventional concrete at 28th day.

Figure 4. Flexural strength of conventional concrete for 28th day

In this work, the mix proportions used to make the geo-polymer concrete were based on the arrangement & the habitual property of flue-ash & GGBFS synthesised Alkali-activate concretes. Types of matter
Fraction for geo-polymer concrete mixers were shown in Table 2. The ratio from alkaline to the binder will be considered as 0.35-0.5, & also like that from sodium silicate to sodium hydroxide solution as 2.5-3. Sum of aggregate in the mass of concrete is 66-88%, & the content of fine aggregate in amount aggregate sum is adopted like 35%. Scale of plasticizer is filled like 2%-4.5% by the mass of binder. Additional water content on condition that lacking can be included in the span of 0.03%-0.07% by mass of bitumen substances.

| Materials Used                        | Range of materials |
|---------------------------------------|--------------------|
| Alkaline liquid-Binder                | 0.35-0.5           |
| Sodium silicate-Sodium hydroxide      | 2.5-3              |
| Distilled Water-Binder                | 0.17-0.25          |
| Sum of aggregate in mass of concrete  | 66-88%             |
| Fine aggregate contented in amount of aggregate | 35%           |
| Water content                         | 0.03%-0.07% of mass of bitumen substances |
| Super Plasticizer                     | 2%-4.5% of mass of bitumen substances |

In the GPC mix design the dissimilar materials used are flue-ash, GGBFS, sodium silicate, sodium hydroxide, fine & coarse aggregates, also water & synthetic polymers. Blend percentage of these medium are taken with the substructure of unit weight of plain concrete. Percentage of fine & coarse aggregates used were 70-30% as a result. Quotient of alkaline to bitumen substance was taken as 0.35 & ratio of sodium silicate & sodium hydroxide was 3. Synthetic polymers of 4.5% was utilize to enhance the viability of fresh GPC. All mix design values were prepared, and the values were shown in Table 3.

| Materials(kg)          | Quantity for 1m3 | For each percentage proportions | Total quantity needed for all proportions. |
|------------------------|------------------|---------------------------------|------------------------------------------|
| Fly-ash                | 373.1            | 14.7                            | 44.1                                     |
| GGBS                   | 106.6            | 4.2                             | 12.6                                     |
| Silica fume            | 53.3             | 2.1                             | 6.3                                      |
| Coarse aggregate       | 1176             | 46.339                          | 139                                      |
| Fine aggregate         | 504              | 19.85                           | 59.55                                    |
| Mass of Na2SiO3        | 65               | 2.56                            | 7.68                                     |
| Total water content in Na2SiO3 | 69            | 2.71                            | 8.13                                     |
| Mass of NaOH           | 13.9             | 0.547                           | 1.64                                     |
| Total water content in Na2SiO3 | 39.09       | 1.54                            | 4.62                                     |
| Super Plasticizer      | 24.48            | 0.96                            | 2.88                                     |

4. Conclusion

Geo-polymers have much potential as construction materials as well as non-pollutant materials due to their excellent mechanical properties. They can be cured at ambient temperature and emit less CO2 compared to Portland cement which leads to control the environmental pollution. The mixture proportions and the manufacturing process used to make the Geo-polymer concrete was based on the
arrangement & the habitual property of flue-ash & ground granulated blast-furnace slag synthesized alkali activate concretes.

- Fly-ash is acknowledged as the superior medium to composing the Geo-polymer concrete & announce to the peak of compressive strength to geo-polymer concretes.
- Fly-ash rooted Geo-polymer concrete indicated magnificent property & approved for structural developing by analyst & with the expanding merit of the NaOH molarity that the stability of Geo-polymer concrete gets grown-up.
- Rising the ratio of GGBS also expanded the fire resistance of concrete.
- By utilizing of silica fume in the concrete that expand the compressive strength. Avoid the breeze forces high corrosion & abrasion resistance, huge structures obtain the silica fume content to allow the high toughness concrete.
- Which is a breakthrough to the furtherance of using super-plasticizer in concrete-technology and here Ceraplast-300 helps to generate intense resilience in concrete no vibration in the course of set down.
- With various leads of these materials as studied detailed in this project, better strength parameters for Geo-polymer concrete are expected by using varying proportions of Fly-ash, GGBS, Silica-fume along with an alkali solution (NaOH and Na2SiO3) than conventional concrete. Thus, Geo-polymer concrete helps in the complete replacement of Portland cement.

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