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EXPERIMENTAL STUDY ON DURABILITY OF ALCCOFINE AND FLY ASH BASED GEO POLYMER CONCRETE

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ABSTRACT** This current work presents the results of an experimental program to investigate the possibility of cement substitution in Geopolymer concrete by fly ash and alccofine.GPC mixes were planned and fly ash and alccofine were substituted for cement in 10%,20%,30%...proportions and the same procedure is followed for GGBS and flyash based GPC. Tests were carried out to test Acid attack test (H_2SO_4), Nitrate attack test (HNO_3), Chloride attack test (HCL), Sulphate attack test(Na_2SO_4), Sorptivity test & water absorption test. The compressive strength of Geopolymer concrete and change in mass percentages were indicated by the tests results. Geopolymer concrete, including aluminate containing materials with a caustic activator, is set up by reacting silicate. More frequently, waste materials such as GGBS, fly ash, metal slag are used, but the advanced materials like Alccofine enhances the strength and durability properties of GPC even in ambient conditions of curing. By adding various supplementary cement materials, various research literatures on the durability of geopolymer concrete are foreseen as their need increases due to persistent components. Past literature review studies have shown that the replacement of cement with chemical admixtures and mineral admixtures increases the strength and durability characteristics of concrete. Micro structures, higher mechanical properties and superior environmental sustainability are observed. In GPC, elevated temperatures and surface degradation are controlled as opposed to OPC. unlike traditional concrete, GPC provides greater resistance for specimens to acid, sulphates and chemical attack, water absorption and sorptivity, have a strong effect on the durability properties in ambient curing conditions.

Key words: Geopolymer concrete, Metakolin, Sodium Sulphate, Sulphuric Acid and Sodium Chloride

1. INTRODUCTION

To produce environmental friendly concrete, we need to supplant the concrete with some different fasteners which ought not to make any terrible impact on condition. The utilization of modern side-effects as covers can decrease the issue. In this regard, the new innovation geo-polymer concrete is a promising method. Regarding decreasing the worldwide temperature alteration, the geo-polymer innovation could lessen the CO2 outflow to the environment brought about by bond and totals ventures by about 80%. And furthermore the best possible use of modern squanders can lessen the issue of arranging the waste items into the air. The term geo-polymer was first authored by Davidovits in 1978 to speak to a wide scope of materials portrayed by chains or systems of inorganic atoms. Geopolymer is delivered by a polymeric response of basic fluid with source material of geographical birthplace or by item material, for example, fly debris, rice husk debris, GGBS and so on.

A. Alccofine

ALCCOFINE 1203 is an uncommonly prepared item dependent on slag of high glass content with high reactivity got through the cycle of controlled granulation. Attributable to its exceptional science and super fine molecule size, ALCCOFINE1203 gives diminished water interest to a given functionality, even up to 70% substitution level according to prerequisite of solid execution. Alccofine 1203 can likewise be used as a high reach water reducer to improve compressive strength or as a super usefulness help to improve stream.

Hence, use of Alccofine1203 along with fly ash gives a fascinating other option and can be named as high strength and superior cement. Use of waste materials, for example, fly ash in development industry lessens the specialized and ecological issues of plants and diminishes power costs other than decreasing the measure of strong waste, ozone depleting substance discharges related with, moderates existing normal assets. Notwithstanding the advantages of fly ash, functional issues stay in field application. Recently created admixtures permit bringing down the water/binder proportion to exceptionally low-levels without loss of functionality.

B. Fly ash

Fly ash is a fine powder resulting from the combustion of powdered coal which is transported by the flue gases of the boiler and collected in the Electrostatic Precipitators (ESP). Conversion of waste into a resource material is an old practice of human society. In the year 1930, in USA, the fly ash became available in coal based thermal power station. For its profitable utilization, scientist started research activities and R.E. Davis, in the year 1937, and his associates at university of California published research details on use of fly ash in cement concrete. This research had laid foundation for its specification, testing & usages.

2. Methodology

In this present examination we need to find out the durability of geopolymer concrete with varying percentages of alcofine and fly ash for M30 grade concrete. In order to find out the durability we need to find the percentage loss of compressive strength and percentage loss of weight loss for cube specimens at 90 days curing.

A. Batching

Generally batching is the method to find the quantity of materials batching is consisting of two types one is volume batching and second one is weight batching. For this present study the weight batching is taken for measuring the quantity of materials which are used in the project like cement, fine aggregates, coarse aggregates, alccofine and fly ashmaterials.

Mixing of concrete

After measuring the quantity of materials we need to mix the concrete as per mix design and as per trial mixes. Initially we need to mix coarse aggregates, fine aggregates, cement, alccofine and fly thoroughly to get the uniformity of the mix after that add water to the mix as per the calculations form mix design and again mix the concrete to get proper trail mix.

Placing and compacting

Mixed concrete is placed in the cube specimen of size 150mmX150mmX150mm in 3 layers each layer is compacted with tampering rod with 25 blows.

Curing

After compaction process allow the cube specimens to get harden for 24hours at temperature of 27±2 and at 90% of relative humidity in moist air for 24 hours±1/2 hours from the time of mixing to the dry constituents. Then the concrete specimens are removed from the mould are immerse in curing tank and allow them to cure for 7days, 14days, 28days compressive strength values and durability values.

Mix proportion of GPC (alccofine+ flyash)

Materials	Binders	Fly ash	Alccofine	FA	CA	Alkaline solution	Na_2SiO_3	NaOH solution	NaOH
For $1m^3$(Kg)	380	304	76	780	1051	220	158	62	20

Testing of concrete results

Durability of concrete is generally performed for acid attack, sulphate attack, permeability, sorptivity, water absorption, alkali aggregates reaction, drying shrinkage, abrasion resistance, impact resistance, rapid chloride ion penetration and corrosion. But in this investigation test conducted on Geo polymer concrete are as follow.

- Acid Attack with H_2SO_4, HCl, HNO_3
- Sulphate Attack with Na_2SO_4
- Sorptivity with Water as test fluid
- Water Absorption

3. RESULTS AND ANALYSIS

Workability of concrete

Slump cone test: The concrete slump test is utilized for the estimation of a assets of fresh concrete. The test is an observational test that estimates the functionality of fresh concrete. All the extra explicitly, it gauges consistency between groups. The test is prevalent because of the straightforwardness of mechanical assembly applied and basic approach.

	Alkali binder ratio	Slump in mm	Compressive strength
FGGPC	0.4	100	31.64
	0.5	107	33.26
FAGPC	0.4	103	33.51
	0.5	111	34.83

Strength of the concrete

Compressive strength: This test was conducted according to IS 516-1959. The cubes of well known size 150x150x150mm have been utilized to find the compressive test of concrete. Cubes were set at the bearing floor of CTM, of restriction 200T without capriciousness and a uniform pace of stacking carried out until the disappointment of the cubes. The finest burden turned into cited and the compressive load.

Durability of concrete

Durability is characterized as the ability of concrete to oppose enduring activity, substance assault and scraped vicinity while preserving up its ideal building residences. It normally alludes to the time period or existence expectancy of issue free execution. Various concretes require numerous ranges of durability depending upon the presentation situation and houses desired. For instance, concrete provided to tidal seawater can have surprising requirements in contrast to indoor concrete.

Sl.No	Mix Id /Proportions of Binders	Compressive Strength (MPa) For 28 Days (For Different Molarity)		
		4M	6M	8M
1	M1 F_{100} A_0	20	18	18
2	M2 F_{90} A_{10}	29	102	27
3	M3 F_{80} A_{20}	34	49	46
4	M4 F_{70} A_{30}	47	34	57
5	M5 F_{60} A_{40}	60	39	51
6	M6 F_{50} A_{50}	63	31	64

Specimens of different mix proportions of geo polymer concrete

Compressive strength in MPa	FGGPC		FAGPC	
	7 days	28 days	7 days	28 days
Specimen 1	24	36	26	40
Specimen 2	25	35	28	36
Specimen 3	26	36	27	38
Average	25	36	27	38

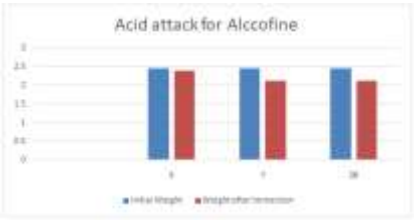
*FGGPC (flyash+GGBS)

*FAGPC (flyash+ Alccofine)

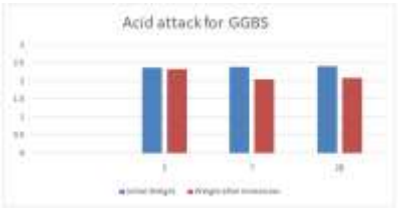
Acid attack

Specimens of size 100X100X100mm are subjected to Acid environment at ages 3, 7, 28 days and are cured in ambient condition, the standard exposure of solution is 5%, and following table-15 shows initial weight and weight after immersion in the Sulphuric acid for which compressive strength is calculated.

We have taken 99% concentrated solution of H_2SO_4 for this experiment.

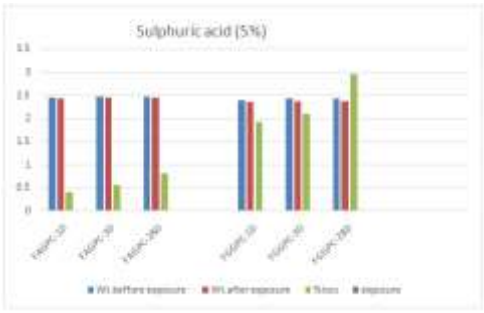


Acid attack for Alccofine



Acid attack for GGBS

Sulphuric acid attack

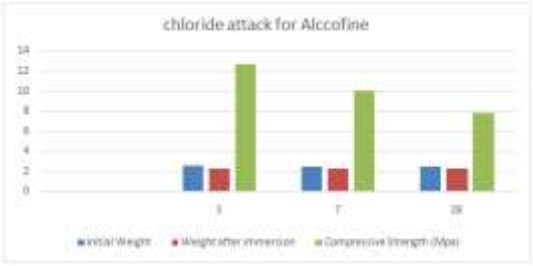


Sulphuric acid (5%)

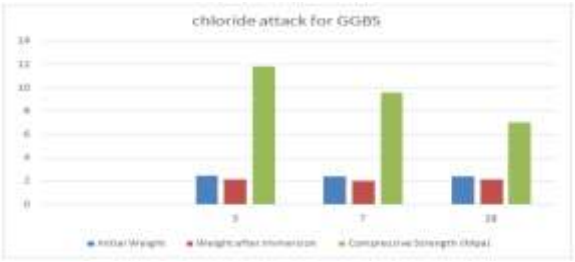
Different loss percentage of Sulphuric acid

Chloride Attack:

Specimens of size 100X100X100mm are subjected to Acid environment at ages 3,7, 28 days and are cured in ambient condition and calculated compressive strength, the standard exposure used for solution was 5%. We have taken 33% concentrated solution of HCl for this experiment.

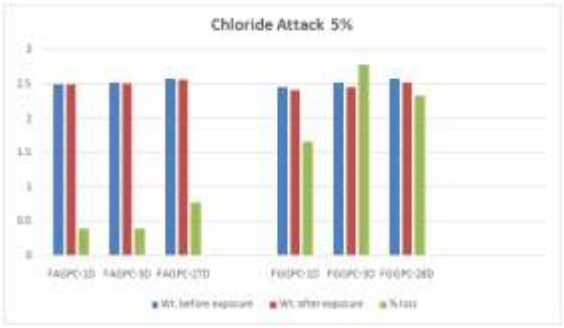


Compressive Strength (MPa) of HCL for Alccofine

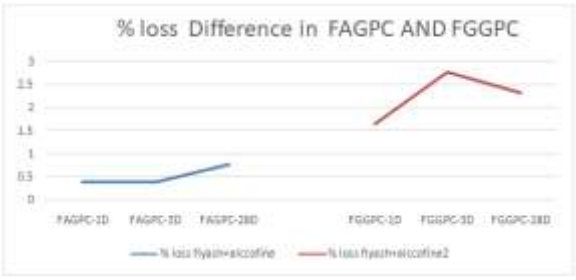


Compressive strength of HCl for GGBS

Percentage mass loss of cube immersed in HCl



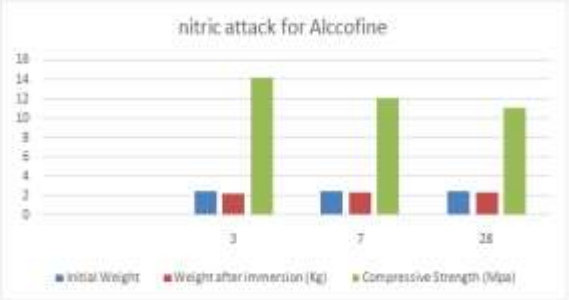
Percentage loss of cube immersed in HCL



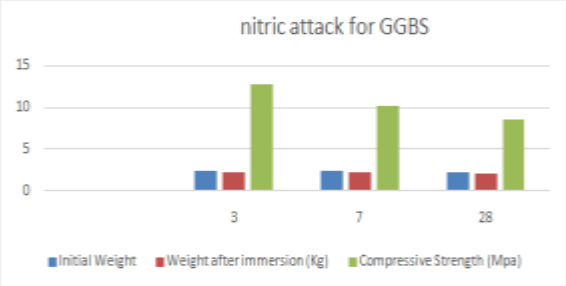
Different loss percentage of HCL for Alccofine and GGBS

Results for Nitric Attack

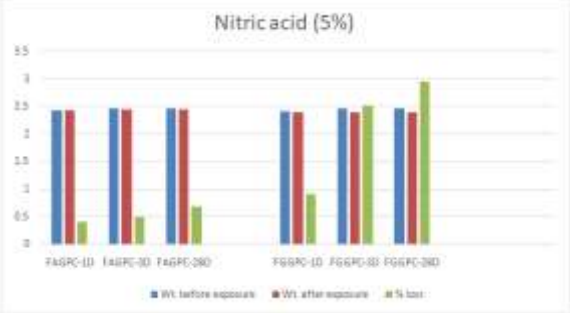
Specimens of size 100X100X100mm are subjected to Acid environment at ages 3,7, 28 days and are cured in ambient condition and compressive strength is calculated, the standard exposure of solution is 5%,



Compressive strength of (HNO3) for Alccofine

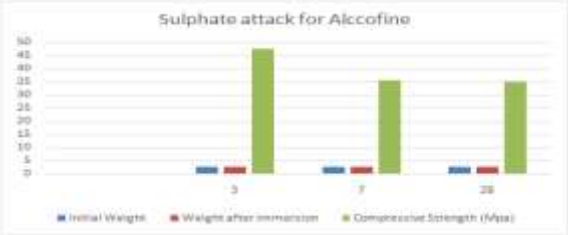


Compressive strength of (HNO3) for GGBS

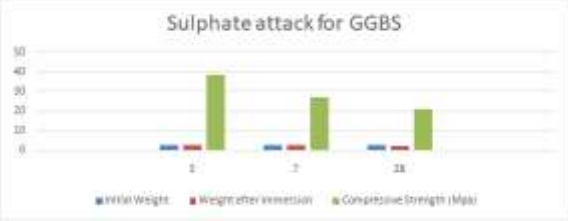


Percentage loss of cubes immersed in HNO3

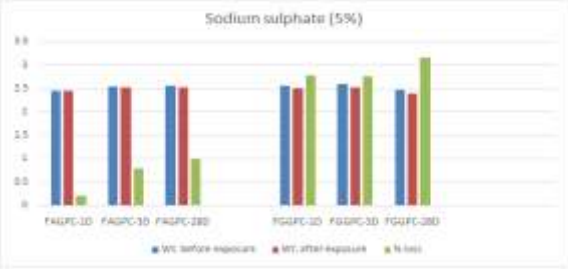
Difference in mass loss percentage of HNO3



Compressive strength of cube immersed in (Na2SO4) of alccofine



Compressive strength of cube of GGBS immersed in (Na2SO4)



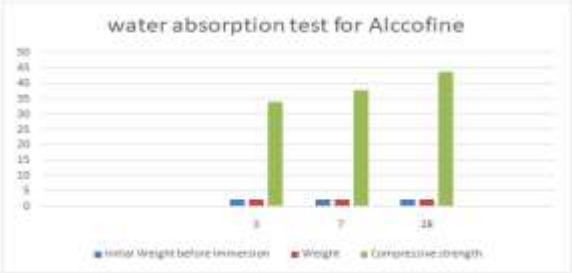
Percentage loss mass of cube immersed in Na2SO4

Loss percentage of cube immersed in Na2SO4

Sulphate Attack:

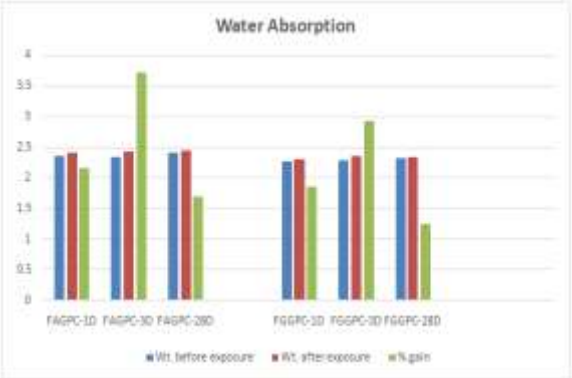
Specimens of size 100X100X100mm are subjected to Acid environment at ages 3,7, 28 days and are cured in ambient condition, the standard exposure of solution is 5%, following table: 24 shows initial weight and weight after immersion for the mix. We have taken 5 % concentrated solution ofNa_2SO_4 for this experiment.

Results for Water Absorption

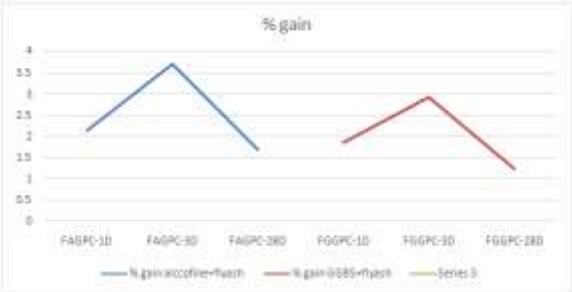


Compressive strength of water absorption test for Alccofine

Compressive strength of Water absorption test for GGBS



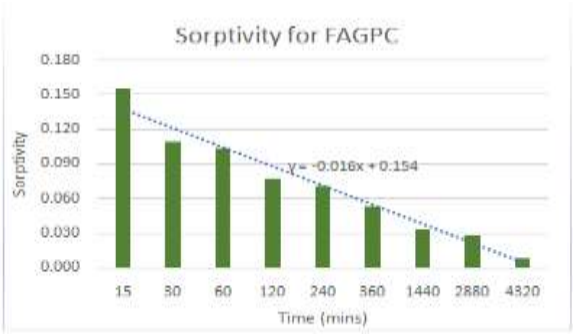
Percentage of Water absorption test for GGBS



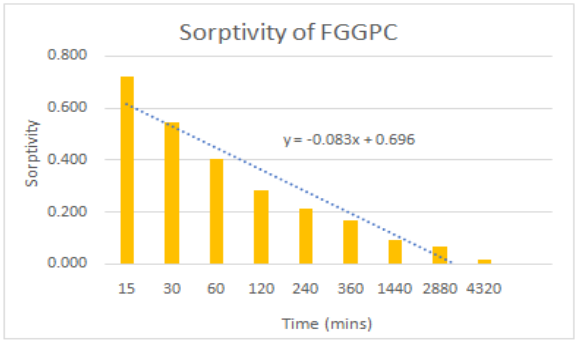
Gain percentage of Water absorption test for both GPCs

Sorptivity results

Sorptivity (S) is a material property that characterizes the tendency of a porous material by capillarity to absorb and transmit water. The cumulative water absorption (per unit area of the inflow surface) increases as the square root of elapsed time (t). This Sorptivity is determined and tabulated by using equation (2).



Sorptivity test results of FAGPC



Sorptivity test results of FGGPC

4. Conclusions

1. GPC with Alccofine and Flyash has compressive strength greater compared to GGBS and flyash based GPC at the age of 7days and more at 28 days.

2. The Sulphuric acid attack causes damage to the surfaces of the specimen and debasement in compressive strength of GPC, the corruption additionally relies upon the corrosive focus and exposure period. However, as per the studies shows better resistance to heat cured flyash based geopolymer concrete of FAGPC than FGGPC.
3. The chloride attack test results demonstrated good performance of geopolymer concrete and significantly lesser decrement in the change of mass after 28 days exposure in Alccofine and flyash based GPC.
4. The alccofine and flyash based GPC performed better resistance to Nitric attack with lesser change in the mass and good compressive strength after 28days exposure when compared to GGBS-flyash based GPC.
5. Sulphate attack results of FAGPC indicated significantly excellent resistance to the sulphate attack after exposure for 28 days in sodium sulphate without causing any damage to the specimen's surface. The compressive strength got better results for FAGPC.
6. In proportion to consideration results of surface water absorption and internal water absorption, the surface water absorption shows higher than that of internal water absorption for all the specimens. This is because, at the cover concrete the rapid water loss is observed while curing process.
7. The results of water absorption show less porosity in FAGPC as alccofine has finer particles compared to GGBS.
8. The change in mass and compressive strength is slightly differed in both the types of concretes although alccofine and flyash based concrete has comparably better compressive strength and less change in mass.
9. The FAGPC has shown better sorptivity results than FGGPC as they have lowest permeability due to their fine structure.

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