EXPERIMENTAL INVESTIGATION OF FLY ASH BASED GEOPOLYMER CONCRETE

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Abstract:- The basic purpose of any research is to obtain environmental friendly product. As we know that concrete is the world's most versatile, durable and reliable construction material in Civil Engineering. After water concrete is most consumed material which required huge amount of Portland cement. Ordinary Portland cement is major generator of carbon dioxide, which is harmful to atmosphere and it contributes 5 to 7 % of total green house gas emission. It also consume large amount of energy. Hence it is essential to find alternative to cement.

Hence we came up with the new technology in concrete, which we called Geo-polymer concrete. Geo-polymer concrete that is zero cement concrete has potential to reduce carbon emission and lead to sustainable development and growth of concrete industry. The main objective of this project is to study important structural properties of concrete like Compressive strength and flexural strength of hardened concrete to determine the tensile and compressive strength of concrete.

This project will provide a momentum to the running wheels of the construction industry and will minimize the effects of global warming to save the environment. Our project will discuss in detail the manufacturing processes of Geo-polymer concrete and also its successful application.

Keywords — Carbon Emission; Polymers ; Durability; High Strength ; Eco-friendly ;Global warming.

Introduction

After wood, concrete is the most often used material by the society. Concrete is conventionally produced by using the ordinary Portland cement (OPC) as the primary binder. The environmental issues associated with the production of OPC are well known. The amount of the carbon dioxide released during the manufacture of OPC due to the calcinations of limestone and combustion of fossil fuel is in the order of one ton for every ton of OPC produced. In addition, the amount of energy required to produce OPC is only next to steel and aluminum.

Fly Ash-Based Geopolymer Concrete

In this work, fly ash-based geopolymer is used as the binder, instead of Portland or any other hydraulic cement paste, to produce concrete. The fly ash-based geopolymer paste binds the loose coarse aggregates, fine aggregates and other un-reacted materials together to form the geopolymer concrete, without admixtures. The manufacture of geopolymer concrete is carried out using the usual concrete technology methods.

As in the OPC concrete, the aggregates occupy the largest volume, i.e. about 75-80 % by mass, in geopolymer concrete. The silicon and the aluminum in the low calcium (ASTM Class F) 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.

Objective

1. To develop a mixture proportioning process of making fly ash-based geopolymer concrete.

2. To identify and study the effect of salient parameters that affects the properties of fly ash-based geopolymer concrete.

3. To study the short-term engineering properties of fresh and hardened fly ash- based geopolymer concrete (compressive, indirect tensile strengths and the workability of fresh concrete).

Preliminary Laboratory Work

In the beginning, numerous trial mixtures of geopolymer concrete were manufactured, and test specimens in the form of 150x150x150 mm cubes were made. Initially, the mixing was done in a mixer. However, this was considered to be not practical in large applications. Therefore, the mixing changed to an eighty litre capacity pan mixer with rotating drum available in the concrete laboratory for making OPC concrete.

Casting Procedure

1. Firstly the mould of 150*150*150 mm mould of given dimension was used.
2. All materials and tools were collected at a place.
3. Fine and course aggregates were sieved according to the size requirement.
4. Weigh batching method was adopted in laboratory for experiment.
5. Pellets of NaOH were dissolved in water to make 16 molar solution i.e.(640 gm NaOH was dissolved in 1000 ml of water).

Mixing

It was found that the fresh fly ash-based geopolymer concrete was dark in colour (due to the dark colour of the fly ash), and was cohesive. The amount of water in the mixture played an important role on the behaviour of fresh concrete. When the mixing time was long, mixtures with high water content bled and segregation of aggregates and the paste occurred. This phenomenon was usually followed by low compressive strength result of hardened concrete.

1. Firstly, a layer of course aggregate was placed in pan mixer. Above which a layer of fine aggregate and flyash was placed. Again a layer of fine and course aggregate were placed.

2. Later, Dry mixing of aggregate was carried out for a period of 3 minutes.
3. Then $NaOH + Na_2SiO_3 + H_2O$ was added together in the specified quantity.
4. Thus the wet mixing of mixture was carried out for 3 minutes.
5. After mixing, concrete was placed in mould into three layer and by tamping each layer 35 times, carried by compaction using table vibrator.

Placing & Compaction

1. Clean the mould and apply oil.
2. After mixing, concrete was placed in mould into three layer and by tamping each layer 35 times by tamping rod (steel bar 16mm diameter and 60 cm long, bullet pointed at lower end).
3. Level the top surface and smoothen it with a trowel.

Curing Procedure

Preliminary tests also revealed that fly ash-based geopolymer concrete did not set immediately at room temperature. When the room temperature was less than 30^{o} C, the setting did not occur at least for 24 hours. Also, the handling time is a more appropriate parameter (rather than setting time used in the case of OPC concrete) for fly ash-based geopolymer concrete.

For the development of Geopolymer concrete, temperature and duration of heating plays an important role in the activation process of polymerization. The cubes were demoulded after 24 hours of casting and then place in an steam curing chamber for heating at 60 °C for a period of 24 hours. After heating, oven was switched off and cubes were allowed to cool down to room temperature.

Testing

Specimens stored in chamber shall be tested immediately on removal. Surface water and grit shall be wiped off the specimens and any projecting removed. The dimensions of the specimen to the nearest 0.2mm and there weight shall be noted before testing.

Placed the specimen in the testing machine the bearing surface of the testing machine shall be wiped clean and any loose sand or other material removed from the surface of the specimen, which are to be in contact with the compression platens. Accordingly, we tested 9 Cubes at suitable intervals of 7days, 28 days and 56

Results & Discussion

We had tested the Geopolymer concrete cubes with different proportion for Compressive strength as prescribed in previous chapter. We tested 9 cubes for each trail at 7days ,28days and 56 days as stated earlier. And the mean result of three cubes is considered as final result.

Test Results for Conventional M35 Grade Concrete

Table V

TRAIL MIX	DAYS	WEIGHT KGs	LOAD KN	STRENGTH MPa
M35 - 1	7 Days	8.67	7.19	31.98
		8.58	7.31	32.5
		9.55	6.80	30.25
	28 Days	8.57	10.24	45.55
		8.99	10.40	46.22
		8.45	9.95	44.25
	56 Days	8.76	11.18	49.7
		8.78	10.92	48.55
		8.72	11.17	49.65

Test Results for Geopolymer Concrete (Trial 1)

Table VI

TRAIL MIX 1	DAYS	WEIGHT KGs	LOAD KN	STRENGTH MPa
G35 -1	7 Days	9.00	6.87	30.55
		8.80	6.58	29.24
		8.88	6.77	30.10
	28 Days	8.76	7.97	35.44
		8.78	7.80	34.69
		8.72	8.10	36.09
	56 Days	9.22	9.54	42.40
		9.08	9.099	40.44
		9.15	9.94	44.21

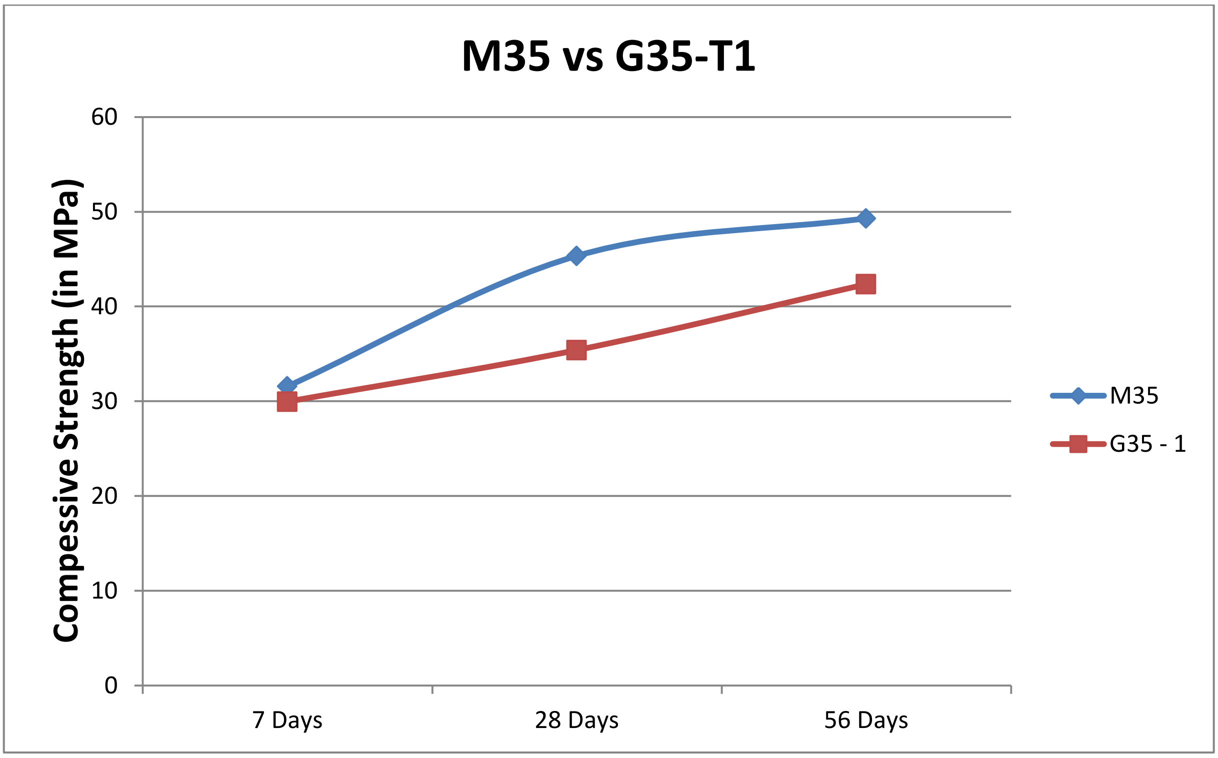


Fig.6.1 Graph of M35 vs G35 T1

Test Results for Geopolymer Concrete (Trial 2)

Table VII

TRAIL MIX 2	DAYS	WEIGHT KGs	LOAD KN	STRENGTH MPa
G35 -2	7 Days	9.00	5.29	23.55
		8.80	5.120	22.75
		8.88	5.45	24.22
	28 Days	8.76	6.85	30.44
		8.78	7.10	31.56
		8.72	6.73	29.9
	56 Days	9.22	10.90	48.44
		9.08	11.15	49.56
		9.15	10.85	48.22

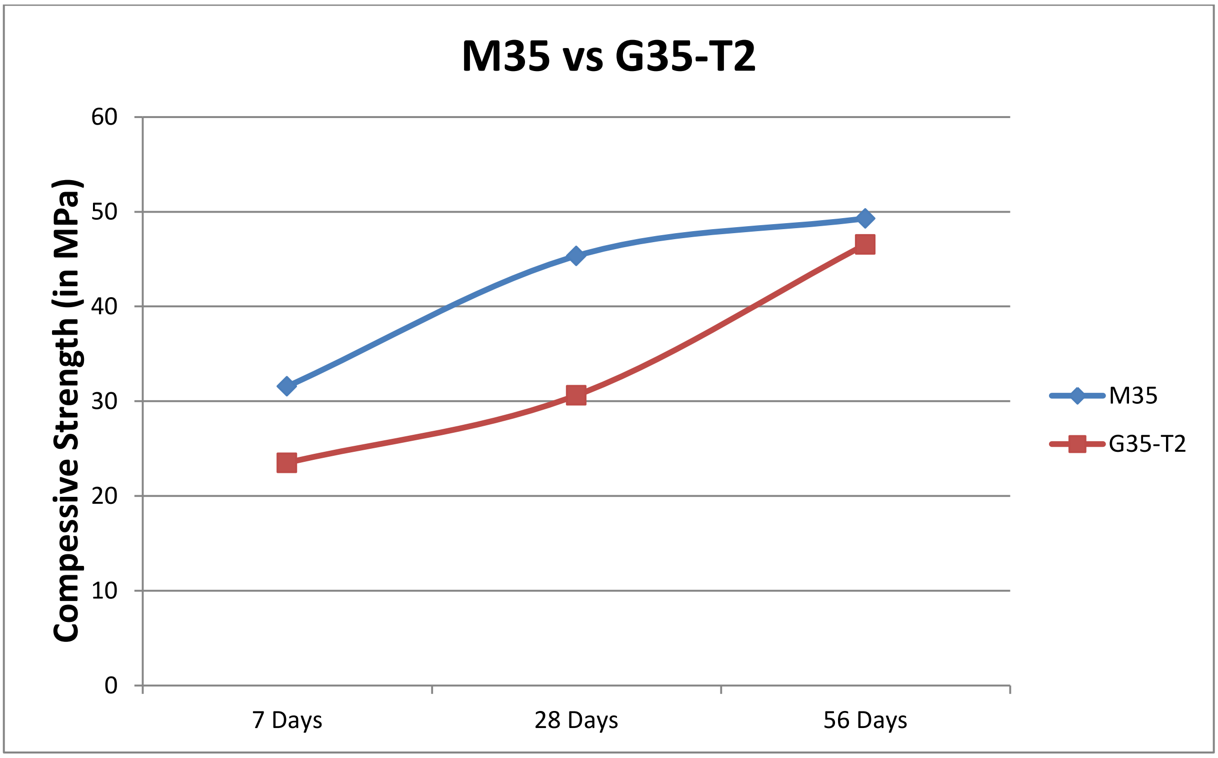


Fig.6.1 Graph of M35 vs G35 T1

Test Results for Geopolymer Concrete (Trial 3/ Final Design)

Table VIII

TRAIL MIX 3	DAYS	WEIGHT KGs	LOAD KN	STRENGTH MPa
G35 -3 Final Mix Design Approved	7 Days	9.00	7.54	33.55
		8.80	7.77	34.56
		8.88	7.10	31.56
	28 Days	8.76	10.20	45.34
		8.78	10.27	45.66
		8.72	10.49	46.63
	56 Days	9.22	11.40	50.7
		9.08	11.62	51.66
		9.15	11.47	50.99

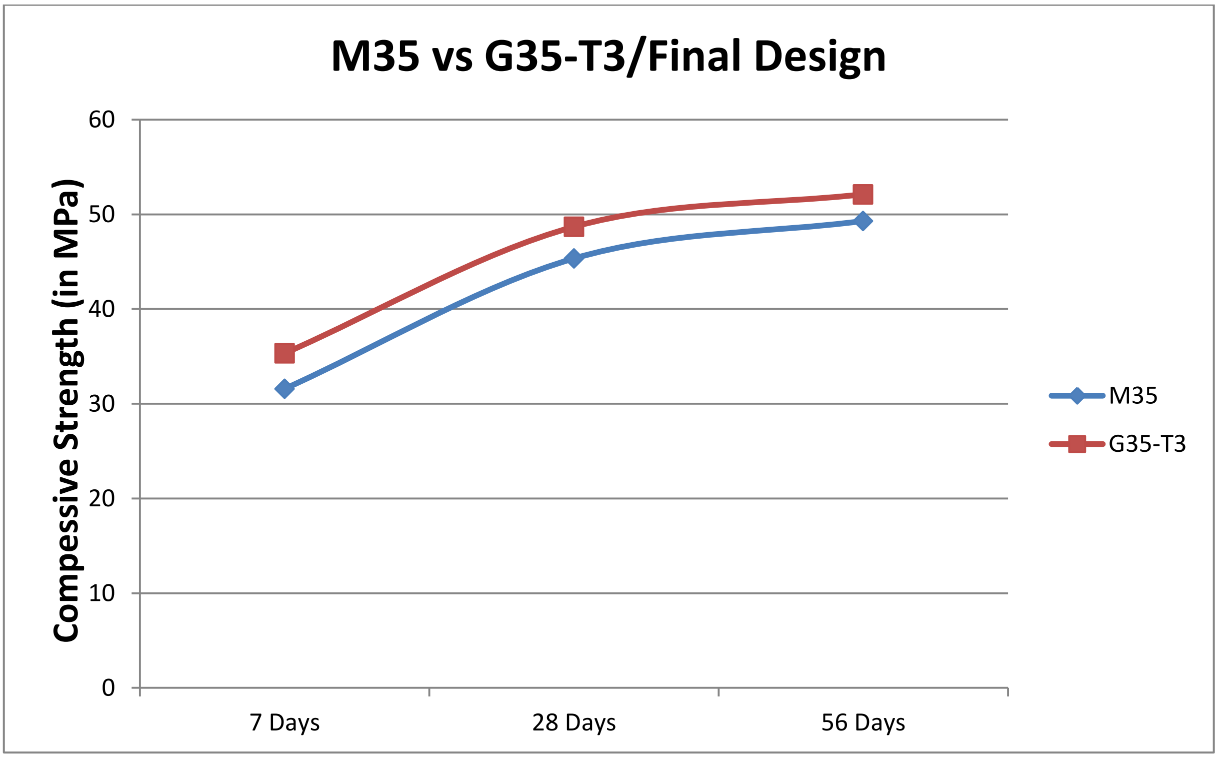
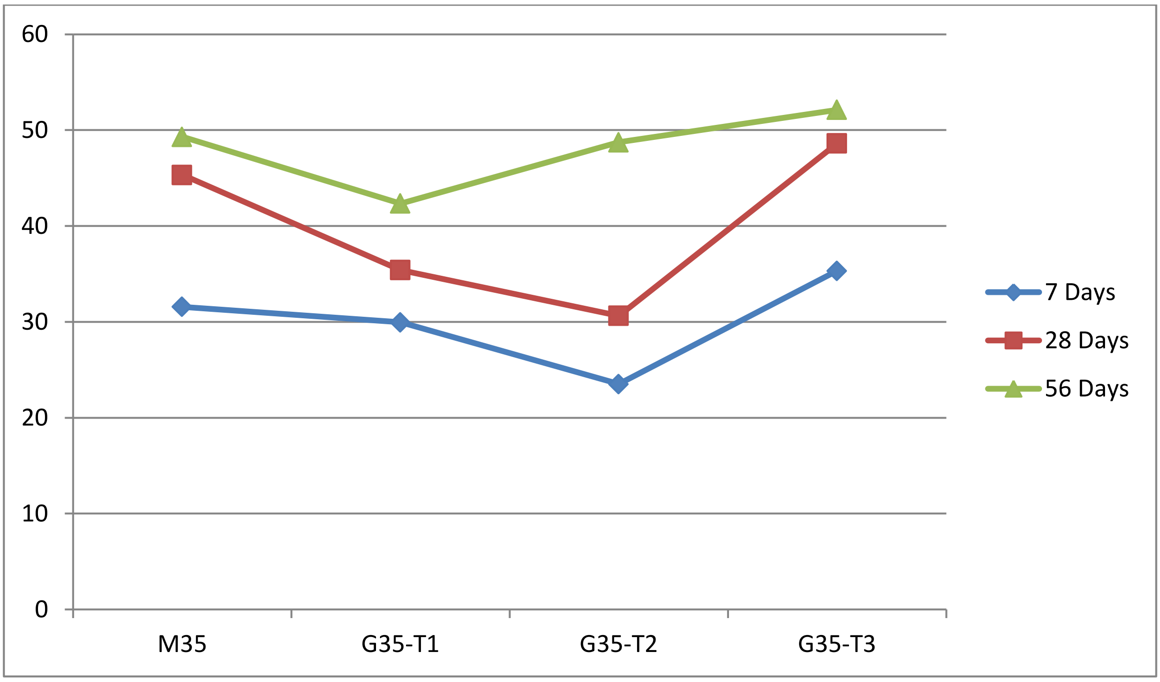


Fig.6.1 Graph of M35 vs G35T1

Average Test Result

Table IX Final Test Results

Material	M35	G35 – T1		G35 – T2		G35 – T3	
Days	Strength	Wt. Kg	Strength MPa	Wt. Kg	Strength MPa	Wt. Kg	Strength MPa
7 Days	31.58	8.89	29.96	8.98	23.51	8.84	35.33
28 Days	45.34	8.75	35.40	8.8	30.63	8.91	48.62
56 Days	49.3	9.15	42.35	9.12	48.74	9.07	52.12



Conclusions

From the above results it is observed that the result of G35-T3 are found nearly equal to M35, the 56 Days test results of G35-T3 is slightly increases when compared to M35. Whereas the 56 days test results of G35-T2 shows the maximum increment that is the compressive strength was found to be increased compared with G35-T1.

Hence from this test result we can conclude that the G35-T3 was found to be optimum mis design for fly ash based geopolymer concrete. Further increase or decrease in percentage or molarity of alkali activator results in less compressive strength. Therefore its found that 16 M & G35 –T3 is suitable to used in concrete to achieve the increase in compressive strength above the desirable compressive strength.

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