Impact Factor (SJIF): 4.542

International Journal of Advance Research in Engineering, Science & Technology

e-ISSN: 2393-9877, p-ISSN: 2394-2444
Volume 4, Issue 3, March-2017

COMPARISON OF OPC(ORDINARY PORTLAND CEMENT) AND GGBFS(GROUND GRANULATED BLAST FURNACE SLAG) CONCRETE

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Abstract - The demand of concrete is increasing day by and Cement is used for satisfying the need day of development of infrastructure facilities, 1 tone cement production generates 1 tone CO2 which adversely affect the environment. In order to reduce the use of OPC and CO2 generation, the new generation concrete has been developed such as GEOPOLYMER CONCRETE. It uses GGBFS and Alkaline Solution as their Binding Materials. Geopolymer requires Oven Curing of Ambient Temperature and 600C for a period of 24hr.,concrete and to study the Effect of Oven Curing and Ambient room temperature curing on them. The alkaline solution used for present study is sodium silicate and sodium hydroxide solution and examine the effect of sodium hydroxide at different molarity. The casted cube and cylinder will be cured at normal room temperature and Oven heat provision for 24 hours and to ascertain the behavior of concrete mixed with GGBFS, thereby examining the changes of properties.

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I. INTRODUCTION

Concrete usage around the world is second only to water. Ordinary Portland cement (OPC) is conventionally used as the primary binder to produce concrete. 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 calcination of limestone and combustion of fossil fuel is in the order of one ton for every ton of OPC produced. In addition, the extent of energy required to produce OPC is only next to steel and aluminium.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 60% by mass is a significant development. Finally, many cement concrete structure have exhibited early distress and problems, which has an adverse effect on the resource productivity of the industry.

'Geopolymer Concrete' (GPC) is a type of inorganic polymer composite, which has recently emerged as a prospective binding material based on novel utilization of engineering materials. It has the potential to form a substantial element of an environmentally sustainable construction industry by replacing/supplementing the conventional concretes. GPC can be designed as high strength concrete with good resistance to chloride penetration, acid attack. Sulphate attack,etc. The geo-polymeric concretes are commonly formed by alkali activation of industrial alumino silicate waste materials such as fly ash (FA) and ground granulated blast furnace slag (GGBS), and have very small footprints of greenhouse gases when compared to traditional concretes. Because of possible realization of even superior chemical and mechanical properties compared to Ordinary Portland cement (OPC) based concrete mixes, and higher cost effectiveness, GPC mixes based on FA and GGBS are being discussed for their potential application in concrete industry including structural concreting, precast panels and ready-mixes. In the present investigation, the strength properties of GPC after exposure to elevated temperatures are studied and are compared with the published results pertaining to OPC mixes.

II. MATERIALS AND METHODS

A. Ground-granulated blast-furnace slag (GGBS or GGBFS)

Ground-granulated blast-furnace slag (GGBS or GGBFS) is obtained by quenching molten iron slag (a by-product of iron and steel-making) from a blast furnace in water or steam, to produce a glassy, granular product that is then dried and ground into a fine powder. GGBS was obtained from JSW cements limited. Bellari, Karnataka. It was given to Laboratory for testing. Two major uses of GGBS are in the production of quality-improved slag cement, namely Portland

Blastfurnace cement (PBFC) and high-slag blast-furnace cement (HSBFC), with GGBS content ranging typically from 30 to 70%; and in the production of ready-mixed or site-batched durable concrete. GGBS cement can be added to concrete in the concrete manufacturer's batching plant, along with Portland cement, aggregates and water.GGBFS is used as a direct replacement for Portland cement, on a one-to-one basis by weight. Replacement levels for GGBFS vary from 30% to up to 85%. Typically 40 to 50% is used in most instances.

Figure 1:GGBFS

B. Alkali Activator Solution

A combination of sodium hydroxide solution (NaOH) and sodium silicate and sodium hydroxide were used as alkaline activator solution.The sodium hydroxide solution was prepared by dissolving the sodium hydroxide solids, in theform of pellets in distilled water. In order to avoid the effect of unknown contaminants in the mixing water, the sodium hydroxide pellets were dissolved in distilled water In this study, the molar concentration of NaOH used is 12M.There are various molar concentration of NaOH but many of research paper shows that the maximum strength of concrete achieve in 12M, after 12M the strength is decreases, So in this investigation it is selected 12M.Since the molecular weight of Sodium Hydroxide is 40g, and in order to prepare 12M solution 12 x 40= 480 gms of Sodium Hydroxide was dissolved in 1000 ml of distilled water. The sodium silicate solution contained Na_2O =14.7%, SiO_2 = 29.4%, and 55.6% of water, by mass. The activator solution was prepared at least 2 hour prior to its use. Same procedure was done for 8M And 12M.

C. Fine Aggregate

Natural river sand conforming to Zone II as per IS 383 (1987)[2], with a fineness modulus of 3.45 and a specific gravity of 2.6, was used.

Weight of fine aggregate sample taken = 1000g

I.S .Seive Size	Weight of aggregate retained in gms	Cumulative weight retained in gms	Cumulative % of weight retained	% of passing	Remarks
10 mm	0	0	0	100	
4.75 mm	0	0	0	100	
2.36 mm	10	10	1	99	Zone –II
1.18 mm	197.5	207.5	20.75	79.25	
600	371.0	578.5	57.85	42.15	
300	353.0	931.5	93.75	6.85	
150	68.5	1000	100	0	

Fineness modulus of Fine aggregate =**427.5 /100=4.27**

D. Coarse aggregate

The crushed coarse aggregate of 20 mm maximum size rounded obtained from the local Site study. In My study, I have used two types of aggregate10 mm and 16 mm . The physical properties of coarse aggregate like specific gravity, bulk density, gradation and fineness modulus are tested in accordance with IS ; 2386

Weight of coarse aggregate sample taken = 5000 g.

I.S.Sieve Size	Weight of aggregate retained in gms	Cumulative weight retained in gms	Cumulative % of weight retained	% of passing
40mm	0	0	0	100
20mm	0	0	0	100
10mm	270	750	15	85
4.75mm	4250	5000	100	0
2.36mm	0	5000	100	0
1.18mm	0	5000	100	0
600 nu	0	5000	100	0
300 nu	0	5000	100	0
150 nu	0	5000	100	0

Fineness modulus of coarse aggregate = **615/100=6.15**

E. TEST CONDUCTED

1. Compressive Test

The compressive strength of the geopolymer concrete was tested as per IS 516:1959 [8]. Cube specimens 150 mm in size were cast for each proportion and tested for their compressive strength at the ages of 3, 7 and 28 days. All the specimens weretested using the Compression Testing Machine (CTM) 2000 kN in capacity under a uniform rate of loading of 140 kg/cm2/min until failure, and the ultimate load at failure was registered to enable calculation of compressive strength.

2.Split Tensile Test

The split tensile strength test was carried out as per IS 5816:1999 [12]. Cylindrical concrete specimens 150 mm in Diameter and 300 mm in height were cast. The specimens were then tested to determine the splitting tensile strength using a Universal Testing Machine (UTM) at the ages of 3, 7 and 28 days.

III. RESULTS

1.COMPRESSIVE STRENGTH(MPa) TEST

Table 1- COMPRESSIVE STRENGTH ON OPC

Day of curing	Sample	Load capacity in KN	Area in MM2	Compressive Strength	Average in N/MM2
3	1	450.5	22500	20.022	19.5036
	2	444.7	22500	19.7644	
	3	421.3	22500	18.724	
7	1	590.0	22500	26.2222	27.5762
	2	630.3	22500	28.0133	

	3	641.1	22500	28.4933	
28	1	852.2	22500	37.8755	37.7510
	2	888.7	22500	39.4977	
	3	807.3	22500	35.8800	

Table 2- Compressive strength at ambient Temperature

Molarity	Material	Compressive strength (N/mm$^{2)}$		
		3 Days	7 Days	28 Days
8 M	GGBFS	23.14	31.26	34.40
10 M	GGBFS	27.20	32.94	39.01
12 M	GGBFS	32.55	35.53	44.43

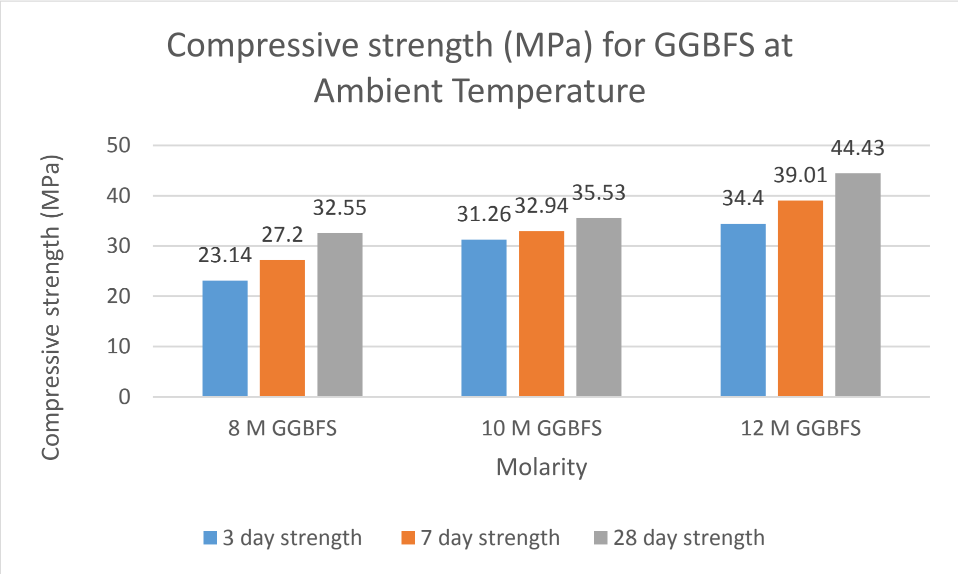

Figure 2-Compressive strength at Ambient Temperature

As shown in figure 2 that 100% of GGBFS at ambient temperature. It is observed that when increase in molarity. The compressive strength of Geopolyymer concrete increase.

2.TENSILE STRENGTH(MPa)TEST

Table 3-Split Tensile Strength

Molarity	Material	Split Tensile strength (N/mm$^{2)}$		
		3 Days	7 Days	28 Days
8 M	GGBFS	1.37	2.12	3.03
10 M	GGBFS	1.58	2.23	3.42
12 M	GGBFS	1.95	2.90	3.59

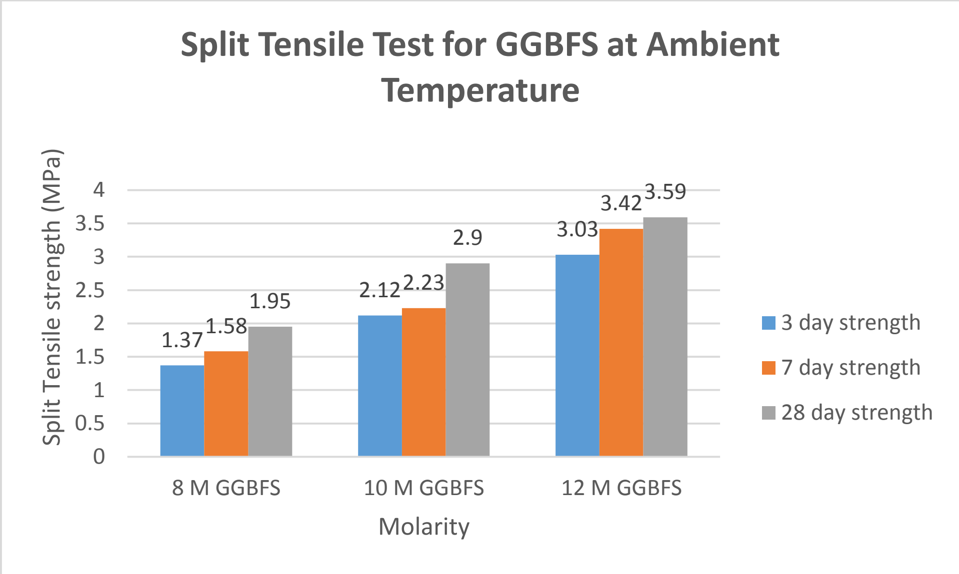

Figure 3-Split Tensile at Ambient Temperature

As shown in figure 3 that 100% of GGBFS at ambient temperature. It is observed that when increase in molarity. The split tensile strength of Geopolyymer concrete increase.

IV. CONCLUSIONS

The experimental results show that it is possible to produce geo-polymer concrete of substantial strength using GGBFS The following conclusions can also be derived from the present study:

- In comparison to the ordinary Portland concrete the setting time of the geo-polymer concrete is very less.
- Compressive Strength as the Molarity of NaoH increase, there is increase in the strength for 3, 7 and 28 days of concrete.
- Split Tensile Strength as the Molarity of NaoH increase, there is increase in the strength for 3, 7 and 28 days of concrete.
- It is also conclude that the compressive and tensile strength is increasing with Increasing the temperature.
- It is possible to achieve comparable strength of Geo-polymer concrete at ambient temperature using GGBFS.

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