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Effect of variation of fly ash on the compressive strength of flyash based Geopolymer Concrete

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ABSTRACT: *The production of Ordinary Portland Cement (OPC) causes havoc to the environment due to the emission of CO_2 as well as mining which results in unrecoverable loss to nature. Geopolymer concrete , a cementless concrete is an innovative construction material in which binding properties are developed by the interaction of alkaline solutions with a source material that is rich in silica and alumina . Fly Ash, a by- product of coal obtained from the thermal power plant is rich in silica and alumina which on reacting with alkaline solution produces aluminosilicate gel that acts as the binding material for the concrete. It can be accepted as an excellent alternative construction material to plain cement concrete without using any amount of ordinary portland cement. Geopolymer concrete promises to be an eco friendly substitute for ordinary portland cement concrete in some applications. This paper briefly pust forward the experimental results of variation of fly ash content on compressive strength of geoploymer concrete.*
Keywords – *Geopolymer concrete, fly ash, aluminosilicate, compressive strength.*

I. INTRODUCTION

Concrete is the second most widely used structural material after water globally owing to its better structural properties, to meet this demand the cement industry is manufacturing cement on a gigantic scale since it is the main constituent of concrete. The massive global production of cement is estimated at over 2.8 billion tones according to recent industry data [1] resulting into massive emission of carbon dioxide emission estimated to be nearly 5 to 7% of the total production of carbon dioxide[2]. Literature investigation reveals that production of one ton Portland cement releases one ton of carbon dioxide gas into the atmosphere[3]. For sustainable development, the concrete industry needs to switch over from Portland cement to a greener alternative binder. The concept of such an alternative was forwarded by a French scientist Joseph Davidovits who proposed that an alkaline liquid as an activator could be used to react with a source material rich in silicon and aluminium, such as by products like fly ash or rice husk ash, to produce binders. Since the chemical reaction between the two is polymerisation he coined the term “Geopolymer” to refer to these binders. Till date concrete with 100% fly ash has been limited to use on low strength applications. The use of 100% fly ash concrete requires knowledge on the basis of which concrete can develop soundly under site conditions , such as ambient curing temperatures. This paper puts forward an attempt to study the effect of variation of fly ash content in geoploymer concrete’s compressive strength property.

II. EXPERIMENTAL PROGRAMME

This paper is based on the experiments conducted on the formulation of fly ash based geopolymer concrete which conforms to the mix design of G40 geopolymer concrete [4]. The mix proportions specified in the reference paper [4]were used to make a control specimen and then later the proportion of fly ash was varied accordingly as per the requirement of the subsequent experiments. The results of the strength obtained from the testing of controlled specimen and the specimens with varied fly ash content were then compared to ascertain the effect of variation in the fly ash content of geopolymer concrete.

- The source material used was class F fly ash which was procured from Ultratech RMC plant.
- Fine aggregate was also procured from the same source.
- The coarse aggregate was procured from a locally available crusher, it comprised of 20mm downgraded and 10 mm downgraded aggregate. The aggregate was washed , dried and prior to use it was lightly sprinkled with water to obtain the aggregate in SSD condition.
- The alkaline liquid comprised of sodium hydroxide and sodium silicate solution. The materials were procured from Grace Scientific, Ambala. Sodium hydroxide was procured in pellet form and since the mixing of distilled water and sodium hydroxide is an exothermic reaction the solution was prepared with distilled water one day in advance prior to the casting, in order to allow the solution to cool down.

Molarity of sodium silicate solution was kept as 12M. Sodium silicate solution was procured in solution form and distilled water was added to it a few hours before the casting.

- A superplasticizer (Galenium), in the quantity of 2% of mass of fly ash was used to increase the workability.
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Table 1 Mix proportions of various mixes (Quantity given in Kg is used for making 12 cubes)

Material		Fly Ash	Course Aggregate (20mm downgraded)	Course Aggregate (10mm downgraded)	Fine Aggregate	NaOH (12M)	Na_2SiO_3	DISTILLED WATER
Mix 1	Kg/m^3	394.27	600.6	600.6	646.8	14.61	37.42	105.42
	Kg	15.93	24.27	24.27	26.13	0.590	1.51	4.26
Mix 2	Kg/m^3	413.82	600.6	600.6	646.8	12.79	32.96	92.26
	Kg	16.72	24.27	24.27	26.13	0.517	1.33	3.73
Mix 3	Kg/m^3	394.27	600.6	600.6	646.8	16.43	43	118.61
	Kg	15.13	24.27	24.27	26.13	0.664	1.74	4.79

Preliminary tests were performed on the aggregates to ascertain any changes in the properties of resulting geopolymer concrete due to variation in the properties of aggregates from those mentioned in the reference paper.

Table 2 Properties of aggregates

Types of Aggregate	Bulk Density (Kg/lit)	Specific Gravity	Water Absorption (percentage)	Fineness Modulus
Coarse aggregate (20mm downgraded)	1.48	3.07	1.31	2.790
Coarse aggregate (10mm downgraded)	1.49	2.64	2.378	7.79
Fine aggregate	1.73	1.95	16.27	2.69

III. RESULTS AND DISCUSSION

Based on the experimental investigations carried out for G40 grade of geopolymer concrete following results for compressive strength have been obtained

Table 3 Compressive strength of mix on respective testing dates (MPa)

	Description	Age			
		3 days	7 days	28 days	Type of curing
Mix 1	Reference mix of G40	5.6	22.8	32.8	Ambient
Mix 2	Mix with 5% increase in fly ash	4.8	18.9	28.4	Ambient
Mix 3	Mix with 5% decrease in fly ash	5.8	24.0	35.4	Ambient

Results shown in table 3 point out the following observations :

(i) Compressive strength obtained after 3 days of ambient curing have not shown expected results.
(ii) 7 days compressive strength has been satisfactorily increased in Mix1 and Mix 3 but slightly less in Mix 2.

(iii) 28 days strength was slightly lesser than expectations.
(iv) The compressive strength results were unsatisfactory and in contradiction with the value of compressive strength mentioned in the reference paper. This contrast in the results can be attributed to the differences in mixing and compacting of the concrete. The reference paper has used a pan mixer and this paper is based on experiments conducted in a drum mixer. Also the reference paper does not mention about poor workability which in this case has hampered the compaction of concrete in the moulds.
(v) On investigation it was found out that similar results of low strength have been observed by another researcher who has also faced the same problems with the workability of geopolymer concrete and has suggested some troubleshooting solutions to avoid flash setting of mix in the mixer [5].

Fig1. Cubes packed in thick plastic wraps for ambient curing.

IV. CONCLUSION

1. Geopolymer concrete is a slump less concrete and these results in its poor workability. Because of workability issues it becomes difficult to compact the concrete and hence complete strength cannot be achieved. Increasing the water content consequently decreases the strength. The use of superplasticizer is essential to increase workability of mix.
2. Adopting a proper sequence for mixing the ingredients helps to increase the workability to some extent.
3. The use of a pan mixture is essential for mixing geopolymer concrete. In case of a drum mixer even mixing is not ensured and this results in lump formation of fly ash, consequently affecting the strength.
4. Ambient cured GPC needs more investigation to sort out the solution for decrease in compressive strength.

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REFERENCES

[1] Cembureau "Cement in Cembureau Countries Statistics 2005- 2007" available at http://www.cembureau.be/Documents/KeyFacts/STATISTICS/Cement%20in%20CEMB%20countries.pdf
[2] Mehta, P. K. 2001 "Reducing the Environmental Impact of Concrete", ACI Concrete TechInternational 23(10):pp. 61-66
[3]. Davidovits, J., Geopolymer Chemistry and Properties. Proceedings of Geopolymer '88, First European Conference on Soft Mineralogy, The Geopolymer Institute, Compiegne, France, 1988,pp. 25-48
[4]. Ramujee,Potharaju " Development of Mix Design For Low Calcium Based Geopolymer Concrete In Low, Medium and Higher Grades – Indian Scenario" Journal of Civil Engineering and Technology(JCIET), Vol 1 Issue 1, July December(2013) pp. 15-25
[5] Lloyd, Darryl Hole; " The mix design development of geopolymer concrete under ambient curing condition" , 2009.