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ijirset@gmail.com

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A Study on Concrete Characteristics with Addition of Geopolymers

KAVANOORU RAJEEV¹, SHAIK MOHAMMAD ABRARTAHA², Dr.K.RAJASEKHAR³

P.G. Student, Siddartha Educational Academy Group of Institutions, Tirupati, India¹

Asst Professor, Siddartha Educational Academy Group of Institutions, Tirupati, India²

Professor, Siddartha Educational Academy Group of Institutions, Tirupati, India³

ABSTRACT: Concrete is termed as universal element in construction industry. now a days usage of concrete is like anything. As this trend goes on one day we may face shortage of resources . so for a solution from my duty towards this nation and as well as world to reduce usage of conventional concrete and move towards adding of geopolymers to help nature.in this research The scope in geopolymer concrete is usage of recycled coarse aggregates as fresh coarse aggregates, SEM tests can be done for GGBS based GPC, Fine aggregates can be replaced by the industrial by-products. the sodium hydroxide solution and sodium silicate solution as alkali activators , and 100% Fly Ash, 50% Fly Ash + 50% GGBS, 100% GGBS used. Compressive strength, 4.5X-RAY DIFFRACTION TEST were done.

KEYWORDS: GEOPOLYMERS ,waste ashes, GGBS,flyash,rice husk ash, Compressive strength, 4.5X-RAY DIFFRACTION TEST.

I. INTRODUCTION

In the past few decades, it has emerged as one of the possible alternatives to OPC binders due to their reported high early strength and resistance against acid and sulphate attack apart from its environmental friendliness. The temperature during curing is very important, and depending upon the source materials and activating solution, heat often must be applied to facilitate polymerization, although some systems have been developed that are designed to be cured at room temperature^[3]. Geopolymer binders might be a promising alternative in the development of acid resistant concrete since it relies on alumina-silicate rather than calcium silicate hydrate bonds for structural integrity.

WHY GEOPOLYMER ?

now a days concrete is using like anything. for constructions one of the key element is concrete. it reached in that stage even trusses also being constructed through concrete. we generally using OPC and PPC cement in OPC huge amount of CO₂ is emitted while manufacturing cement it causes huge damage to environment. Environmental pollution is the biggest menace to the human race on this planet today. It means adding impurity to environment. It has a severe effect on the ecosystem. There are many reasons which cause pollution. In our construction industry, cement is the main ingredient/ material for the concrete production. But the production of cement means the production of pollution because of the emission of CO₂ during its production^[4]. There are two different sources of CO₂ emission during cement production. Combustion of fossil fuels to operate the rotary kiln is the largest source and other one is the chemical process of calcining limestone into lime in the cement kiln also produces CO₂. In India about 2,069,738 thousand of metric ton of CO₂ are emitted in the year of 2010. The cement industry contributes about 5% of total global carbon dioxide emissions^[5]. And also, the cement is manufactured by using the raw materials such as limestone, clay and other minerals. Quarrying of these raw materials is also causing environmental degradation. To produce a ton of cement, about 1.6 tons of raw materials are required and the time taken to form the limestone is much longer than the rate at which humans use it. On the other side the demand of concrete is increasing day by day for its ease of preparing and fabricating in all sorts of convenient shapes. So, to overcome this problem, the concrete to be used should be environmental friendly.



II. OBJECTIVE AND SCOPE

The main objective of this project is to study the performance of geopolymer concrete by considering two different pozzolanic materials and to investigate the effect of alumina-silicate source material and alkaline solution in Geopolymer concrete.

The scope in geopolymer concrete is usage of recycled coarse aggregates as fresh coarse aggregates, SEM tests can be done for GGBS based GPC, Fine aggregates can be replaced by the industrial by-products.

II. EXPERIMENTAL PROGRAM

CONSTITUENTS OF CONCRETE:

1. Fly Ash
2. Ground Granulated Blast Furnace Slag (GGBS)
3. Fine Aggregate
4. Coarse Aggregate
5. Sodium Hydroxide (NaOH)
6. Sodium Silicate (Na_2SiO_3)
7. Distilled Water

MIX DESIGN:



Constituents in Mix design of Geopolymer Concrete

Mix. No	Type of Mix	Mix Name	S.No	Materials	Mix-1	Mix-2	Mix-3
			1	Fly ash	514.3	257.15	0
			2	GGBS	0	257.15	514.3
			3	Fine aggregate	672	672	672
Mix - 4	6 Molar	G-GPC-6	4	20mm Coarse aggregate	705.6	705.6	705.6
Mix - 5	8 Molar	G-GPC-8	5	10 mm Coarse aggregate	302.4	302.4	302.4
Mix - 6	10 Molar	G-GPC-10	6	Sodium silicate	146.92	146.92	146.92
Mix - 7	12 Molar	G-GPC-12	7	Sodium hydroxide	18.22	18.22	18.22
Mix - 8	14 Molar	G-GPC-14	8	Distilled Water	40.55	40.55	40.55
			9	Molarity	10 M	10 M	10 M



S.No	Materials	Mix-4	Mix-5	Mix-6	Mix-7	Mix-8
1	GGBS	514.3	514.3	514.3	514.3	514.3
2	Fine aggregate	672	672	672	672	672
3	20 mm Coarse aggregate	705.6	705.6	705.6	705.6	705.6
4	10 mm Coarse aggregate	302.4	302.4	302.4	302.4	302.4
5	Sodium silicate	146.92	146.92	146.92	146.92	146.92
6	Sodium hydroxide	11.75	14.69	18.22	20.57	23.51
7	Distilled Water	47.02	44.08	40.55	38.20	35.26
8	<u>Molarity</u>	6 M	8 M	10 M	12 M	14 M

PREPARATION OF SPECIMENS

The cast iron moulds are cleaned of dust particles with mineral oil on all sides before the concrete is poured into the moulds. The moulds are placed on a level platform. The well mixed concrete is filled into the moulds immediately after mixing, in three layers and compacted with manual strokes and kept on a vibration table. Excess concrete was removed with a trowel and the top surface level is smoothly finished as per IS 516- 1959.



CURING OF THE SPECIMENS

The specimens are left in the moulds undisturbed at room temperature for about 24 to 36 hours as it was geopolymer concrete after casting. The specimens are then removed from the moulds and they are exposed to sunlight and air for desired periods.





Slump test

Slump test is the most commonly used methods and measuring the consistency of concrete, which is employed in the laboratory or at the site work. In the present work, slump tests were conducted as per IS: 1199 – 1959 for all mixes. It is not a suitable method for vary wet or dry concrete. This method is suitable for medium slump.



Slump Test in progress

Compressive Strength Test

The cube of sizes 100mm × 100mm × 100mm was cast. After 24 hours to 36 hours, the specimens are removed from the moulds and subjected to curing for 7, 14 and 28 days of phase-1 and the specimens of phase-2 are removed from the moulds and subjected to curing for 7, 14, 28 and 56 days exposed to sunlight. After curing, the specimens are tested for compressive strength using compression testing machine of 2000 KN capacity (IS: 516 - 1959).



Sorptivity Test

The sorptivity can be determined by the measurement of the capillary rise absorption rate on reasonably homogeneous material. Water was used of the test fluid.

The cubes after casting were immersed in water for 28 days curing. The specimen size 100mm × 100mm × 100mm after drying in oven at temperature of 85°C or sunlight, it was drowned with water level not more than 5 mm



above the base of the specimen and the flow from the peripheral surface is prevented by sealing it properly with non-absorbent coating or sealing with the plaster.

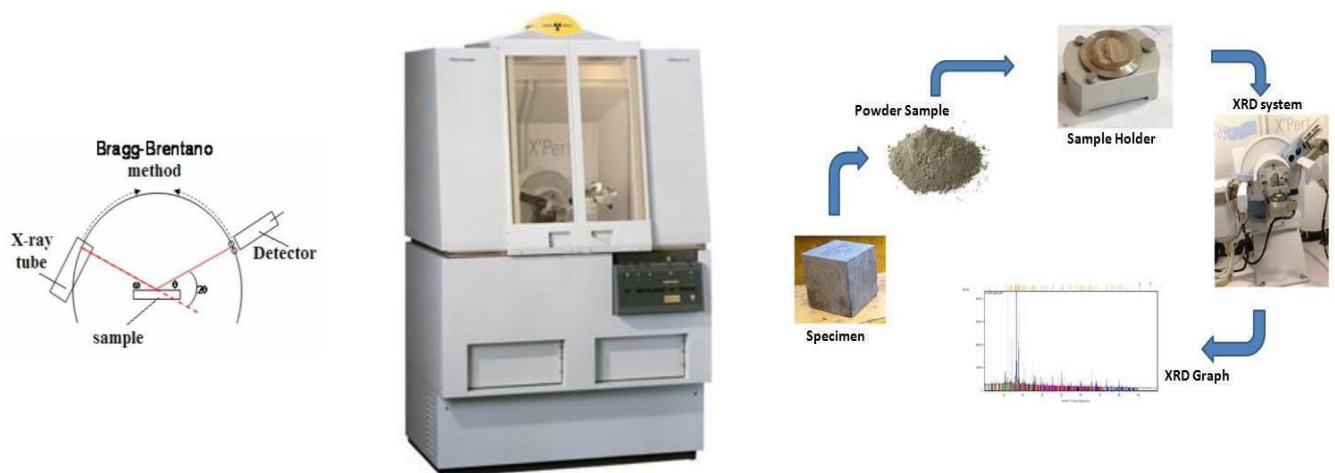


Specimens testing for sorptivity

The quantity of water absorbed in the time period of 30 minutes was measured by weighting the specimen on a top pan balance weighting up to 0.1 mg. Surface water in the specimen was wiped off with a dampened tissue and each weighting operation was completed within 30 seconds.

X Ray Diffraction Test (XRD)

Diffraction is a physical phenomenon that consists in electromagnetic waves avoiding obstacles if the size of the obstacles compared to the wavelength. This phenomenon can be applied to the analysis of materials as the atom plans are placed at comparable distances to X-ray lengths. X-rays are electromagnetic waves similar to light, but whose wavelength is much shorter ($\approx 0,2 - 200 \text{ \AA}$). XRD is produced as a reflexion at well defined angles. Every crystalline phase has its own diffraction image. The diffraction image contains a small number of maximum points that is not all the families of crystallographic planes give maximum diffraction points; all the crystalline phases with the same type of elementary cell will exhibit the same succession of Miller indices for the crystalline planes families giving a diffraction maximum points. For the XRD analysis, we use diffraction devices (diffractometers), mainly according to the Bragg–Brentano system (the sample rotates at a diffraction angle ‘ θ ’, while the detector rotates at the angle ‘ 2θ ’).



**III. PRESENTATION OF RESULTS****SLUMP TEST**

S.No	Mix Name	Type of Mix	Slump Value (mm)
1	FA-GPC	100% Fly Ash	97
2	FG-GPC	50% Fly Ash + 50% GGBS	91
3	G-GPC-10	100% GGBS	89

SORPTIVITY

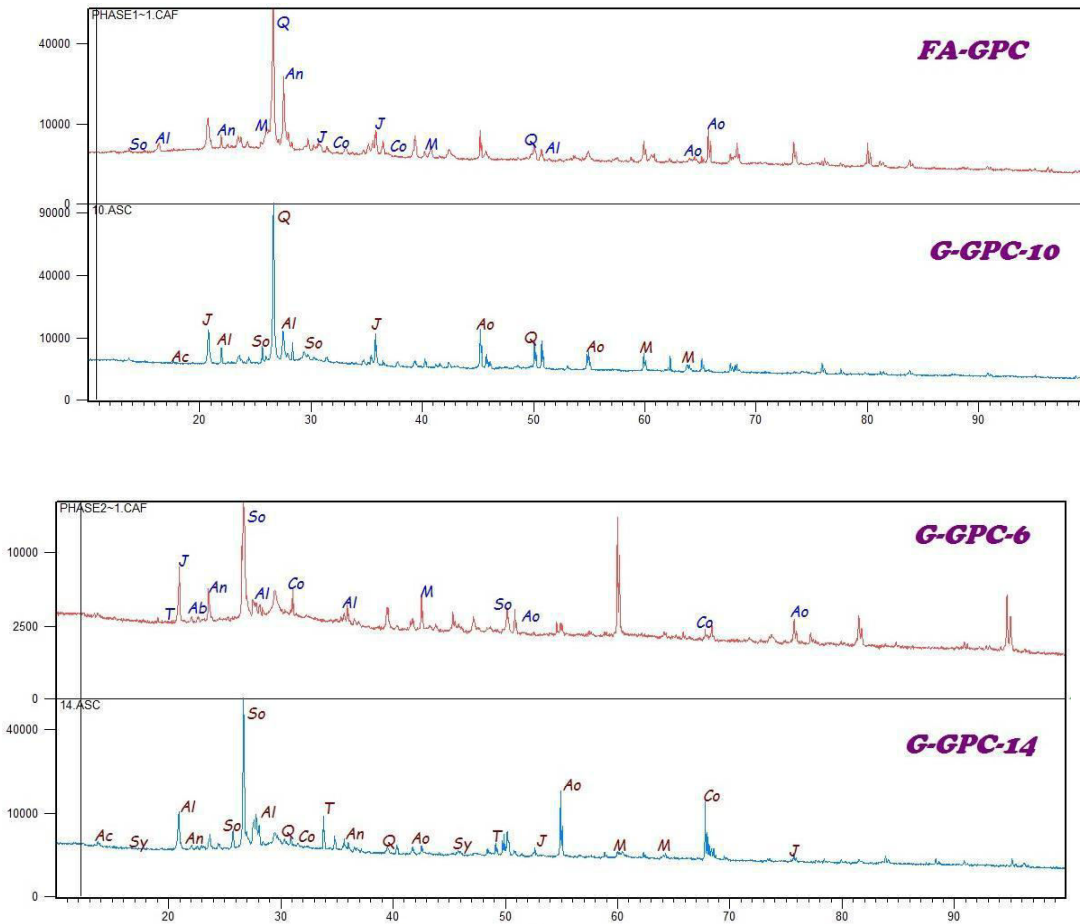
S.No	Mortar Type	Dry Wt. in grams (W ₁)	Wet Wt. in grams (W ₂)	Change in Wt. in grams (W ₂ -W ₁)	Sorptivity value in 10 ⁻⁴ mm/min ^{0.5}
1	FA-GPC	2362.3	2379.0	16.8	0.31
2	FG-GPC	2519.3	2534.7	15.4	0.29
3	G-GPC-10	2551.7	2564.0	12.4	0.25

COMPRESSIVE STRENGTH

S.No.	Type of specimen	Compressive Strengths in MPa			
		7 days	14 days	28 days	56 days
1	G-GPC-6	29.33	33.00	42.00	43.33
2	G-GPC-8	35.33	36.33	54.33	56.66
3	G-GPC-10	58.00	63.67	68.33	69.87
4	G-GPC-12	63.70	68.33	70.66	71.66
5	G-GPC-14	65.70	71.00	75.33	76.33



X-RAY DIFFRACTION TEST



Q - Quartz	Co - Calcium Oxide	Ac - Analcime
An - Anorthite	So - Silicon Oxide	J - Jadite
M - Mullite	Ao - Aluminium Oxide	Al - Albite
Ab - Analbite	T - Thenardite	Sy - Syngenite

IV. CONCLUSIONS

1. In comparison of GGBS and Flyash, Fly ash give good results.
2. The reaction of GGBS in geopolymer concrete with alkaline solution attains higher strength and less sorptivity confirms GGBS is the best suitable material in Geopolymer concrete compared to fly ash.
3. The Sorptivity and XRD analysis proves that GGBS based GPC absorbs less water due to its crystalline structure.
4. NaOH plays a major role in attaining the strength of the concrete, hence it is recommended 10M concentrations for medium grade.
5. The rate of increase in strength after 10 Molar concentration is decreased. So, considering 10M and 12M as the optimum dosage for GPC mix.
6. The increase in molarity of NaOH leads to less voids and good crystalline structure that results in less water absorption.



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