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Effect of Temperature on Strength Properties of Fly ash and GGBS Blended Geopolymer Concrete using Quarry Dust

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Abstract - *The major problem that the earth facing today is the environmental pollution. Within the housing industry mainly the assembly of Portland cement will causes the emission of pollutants ends up in environmental pollution. Globally, the assembly of cement contributes a minimum of 5 to 7% of CO_2. We can reduce the pollution effect on environment, by increasing the usage of commercial products in our housing industry. This work carried on studies of temperature effect on strength of geopolymer concrete using quarry dust as fine aggregate. Geo-polymer concrete is manufactured class F fly ash and ground granulated blast furnace slag (GGBS) in 75% : 25% proportion. Sodium silicate solution and sodium hydroxide solution used as alkaline activator. Cubes of size 150mmX150mmX150mm were made at solution to ash ratio of 0.35. All specimens were cured in oven at 50^{0}C, 60^{0}C, 70^{0}C, 80^{0}C & 90^{0}C for different molarity 5M, 7M, 9M for a period of 20 hours. After oven curing, cubes moved to temperature for curing period. The slump cone test was carried to review the workability of concrete. After curing period of 7 days and 28 days UPV test and compressive test were performed. Concluded that different molarity GPC attains maximum strength at different temperature conditions. Test results show that the 5M, 7M and 9M GPC has optimum temperature of 70^{0}C.*

Key Words: Fly ash, Alkaline activators

1.INTRODUCTION

Geopolymer concrete is associate unindustrialized material goes to be a revolution at intervals the analysis field and conjointly at intervals the development business. Increase of cement demand winds up within the increase of production of cement. Cement is that the foremost material from the concrete industry throughout the planet. Day by day, the need of cement at intervals the concrete business and at intervals the event field is increasing quite alarmingly. To overcome the greenhouse gas drawback towards atmosphere, Davidovits Joseph in 1978 introduced new kind of concrete named as Geopolymer concrete. Geopolymer cement might even be a binding system that hardens at temperature. Geopolymer concrete is eco-friendly construction material associated an alternate to hydraulic cement. Geopolymer binders are found to be the simplest alternate to cement binders. Use of geopolymer reduces the demand of hydraulic cement that is responsible for high dioxide emission. Geopolymer concretes are cement less concrete that utilize by product materials like ash at intervals the presence of base forming resolution to produce binders.

2.LITERATURE REVIEW

Geopolymer concrete was introduced by Davidovits Joseph in 1978. The cement is primary binding material in the concrete. As the increase in demand of cement, results in increase of production of cement which results emission of carbon dioxide in greater quantity into environment causing global warming. To overcome this issue, Davidovits Joseph from his research introduced geopolymers which are rich in silica and alumina containing cementitious properties. This geopolymers are wastages from chemical, thermal and steel plant industries. This geopolymers are used as primary binding material by replacing cement in concrete. This concrete known as geopolymer concrete. Geopolymer concrete has greater strength, durability, fire resistance and many advantages compare to normal conventional concrete. Generally, strength of geopolymer concrete is higher than normal concrete. Geopolymer concrete was manufactured replacing cement with fly ash, GGBS and other cementitious material.

3.EXPERIMENTAL STUDY

In this study mainly explains about the effect of geopolymer concrete attains smart strength beneath temperature condition. Once cured at warm temperature conditions the strength of geopolymer concrete will increase. Typically, ordinary hydraulic cement is cured by water treatment methodology. Geopolymer concrete exhibits distinctive nature beneath temperature impact. The base-forming resolution act as accelerator in geopolymer concrete once exposure in temperature. Geopolymer concrete attain strength >70 N/mm2 beneath warm temperature conditions. Geopolymer concrete can attain higher strength in one day. Increase in strength, durability, heat resistance once geopolymer concrete cured at warm temperature conditions.

3.1Mix Proportions

In the below tables awarded as different type of mixes as well indifferent proportions of constituent materials. which are shown in Tables below.

Table-1: Constituent materials for 5M Geopolymer concrete

Material	Initial (kg/cum)	Adjusted (kg/cum)	Required Quantity in kgs per cube	Required Quantity in gms per cube
Fly ash	306.7	306.7	1.04278	1042.78
GGBS	102.2	102.2	0.34748	347.48
CA1 20 mm	776.16	773.8	2.63092	2630.92
CA2 10 mm	517.44	515.9	1.75406	1754.06
Sand	554.4	548.9	1.86626	1866.26
SS sol	102.2	102.2	0.34748	347.48
SH sol (reqd)	40.9	40.9	0.13906	139.06
SH pellets	8.18	8.18	0.03272	32.72
Water for SHS	32.72	32.72	0.13088	130.88

Table-2: Constituent materials for 7M Geopolymer concrete

Material	Initial (kg/cum)	Adjusted (kg/cum)	Required Quantity in kgs per cube	Required Quantity in gms per cube
Fly ash	306.7	306.7	1.04278	1042.78
GGBS	102.2	102.2	0.34748	347.48
CA1 20 mm	776.16	773.8	2.63092	2630.92
CA2 10 mm	517.44	515.9	1.75406	1754.06
Sand	554.4	548.9	1.86626	1866.26
SS sol	102.2	102.2	0.34748	347.48
SH sol (reqd)	40.9	40.9	0.13906	139.06
SH pellets	11.452	11.452	0.045808	45.808
Water for SHS	29.448	29.448	0.117792	117.792

Table-3: Constituent materials for 9M Geopolymer concrete

Material	Initial (kg/cum)	Adjusted (kg/cum)	Required Quantity in kgs per cube	Required Quantity in gms per cube
Fly ash	306.7	306.7	1.04278	1042.78
GGBS	102.2	102.2	0.34748	347.48
CA1 20 mm	776.16	773.8	2.63092	2630.92
CA2 10 mm	517.44	515.9	1.75406	1754.06
Sand	554.4	548.9	1.86626	1866.26
SS sol	102.2	102.2	0.34748	347.48
SH sol (reqd)	40.9	40.9	0.13906	139.06
SH pellets	14.724	14.724	0.058896	58.896
Water for SHS	26.176	26.176	0.104704	104.704

3.2 Results and discussion

3.2.1 Slump cone test

The slump cone test performed according to procedure mentioned in IS: 1199-1959 code. This test conducted to determine the workability of concrete. The test carried when the concrete is in fresh state or in other words immediately after mixing of concrete. The test conducted for every molarity and geopolymer concrete at stage freshness before casting the samples. The test results for 5M, 7M, 9M geopolymer concrete was tabulated below and explained about the results.

Table- 4: Slump cone test values

S.No	Molarity of solution	SLUMP(mm)
1	5M	23
2	7M	19
3	9M	11

Fig-1: Slump cone Test

3.2.2 Compressive strength test

The compressive strength test is used to determine the strength of concrete. Generally compressive strength conducted on samples of concrete at 3days, 7days, 14days, 28days, 56days and 90days. In this project, the compressive strength test performed at 7days and 28days. The procedure of compressive strength followed in this project according to IS-516:1959. The compressive strength conducted on 3 samples for each temperature condition cured of every molarity geopolymer concrete. The values of every sample cube cured under different temperatures were noted. The average values of 3 samples of every molarity geopolymer concrete taken as final value of strength. The results of compressive strength are explained below.

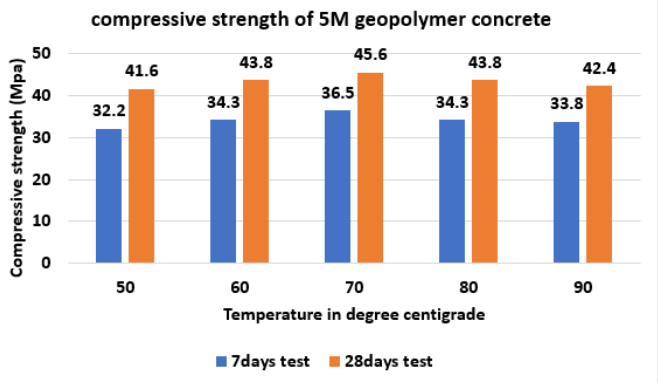

Fig-2: Compressive strength of 5M geopolymer concrete at different temperatures

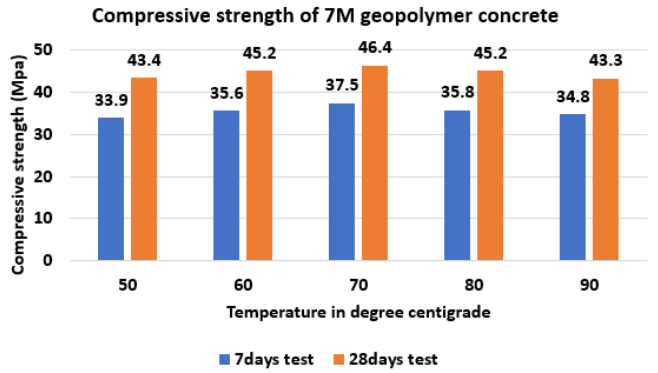

Fig-3: Compressive strength of 7M geopolymer concrete at different temperatures

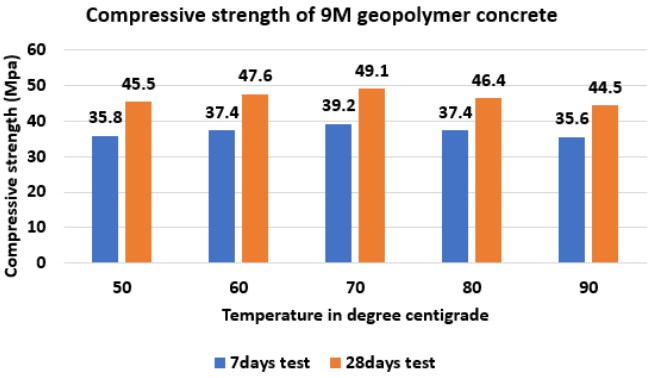

Fig-4: Compressive strength of 9M geopolymer concrete at different temperatures

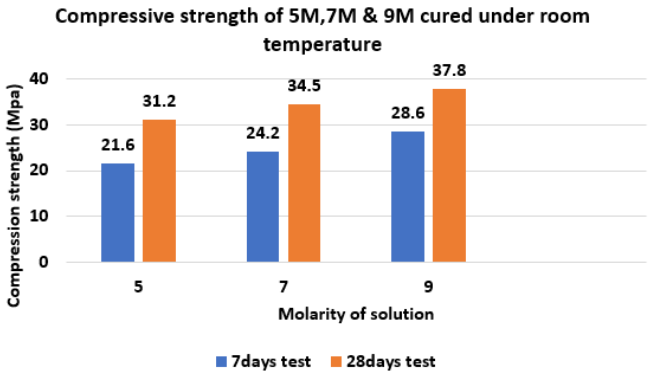

Fig-5: Compressive strength of 5M, 7M & 9M geopolymer concrete at different temperatures

3.2.3 Ultrasonic pulse velocity test

It is one of the non-destructive test performed in these project. Test procedure followed according to IS-13311(part1):1992 code. The results of UPV test define quality of concrete. These test conducted on concrete cubes after curing period of 7days and 28days. 5M, 7M, 9M geopolymer concrete cubes cured under room condition and in oven curing for period of 20hrs under different temperature conditions 50°, 60°, 70°, 80° and 90°. For every curing condition of 3 samples of each molarity of geopolymer concrete cubes were tested and average are calculated and tabulated. The test results and summary are mentioned below.

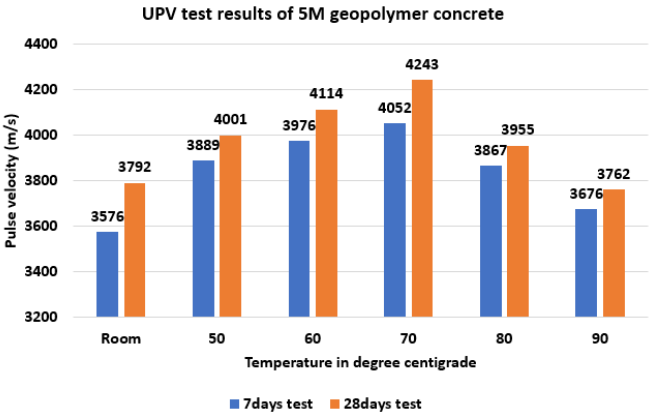

Fig-6: UPV results of 5M geopolymer concrete at different temperatures

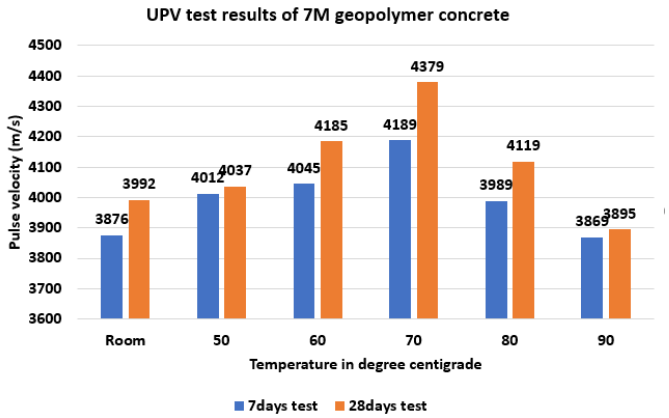

Fig-7: UPV results of 7M geopolymer concrete at different temperatures

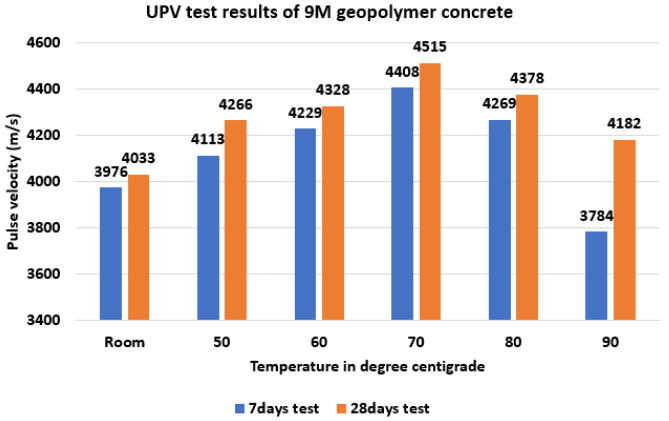

Fig-8: UPV results of 9M geopolymer concrete at different temperatures

4. CONCLUSIONS

(1) Molarity of alkaline solution increases with decrease in slump of GPC due to increase of concentration of NaOH pellets, which shows increase of viscous nature of concrete.
(2) Curing period increases with increase in compressive strength, because polymerization increases for long period.
(3) 70^0C is the optimum temperature for 5M , 7M & 9M Geopolymer concrete mix cubes.
(4) Due to rate of polymerization increases up to temperature, the strength of GPC increases up to optimum temperature.
(5) UPV results of 5M, 7M, 9M GPC ranges from 3500 to 4500 m/s. Hence, GPC samples in this study are in good state.

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