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Strength Properties of Concrete (Geo-polymers)

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A B S T R A C T

Geo-polymer concrete is an innovative construction material which shall be produced by the chemical action of inorganic molecules. Fly ash, a by-product of coal obtained from the thermal power plant is plenty available worldwide. Fly ash is rich in silica and alumina reacted with alkaline solution produced alumina silicate gel that acted as the binding material for the concrete. It is an excellent alternative construction material to the existing plain cement concrete. Geo-polymer concrete shall be produced without using any amount of Ordinary Portland Cement. This work briefly reviews the constituents of geo-polymer concrete, its strength and potential applications.

Keywords: Compressive strength, geo-polymers, concrete.

1. Introduction

On the other hand, the abundant availability of fly ash worldwide creates opportunity to utilize this by-product of burning coal, as a substitute for OPC to manufacture concrete. When used as a partial replacement of OPC, in the presence of water and in ambient temperature, fly ash reacts with the calcium hydroxide during the hydration process of OPC to form the calcium silicate hydrate (C-S-H) gel. The development and application of high volume fly ash concrete, which enabled the replacement of OPC up to mass is a significant development.

The various objectives expected from this work are as follows

- Understand what a geopolymer is through publically & privately accessible literature. The history of geopolymers, where they were first used, who pioneered their use in concrete, their significance & the comparative advantage of geopolymer concretes to ordinary concrete.
- To investigate chemical Resistance properties of Ordinary Portland cement & Geopolymer concrete. Cast 20 Ordinary Portland cement, 20 Geopolymer concrete samples. Each type of concrete will be tested at 7, 14 & 28 days compressive strength of 3 to 4 samples will, be tested.
- To compare the compressive strength & ordinary Portland cement concrete after exposure to the carbonation process.

2. Discussion

2.1. Test of compressive strength of concrete cubes

The concrete cubes of size 150 x 150 x 150mm 12 numbers for each proportions are prepared as per BIS 10262- 2009 procedure and tested in

compressive testing machine. The quantities of materials estimated for one meter cube are tabulated in table of the results of compressive strength test after 3, 7, 21 and 28 days curing. Adding of geopolymer in dryconcrete is shown in photo.3 and testing of cubes

2.2. Environment Impact of Cement Production

Cement is produced in 156 countries across the Globe. During 2008, the global production capacity of cement stood at around 2872 million tones with China accounting for approximately 1400 million tones and India a distant second with total production of 183 million tones. The production of Cement is highly skewed with top ten countries together accounting for close to 70% of total cement production. These countries account for close to 70% of total population. High concentration of cement production may be attributable tohigh capital costs and long gestation periods in cement industry. As predicted by Scientists, the worldwide requirement of cement, in the recent years, would be around 2.2 billion tones. Also, production of one tone of cement leads to the emission of 0.8 tone of CO2, the prime green house gas which mostly contributes to global warming. This underlines the need for newtechnologies to overcome the environmental issue. In this scenario, the geopolymer Technology has emerged as the viable alternative to ordinary Portland cement, which was vented by Davdovits. On the other hand, the fly ash, the byproduct from coal based thermal power stations, also poses disposable problems requiring large area for its dumping which ultimately leads to environmental hazards. In spite of various technologies developed for fly ash use in concrete, the utilization rate of fly ash in them is still quite low. This increased usage of fly ash would help to reduce disposable problems and total elimination of cement in concrete and would contribute in a minor way, cleaner environment. Davidovits invented that Geopolymers were members of the family of inorganic polymers similar to natural Zeolitic materials, when produced with low Si: Al ratio 2 would be suitable for construction industries.

As in the Portland cement concrete, the aggregates occupy the largest volume, i.e. about 75- 80% by mass, in geopolymer concrete. The silicon and the aluminum in the fly ash are activated by a combination of sodium hydroxide and sodium silicate solutions to form the geopolymer paste that binds the aggregates and other un-reacted materials.

2.3. Fly Ash Based Geopolymer Replacement

It is found by the study that it is possible touse fly ash with total replacement of cement in concrete without compromising on density and strength of concrete. This study opens up a major avenue for utilization of fly ash. The use of fly ash based geopolymer is totally replacement of ordinary Portland cement in concrete gives higher compressive strengththan standard concrete.

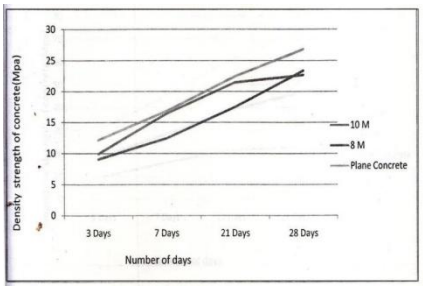

Figure : - Comparison of Compressive Strength Between8M, 10M & Plane Concrete

3. Result

The compressive strength of ordinary Portland cement concrete is less as compare with fly ash based geopolymer concrete. It is increases with increase molarities inan alkaline solution

Table1 : - Compressive Strength of Concrete (Mix-I)

	Specimen	Compressive Strength (MPa)	Average Compressive Strength (MPa)
3 Days	Sample 1	11.11	9.92
	Sample 2	9.33	
	Sample 3	9.33	
7 Days	Sample 1	15.55	16.14
	Sample 2	15.11	
	Sample 3	17.77	
21 Days	Sample 1	20.44	21.48
	Sample 2	22.22	
	Sample 3	21.77	
28 Days	Sample 1	22.67	22.67
	Sample 2	2311	
	Sample 3	22.22	

Table 2: - Compressive Strength of Concrete (Mix-II)

	Specimen	Compressive Strength (MPa)	Average Compressive Strength (MPa)
3 Days	Sample 1	8.23	9.05
	Sample 2	9.23	
	Sample 3	9.68	
7 Days	Sample 1	12.33	12.42
	Sample 2	12.60	
	Sample 3	12.33	
21 Days	Sample 1	17.20	17.50
	Sample 2	17.21	
	Sample 3	18.10	
28 Days	Sample 1	22.80	23.38
	Sample 2	23.67	
	Sample 3	23.67	

Table 3: -Compressive Strength of Concrete for Mix-III(10M)

	Specimen	Compressive Strength (MPa)	Average Compressive Strength (MPa)
3 Days	Sample 1	12.00	12.14
	Sample 2	12.21	
	Sample 3	12.20	
7 Days	Sample 1	16.32	16.85
	Sample 2	17.00	
	Sample 3	17.22	
21 Days	Sample 1	22.42	22.47
	Sample 2	22.42	
	Sample 3	22.56	
28 Days	Sample 1	26.68	26.82
	Sample 2	25.89	
	Sample 3	27.89	

4. Conclusion

Geopolymer concrete has excellent properties within bothacid and salt environments comparing to Portland cement,the production of geopolymer have a relative higher strength, excellent vol. stability, better durability.The increase in percentage of fine aggregates and coarse aggregates increase the compressive strength upto optimum level. This may be due to high bonding between the aggregates and alkaline solution.As the curing temperature in the range of 60º to 90ºC increases, the compressive strength of fly ash based geopolymer concrete also increases With proper design and construction process, Geopolymerconcrete can be used in reinforced concrete beams and columnsAs the cost of geopolymer concrete is less as compare to “OPC”, we can use G.C for road embankment construction, college’s path way, etcUsing geopolymer concrete we can produce more durable infrastructure capable of design As the cost of geopolymer concrete is less as compare to “OPC”, we can use G.C for road embankment construction, college’s path way, etc life measure in hundredof years.It can also protect aquifers and surface bodies of fresh water via the elimination of fly ash from disposal site.

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