An Experimental Study on Performance of Fly Ash Based Geopolymer Concrete in Chemical Atmosphere

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Abstract - The incorporation of extra cementitious elements as partial substitutes for cement in concrete will significantly contribute to environmental management of greenhouse effects and the lowering of global temperatures. The development of geopolymer concrete (GPC), in which all of the portland cement is replaced with fly ash (in combination with sodium hydroxide and sodium silicate solutions), offers a promising alternative to ordinary portland cement concrete. In general the results of Geo-polymer concrete obtained from the behavior of a source material i.e. high in silica, alumina and with alkaline liquid. The word geo-polymer was coined by Davidovit's. Geo-polymer substances lately described as entity to acid opposition. The present thesis studies the laboratory investigation information on Behavior of fly-ash deployed geo-polymer concretes revealed inThe development of geopolymer concrete (GPC), in which all of the portland cement is replaced with fly ash (in combination with sodium hydroxide and sodium silicate solutions), offers a promising alternative to ordinary portland cement concrete. In general the results of Geo-polymer concrete obtained from the behavior of a source material i.e. high in silica, alumina and with alkaline liquid. The word geo-polymer was coined by Davidovit's. Geo-polymer substances lately described as entity to acid opposition. The use of supplementary cementitious materials as partial replacements of the cement in concrete will play a significant role with respect to the environmental control of greenhouse effects and global temperature reduction. The development of geopolymer concrete (GPC), in which all of the portland cement is replaced with fly ash (in combination with sodium hydroxide and sodium silicate solutions), offers a promising alternative to ordinary portland cement concrete. In general the results of Geo-polymer concrete obtained from the behavior of a source material i.e. high in silica, alumina and with alkaline liquid. The word geo-polymer was coined by Davidovit's.

Key Words: Geopolymer, Cement, Fine aggregate, Coarse Aggregate, H_2SO_4, Hcl and $MgSO_4$

1.INTRODUCTION

The consumption of concrete globally ranks second only to that of liquids. The purpose of Ordinary Portland cement (OPC) as an initial binder to produce concrete. Everybody knows The environmental aspects regarding the manufacture of OPC. At the time of producing ordinary Portland cement dischargingCO2because of calcination of limestone and burning of fossil fuel.

The term "Geo-polymer" was derived by Davidovits in the year of 1978. Geopolymer is an inorganic alumino-silicate polymer. Integrated from mostly silicon and aluminum materials that is fly-ash. The purpose of the Alkaline solutions is to inject the silicon and aluminum atoms. In the source materials (fly-ash) to disappear form of gel The polymerization procedureishelp full byentered heat followed by drying. The geo-polymer paste binds the loose fine and coarse aggregatesThe purpose of Ordinary Portland cement (OPC) as an initial binder to produce concrete. Everybody knows The environmental aspects regarding the manufacture of OPC. At the time of producing ordinary Portland cement dischargingCO2because of calcination of limestone and burning of fossil fuel.

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1.1 OBJECTIVE OF THE THESIS

It was noted ancient, many of the research published papers on geo-polymers represents the behavior of various gels using different kinds of source materials. In acidic environment concrete the geo-polymer binders is to be a good alternative material. The Geo polymer cement having eminent properties with in both salt and acidic environment atmosphere. This present thesis setted the experimental investigation information about the present thesis stetted as follows.

1.2 SCOPE OF WORK

In this experimental work, study of the mass loss and compressive strength of geopolymer material concrete againstchemical environment is done.

And also the variation in results of geo-polymer concrete in chemical environment with conventional concrete againstacidic environment is studied.

2. LITERATURE REVIEW

The commence of carbon dioxide (CO2) issuance is an important variable for the industry sectors. In 1999 & 2004, Malhotra gave a clear indication about investment has faced that the one T of issuance can have a commenced value about US$10. The changes of climate is varied occurred to not only the Global warming, even also be the not being normal global dimming regarding the polluted atmosphere. In 2002-2005, Fortune reported the effect of Global Dimming effect may be reduced the Air pollution. In 2002 and 1999, Mccaffrey and Roy presented the value of de-carbonation of limestone in that kiln during producing of cement and burning of fossil fuels. In 2002 Mehta in order to manufacture ecofriendly concrete proposed suggested the importance of fewer natural resources, low energy, and minimize the release of carbon dioxide.

3. MATERIALS AND EXPERIMENTAION

3.1 INTRODUCTION

This segment explains the procedure of making low calcium fly ash-based geopolymer concrete.

This segment studies the properties of materials. The size of casted cubes are 150mm x150mmx150mm andthe grade of conventional and geo-polymer concrete is M35. The concrete specimens were submerged in 5% of HCL, H2SO4, and MgSO4 for a period of 7, 14 and 28 days. Later completion of curing period the concrete cubes were tested on U.T.M and noted the test results.

3.2 MATERIALS

- Cement
- Fine andCoarse Aggregates
- Water
- Fly Ash
- Alkaline Liquid

3.3 PRELIMINARY LABORATORY WORK

The basic concept underlying primary lab work is as follows. To better understand how the sequence of mixing the alkaline liquid with the prepared material impacts the geopolymer concrete, we created test specimens in the shape of 150 mm cubes. They attempted to mix it in a Tilting Drum Mixer.

The primary objectives of the first lab work were to learn how to make fly ash-based geo-polymer concrete; to understand how the order of mixing the alkaline liquid with the solid materials affects the reaction of raw fresh geo-polymer concrete; to learn how to mix and cure concrete; and to learn how to do all of the above. The preparatory laboratory work consists of the following few phases.

MIX DESIGN

4.1 Design of Geo-polymer Concrete Mixtures:

Similar to Portland cement concrete, the character and effect are accepted on an equal basis. The weight of the aggregate combination ranged from 74.9% to 79.9% of the weight of the geopolymer concrete. The suggested range of values for the fly-ash to alkaline liquid ratio by weight is 0.28 to 0.45. in light of the laboratory results obtained over a four-year period. The values in the table are recommended for the design of geopolymer concrete with a low calcium fly ash content. After casting is finished, we should be aware that the wet-mixing process takes four minutes and that the steam-curing process takes twenty-four hours at 60 degrees Celsius.

The sodium silicate solution is significantly less in sodium hydroxide than inThe weight of the aggregate combination ranged from 74.9% to 79.9% of the weight of the geopolymer concrete. The suggested range of values for the fly-ash to alkaline liquid ratio by weight is 0.28 to 0.45. in light of the laboratory results obtained over a four-year period. The values in the table are recommended for the design of geopolymer concrete with a low calcium fly ash content. After casting is finished, we should be aware that the wet-mixing process takes four minutes and that the steam-curing process takes twenty-four hours at 60 degrees Celsius.

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4.2 MIX DESIGN

Assume Unit-mass of concrete = 2400 kg/m3.

The mass of combined aggregates = 77%,

i.e. 0.77x2400= 1848 kg/m3.

Mass of low-calcium fly ash and the alkaline liquid =

2400 – 1848 = 552 kg/m3.

Bring the alkaline liquid-to-fly-ash ratio by mass = 0.35.

The mass of fly ash = 552/ (1+0.35) = 408 kg/m3

The mass of alkaline liquid = 552 – 408 = 144 kg/m3.

Consider the Na2SiO3 to NaOH solution ratio by = 2.5.

Mass of NaOH solution = 144/ (1+2.5) = 41 kg/m3.

The mass of Na2SiO3 solution = 144 – 41 =103 kg/m3.

To manufacture the geo-polymer concrete mixture, the various compositions listed as follows that is

Na2O = 14.7%,, SiO2 = 29.4%, Water = 55.9%

The variation of purity of NaOH = 97-98% Concentration = 8 Molar.

This solution constitute 26.2% of NaOH solids and 68.6% water, by mass.

Table: Mixture Proportions of Geo- polymer Concrete

Materials		Mass (kg/m^3)
Coarse aggregates in mm:	20	272
	14	368
	7	642
Fine aggregate (Sand)		550
Fly-ash		410
Sodium silicate solution($SiO_2/Na^2O=2$)		106
Sodium hydroxide solution		43 (8 Molar)

Mix Design of M35 Grade Conventional Concrete (Ncc):

Characteristic compressive strength (f_{ck})	=	36 N/mm^2
Greatest size of aggregate	=	20mm (angular)
Degree of workability	=	0.85
Quality control	=	Good
Exposure	=	Mild
Grade of Cement	=	OPC53
Specific gravity (cement)	=	3.08
Maximum &min size of the aggregate used	=	20 mm,12.5 mm
Specific gravity (sand)	=	2.54
Specific gravity (coarse aggregate)	=	2.77
Bulk density (coarse aggregate)		
(Before compaction)	=	1530 Kg/m^3
(After Compaction)	=	1670Kg/m^3
Bulk density of fine aggregate		
(Before compaction)	=	1615 Kg/m^3
(After Compaction)	=	1710Kg/m^3
Modulus of Fineness (Coarse Aggregate)	=	6.95
Modulus of Fineness (Fine aggregate)	=	2.65
Approximate amount of entrapped air Volume of concrete	=	2%

Images of Experimentation Work

Shows Sodium-silicate and sodium hydroxide solution

PREPARATION OF CONSTITUENTS

Aggregates and fly ash are mixed for three minutes

- Add sodium silicate, sodium hydroxide and water to the above material (solids) and mix for four minutes.
- After this process is completed it may appear dark in color, shiny and cohesive.
- The above mixture should be maintained for up to 2 hours without any signs of settling
- Fresh concrete is cast into cubes and compacted by normal methods.
- The above casting cubes are cured under atmospheric conditions, heat curing is generally preferred
- Heat curing helps in the chemical reaction, which can produce a geo-polymer paste.

5. RESULTS & DISCUSSION

This Chapter presents the laboratory results and discusses them. The information are presented in tables and figures.

Table: 5.1 Residual compressive strength on acid sunk

S.No	Concrete	Compressive strength 28days (earlieracid immersion) (N/mm^2)	After 7 days Compressive Strength (N/mm^2)			After 14 days Compressive Strength (N/mm^2)			After 28 days Compressive Strength (N/mm^2)		
			Nature of Curing : Acid Immersion								
			Type of Acid			Type of Acid			Type of Acid		
			HCL	H_2SO_4	$MgSO_4$	HCL	H_2SO_4	$MgSO_4$	HCL	H_2SO_4	$MgSO_4$
1	Conventional Concrete (M30)	49.75	44.4	34.5	44.9	42.15	29.5	43.7	41.86	22	42.5
2	Geopolymer Concrete	33.2	29.84	27.56	28	28	26.12	27.68	27.62	23.5	26.7

Table: 5.2 The percentage of defeat compressive strength on acid sunk.

S.No	Concrete	After 7 days Compressive Strength (N/mm^2)			After 14 days Compressive Strength (N/mm^2)			After 28 days Compressive Strength (N/mm^2)		
		Nature of Curing : Acid Immersion								
		Type of Acid			Type of Acid			Type of Acid		
		HCL	H_2SO_4	$MgSO_4$	HCL	H_2SO_4	$MgSO_4$	HCL	H_2SO_4	$MgSO_4$
1	Conventional Concrete (M30)	11	29.52	9.21	14.5	42.20	12.15	18.5	58.1	15.85
2	Geopolymer Concrete	8	15.5	9.5	11	20.2	14.2	15.10	26.8	18.2

Table: 5.3 Conventional concrete

S.No	Acid Type	Weight (Kg) of Concrete cubes before acid sunk (days)			Weight (Kg) of Concrete cubes before acid sunk (days)		
		7	14	28	7	14	28
1	Hcl	8.78	8.80	8.76	8.58	8.53	8.43
2	H_2SO_4	8.79	8.78	8.7	8.30	8.20	8.0
3	$MgSO_4$	8.78	8.79	8.8	8.60	8.60	8.56

Table: 5.4 Geopolymer Concrete

S.No	Acid Type	Weight (Kg) of Concrete cubes before acid sunk (days)			Weight (Kg) of Concrete cubes before acid sunk (days)		
		7	14	28	7	14	28
1	Hcl	7.84	7.85	7.83	7.81	7.79	7.76
2	H_2SO_4	7.95	7.78	7.82	7.87	7.64	7.65
3	$MgSO_4$	7.88	7.9	7.8	7.85	7.86	7.74

Table: 5.5 Conventional concrete

S.No	Acid Type	% Weight defeat of concrete cubes after acid sunk		
		7	14	28
1	Hcl	2.21	3.062	3.763
2	H_2SO_4	5.5	6.6	8
3	$MgSO_4$	2.0	2.16	2.72

Table: 5.6Geopolymer Concrete

S.No	Acid Type	% loss of weight cubes after the acid immersion		
		7	14	28
1	Hcl	0.43	0.72	0.91
2	H_2SO_4	1.0	1.7	2.2
3	$MgSO_4$	0.3	0.5	0.7

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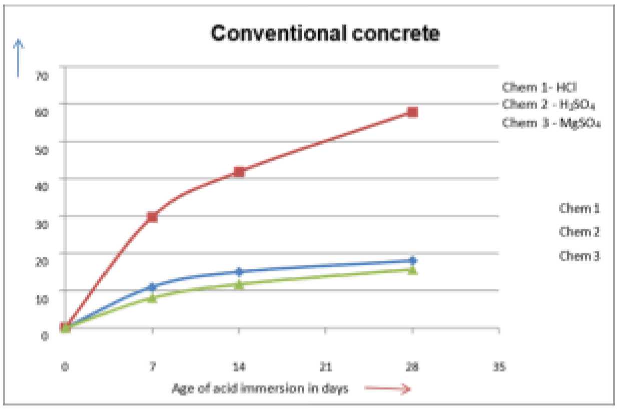
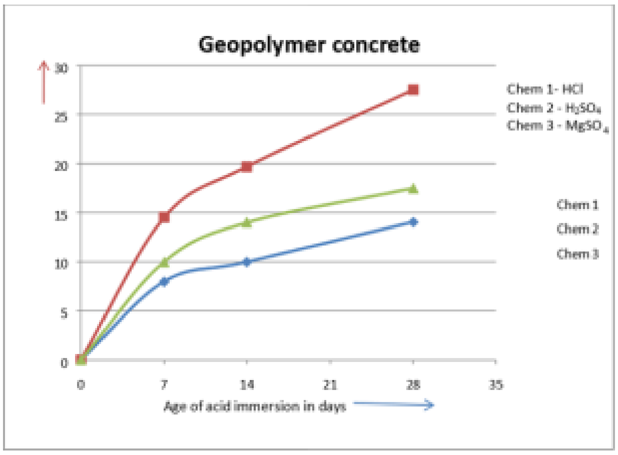
Graph.1



Graph.2



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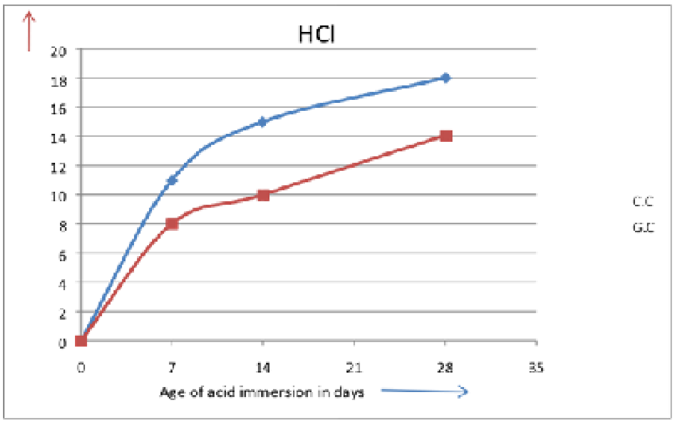

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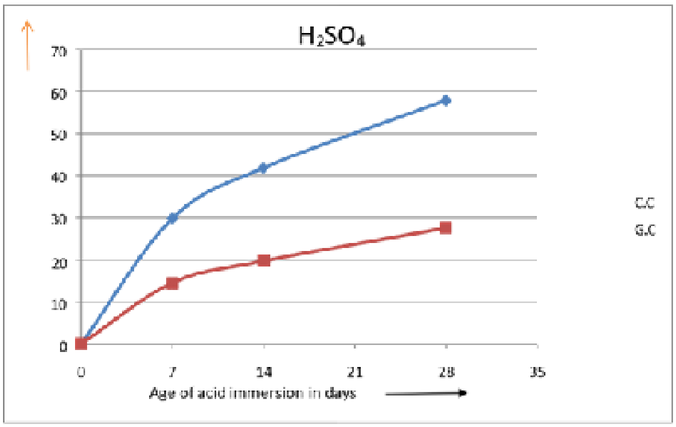

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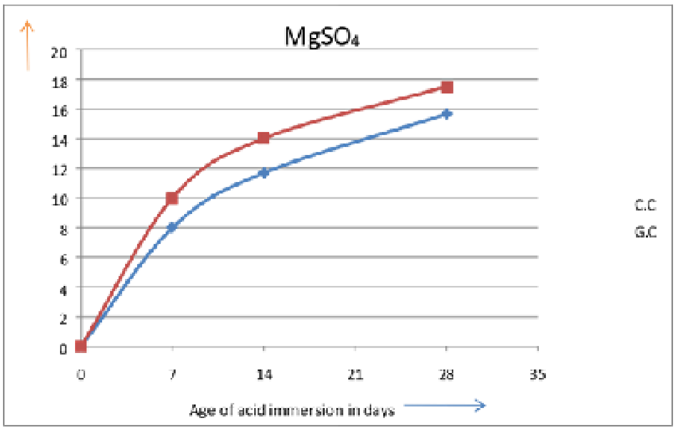

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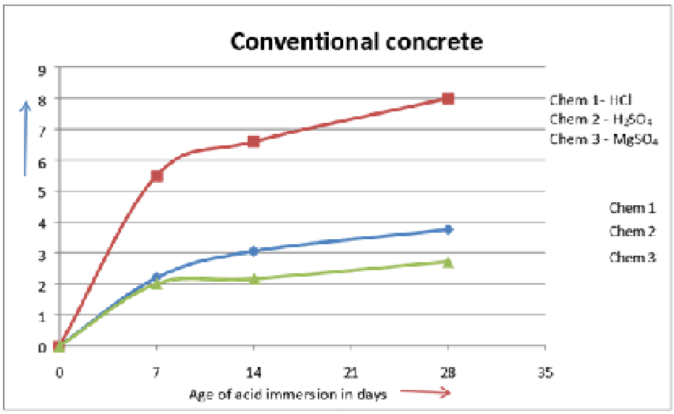
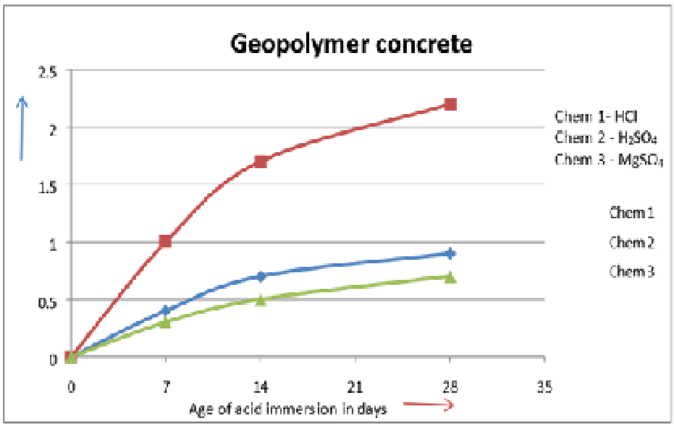


Graph.7



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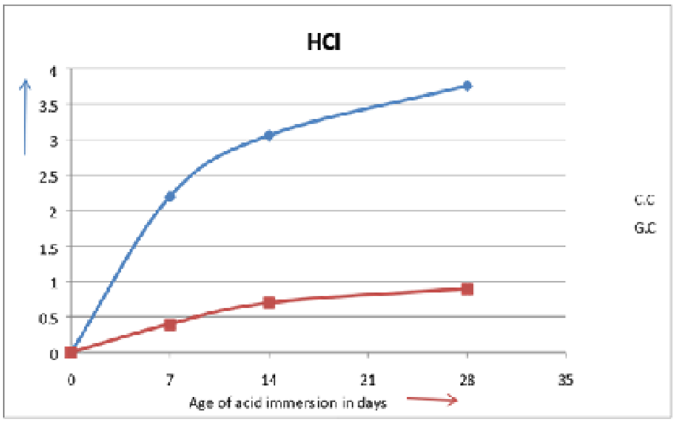

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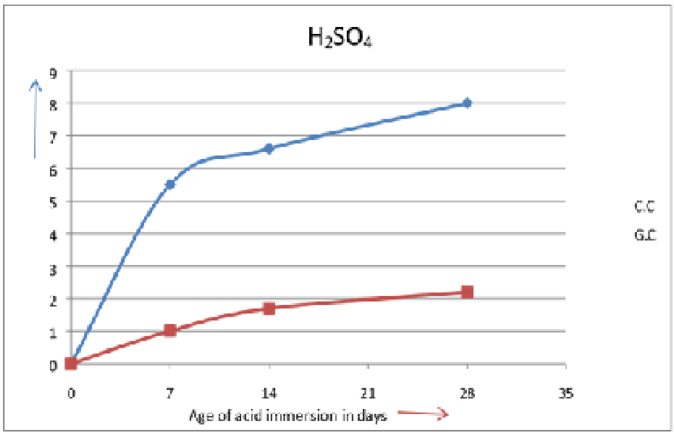
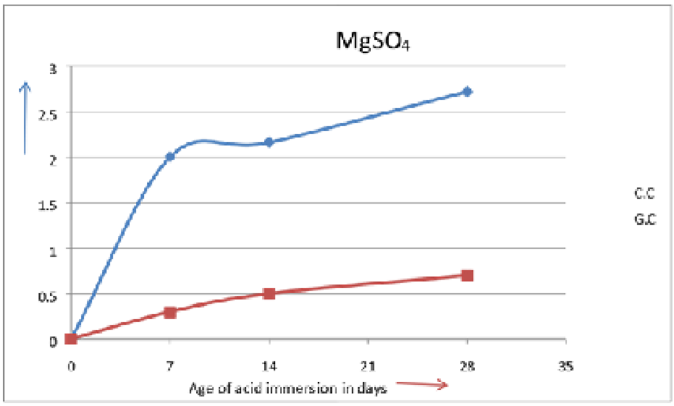


Graph.10



6.CONCLUSION

This chapter summarizes the thesis, findings, strengths, and shortcomings.

The current paper literature only provides focused information and typical procedures to the manufacture of low-calcium fly ash-based geopolymer concrete. Several research have investigated the benefits of employing metakaolin or calcined kaolin as a raw material for geopolymer gel. Furthermore, the true information about combination compositions and geopolymer preparation processes are concealed in patented and commercially oriented research materials.

- Based on the available information about geo-polymers, a trial-and-error method should be implemented to develop the preparation of fly ash-based geo-polymer concrete. To avoid the number of variables in this trial-and-error method, the thesis is limited to low calcium fly ash.
- Geo-polymer concrete mixtures resist acid attack in a better manner compared to conventional concrete when exposed to HCl, H2SO4 and MgSO4 for 7, 14, 28 days.
- It was observed that the % loss of compressive strength of all geo-polymer concrete mixtures was significantly less than that of conventional concrete mixtures.
- A greater loss of compressive strength and weight was also observed in the case of immersion in H2SO4 acid compared to HCl and MgSO4 acids.
- The loss of compressive strength of conventional concrete is almost twice as much as the loss of compressive strength of geo-polymer concrete when immersed in H2SO4 acid.
- The percentage of weight loss of conventional concrete is higher when compared to geo-polymer concrete.
- It is observed that the loss of compressive strength of geo-polymer concrete is higher when compared to conventional concrete when immersed in MgSO4 acid.
- The weight loss of geo-polymer concrete is very less compared to conventional concrete mixtures which are exposed to 5% acid attack..

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