Research Paper Engineering

Experimental Investigation on Self-Compacting Geopolymer Concrete (SCGC)

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ABSTRACT

- Continuous increase in production of cement causes large amount of carbon-dioxide emission which results into greenhouse effect. In order to overcome this problem many researchers have put in their efforts to achieved optimum strength of concrete by replacing cement with fly ash and when it combine with alkaline solution which is known as a Geopolymer concrete. SCGC (low-calcium fly ash) is an improved way of concreting execution that does not require compaction and is made by complete elimination of ordinary Portland cement content. SCGC were synthesized from low calcium fly ash, activated by combination of sodium hydroxide and sodium silicate solution and by incorporation of super plasticizer for self-compatibility. This project report is an attempt to find out suitable utilization of fly ash by assembly the SCGC. By studying the compressive strength of SCGC and to observe the some durability characteristics of self-compacting Geopolymer concrete.

Keywords : Faecal Bifidobacteria, Bifidobacteria isolation

INTRODUCTION

The production of cement generates large amount of carbon dioxide. Carbon dioxide could be reduced if the production of cement could be reduced as well. Scientists have been doing research and development for more than 20 years on a new material called “geopolymer” to replace the use of cement. This material is made basically of a mixture of sodium hydroxide and sodium silicate solution which, when combined with certain powder material such as fly ash forms a material with cementitious properties similar to and in the same range as Portland cement paste. Now attempt is made geopolymer concrete as a self-compacting geopolymer concrete therefore execution of concrete in a congested area by complete elimination of compaction.

Although the components have a great deal, sodium silicate to sodium hydroxide solution ratio, concentration of sodium hydroxide, two solution to flyash ratio, percentage of superplasticizer to make self-compactibilty by such general consensus that the reaction producing the SCGC in the form of polymerization.

Polymerization reaction takes place at higher temperature but it is necessary to compare the strength of normal temperature cure concrete and higher temperature cure concrete specimen.

Humans have overused the resources in the environment bringing about negative changes such as acid rain for that the long term requirements of structure dictates that durability of material be given a serious consideration for structural materials used in aggressive environment. therefore effect of SCGC on adverse conditions are used to test its durability namely, carbonation permeability, acid attack, water absorption.

The objectives of this study were to assess the performances of self-compacting geopolymer concrete under the normal cured concrete and high temperature cured concrete.

The investigation of flyash based self-compacting geopolymer concrete is made due to their relatively lower cost and simple synthesis procedures. The research presented the experimental work undertaken to develop class F flyash based self-compacting geopolymer concrete.

MATERIAL SELECTION

FLY ASH

Fly ash used in this study was low-calcium (ASTM Class F) dry fly ash (of wanakbori) obtained from the Pyramid chemicals Pvt ltd. The chemical composition and physical analysis of Fly-ash report is given in table no 1 & 2.

Table1: Chemical analysis test results:

Sr No	Chemical	Test Result
1	Si02+ Al2O3+ Fe2O3	95
2	SiO2 % by mass	62
3	SO3	0.30
4	MgO	0.50
5	Na2O	0.90
6	Loss of ignition % by mass	1.20
7	Total chloride content	0.035

Table no 2. Physical analysis test results:

Sr No	Physical Analysis	Test Result
1	Retention on 350 micron sieve	12%
2	Fineness by Blaine permeability method	400+
3	Lime reactivity Avg comp strength	6.2
4	Avg comp strength on 30% replacement	98%
5	Soundness Auto clave method	0.05
6	Dry shrinkage percentage	0.04
7	Specific gravity	2.25

ALKALINE LIQUID
The alkaline liquid used was a sodium silicate solution and sodium hydroxide solution. The sodium silicate solution was purchased from a local supplier in bulk. The sodium hydroxide (NaOH) in flakes or pellets form with 97%-98% purity was also purchased from a local supplier in bulk. The NaOH solids were dissolved in water to make the solution. For making NaOH solution eg 8M in one liter of water the 320 gm (molar * molecular weight) of flakes is dissolved.

AGGREGATE
Coarse aggregate used in this research was crushed granite stone with maximum size of 20 mm and 10 mm used. The specific gravity of coarse aggregate is 2.90 with SSD condition while the fine aggregate used is dry clean natural sand of specific gravity of 2.40 according IS 383-1970.

LIME
Locally available lime is used of brand name chamak.

During making SCGC, non-hydrated lime is used which was passed through 150 micron.

SUPER-PLASTICIZER
In order to improve the workability of fresh concrete, high-range water-reducing naphthalene based super plasticizer are used.

MIXING METHOD
The concrete mixing procedure consists of dry and wet mixings. The solids components of SCGC, i.e. fly ash, lime, fine aggregate and coarse aggregate, were dry mixed in the mixer for about 2.5 minutes. The sodium silicate solution and the sodium hydroxide solution are added directly in dry mix and solution is prepared during mixing time individually added. The water and super-plasticizer were added after solution is mixed thoroughly to achieve the workability. It was believed that the chemical reaction between alkaline solution, super plasticizer and water took place and the reaction played an important role in giving the required workability for SCC. The fresh SCGC had a flowing consistency and with high tendency of filling ability, passing ability and resistance to segregation.

CASTING AND CURING
The fresh concrete was filled in 150*150*150 mm moulds and allowed to fill all the spaces of the moulds by its self-weight (no need to vibrate for compaction). After casting the specimens including the moulds were kept for rest period of one hour and then kept in an oven at a temperature of 100°C for 24 hours duration and another for normal curing are kept at room temperature for 24 hours then the specimens were demoulded for normal curing specimen kept in water tank for 28 days and high temperature cured mould kept at room temperature.

MIX PROPORTION
The mix design proportion adopted in the research and details of these mixes are shown in Table 3. The ratio of sodium silicate to sodium hydroxide solution by mass was 2.0 for all mixture proportion. The mass ratio of alkaline solution to fly ash was 0.55 for all mixture. Mix sample of different molarity were prepared to study the influence of molarity of alkaline solution on compressive strength of SCGC. The designed SP dosages were kept 7% and all the other test parameters were held constant. The different molarity of NaOH solution was setted as 8M, 10M, 12M, 14M and 16M respectively. All the other test parameters were kept constant while the molarity varied.

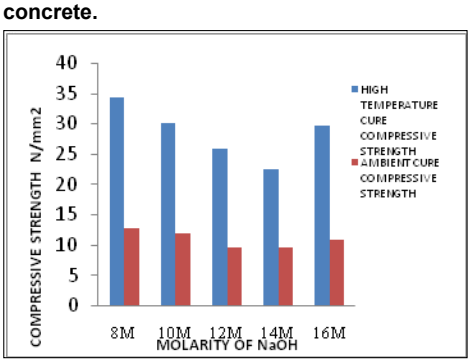
MIX PROPORTION DESIGN
For all mix proportion the design are kept same but only molarity is changed. Table no. 3 shown the Mix-design of SCGC.

Table no. 3. Mix-Design of SCGC

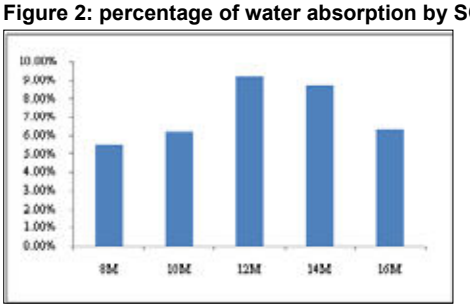
Material	Weight(Kg)
Fly Ash	320.51
Sand	739.2
Aggregate (20 mm)	443.52
Grit(10mm)	665.28
Lime	35.62
Sodium Silicate	130.58
Sodium Hydroxide	65.29
Super-Plasticizer	24.92
Water	106.8

TEST PROCEDURE
A concrete mix can only be considered as SCC if three characteristics for workability are satisfied. The three fresh concrete characteristics mandatory for SCC are filling ability, passing ability and resistance to segregation. Different test methods have been developed in attempts to measure the three properties of SCC however, so far no single standard methods is capable of determining all the relevant workability aspects at a time so each mix design should be assessed by more than one test method for the different workability characteristics. For that V-funnel Test and Slump Flow test are carried out. At 28 days specimen are tested for direct compression in a digital 2000KN Compression testing machine, and other some durability test also carried.

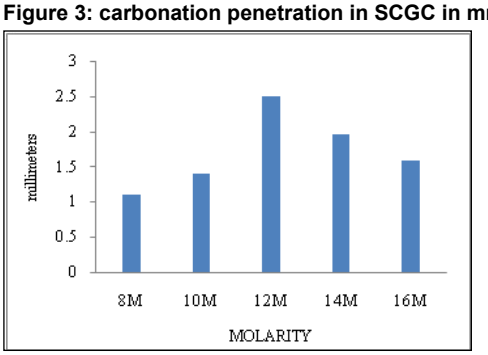
RESULT
Figure 1: comparison of elevated cured and normal cured concrete.



WATER ABSORPTION
Figure 2: percentage of water absorption by SCGC

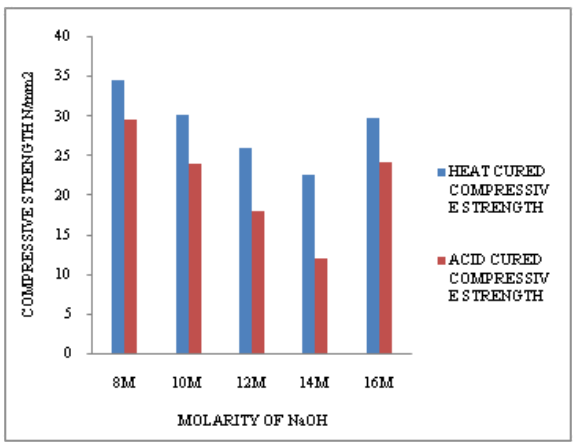


CARBONATION PENETRATION
Figure 3: carbonation penetration in SCGC in mm.



ACID ATTACK TEST

Figure 4: comparison of compressive strength of elevated and acid cured concrete.



CONCLUSION

It is observed that maximum compressive strength of self-compacting geopolymer concrete is achieved at elevated temperature cured concrete, and as molarity increases the strength goes on decreasing but after 14M the strength again increases at 16M and at 8M maximum strength is observed.

After 28 days the heat cured concrete are immersed in water for 72 hours then percentage weight difference are carried out which shown in figure 2 in which at 12M maximum percentage of water is absorb.

At 8M compressive strength increase and on other hand the water absorption of 8m was less compared to other molarity. So it can be said that 8M are less porous.

In carbonation penetration test the penetration of 8M is having 1.2 mm penetration while compare with other it has low penetration value.

For acid attack test the concrete were immersed in sulphuric acid whose PH value 5 are maintained for 28days and result are compared with heat cured concrete which is shown in figure 4, for 8M, 14% of strength decrement is observed.

From this experimental work, for SCGC 8M is proved to be superior then other molarity of concrete.

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