RESEARCH ARTICLE OPEN ACCESS

An Experimental Study on Behavior of Partial Replacement of Cement with Ground Granulated Blast Furnace Slag

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ABSTRACT
Concrete has occupied an important place in construction industry in the past few decades and it is used widely in all types of constructions ranging from small buildings to large infrastructural dams or reservoirs.GGBS is obtained from making of iron.It Is no use for other things.It pollutes the environmental such as land pollution, water pollution etc..when we use the GGBS in partial replacement of cement it increase the strengths of the cubes as well as decrease the pollution of the environmental.In my investigation GGBS used at 10%,20%,30%,40%,50% for M_{20} and M_{30} 43 grades.It is gives increase strength values at 10%,20% and 30% compared to normal mixes.
***Keywords*:** cement(M_{20},M_{30}),sand,ggbs,fosroc conplast sp 430

I. INTRODUCTION

In India, the production is about 7.8 million tonnes of GGBS as a by-product obtained in the manufacture of pig iron in the blast furnace. Blast furnace slag is a solid waste discharged in large quantities by the iron and steel industry in India. The recycling of these slags will become an important measure for the environmental protection. Iron and steel are basic materials that underpin modern civilization, and due to many years of research the slag that is generated as a by-product in iron and steel production is now used as a material in its own right in various sectors.

II. LITERATURE REVIEW

The first recorded production of portland blast furnace slag cement was in Germany in 1892; the first United States production was in 1896. Until the 1950s, GGBS was used in production of cement or as a cementitious material in two basic ways: as a raw material for the manufacture of portland cement, and as a cementitious material combined with portland cement, hydrated lime, gypsum or a hydrate

Kamran and Usman (2004): conducted a research on GGBS which was collected from steel mills in Karachi (Pakistan) and pulverized to a very fine degree from a pulverizer. They found that there was an appreciable increase in the workability of concrete with increasing percent replacement of cement with GGBS.

Shariq et al (2008): studied the effect of curing procedure on the compressive strength development of cement mortar and concrete incorporating GGBS. GGBS based concrete 40% replacement is found to be optimum.

Nagaraj et al (2011): They made an attempt to minimize the cost of cement with nominal concrete mix grades M20 and M30 by studying the mechanical behavior of these concrete mixes by replacing marginal products such as RHA and GGBS over the increasing cost of cement. They concluded that the partial replacement of such marginal materials can be done by replacing with the cement in percentage wise without altering much the strength of concrete.

III. MATERIALS USED

- Cement 43 grade($M_{20,}M_{30}$)
- Ggbs(ground granulated blast furnace slag)
- Sand
- Coarse aggregates
- Fosroc conplast sp 430(admixture)

3.1ground Granulated Blast Furnace Slag:

It is obtained from making of iron.This is one type of blast furnace slag.GGBS and finely ground pelletized slag are marketed separately to the concrete producer and used as a partial replacement for portland cement. Replacement dosages between 5% and 70% by mass of cement material are common. Fineness, glass content and mineral constituents are generally considered to be important factors regarding the cement activity of slag.

3.1.1sources of GGBS:

Blast furnace slag is by-product from the blast furnaces used to make iron. These operate at a temperature of 1500 ^{o}C and are fed with a carefully controlled mixture of iron ore ,coke and lime stone. The iron-ore is reduced to iron and the remaining materials form a slag that floats on top of the iron. This slag is periodically tapped off as a molten liquid and if it is to be used for the manufacture of GGBS it has to be rapidly quenched in large volumes of water. The quenching optimizes the cementitious properties and produces granules similar to coarse sand. This granulated slag is then dried and ground to a fine powder less than 45µ having specific surface about 400 to 600m^2/kg, which is GGBS (ground granulated blast furnace slag) cement. Grinding of the granulated slag is carried out in a rotating ball mill.

3.2Fosroc conplast sp 430:

It is admixture used in this experiment. Admixtures are used to give special properties to fresh or hardened concrete. Admixtures may enhance the durability, workability and strength characteristics of a given concrete mixture. Admixtures are used to overcome difficult construction situations such as hot or cold weather placements, pumping requirements, early strength requirements or very low water-cement ratio specifications. Conplast SP-430 has been specially formulated to give high water reductions up to 25% without loss of workability or to produce high quality concrete of reduced permeability. Four mixes were studied with GGBS & glass fiber using a water binder ratio of 0.26. They observed that the mix with replacement level as 7.5% GGBS and 0.3% glass fiber shows the maximum compressive strength

IV. APPLICATIONS AND USES

Two major uses of GGBS are in the production of quality-improved slag cement, namely PBFC and HSBFC, with GGBS content ranging typically from 30 to 70%; and in the production of ready mixed or site-batched durable concrete.

Concrete made with GGBS cement sets more slowly than concrete made with ordinary portland cement, depending on the amount of GGBS in the cementitious material, but also continues to gain strength over a longer period in production conditions. This results in lower heat of hydration and lower temperature rises, and makes avoiding cold joints easier, but may also affect construction schedules where quick setting is required.

Use of GGBS significantly reduces the risk of damages caused by ASR, provides higher resistance to chloride ingress reducing the risk of reinforcement corrosion, provides higher resistance to attacks by sulphate and other chemicals, workability-making placing and compaction easier and lower early-age temperature rise, reducing the risk of thermal cracking in pores.

V. PROPERTIES OF GGBFS

5.1 Physical properties of GGBFS (AS PER SUPPLIER)

s.no	properity	values
1	colour	White
2	Water absorption	0.75%
3	Specific gravity	2.77
4	Residue on 45 micron sieve	3.0%
5	finess	395m^2/kg

5.2 Chemical properties of GGBS (AS PER SUPPLIER):

GGBs also have chemical properties ,These are Calcium oxide (CaO)- 0.40%, Silicon Dioxide (SiO_2)- 0.35%,Aluminium Oxide (Al_2O_3)- 0.13%, Magnesium Oxide (MgO)- 8.2%, Insoluble residue- 0.66%, Manganese oxide (MnO)- 0.40%, Sulfide sulfur (S)- 0.79%, $\underline{CaO + MgO + 1/3\ Al_2O_3}$,SiO_2 + 2/3 Al_2O_3-1.04, $\underline{CaO + MgO + Al_2O_3}$ SiO_2-1.84.

VI. RESULTS AND GRAPHS

6.1 Workability in terms Slump Cone test of M_{20} and M_{30} grades

Grade of concrete		M_{20}	M_{30}
PERCENTAGE OF GGBS ADDED	PERCENTAGE OF ADMIXTURE ADDED	SLUMP (in mm)	SLUMP (in mm)
00.00	0.0	43	39
10.00	0.0	46	42
	0.05	57	50
20.00	0.0	50	45
	0.1	64	54
30.00	0.0	58	52
	0.25	67	59
40.00	0.0	69	64
	0.4	74	69
50.00	0.0	76	71
	0.5	82	81

6.2Compressive Strengths OF M_{20}

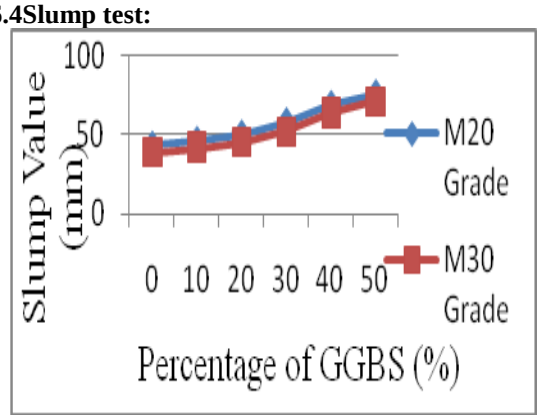
Age (Days) mpa	M_{20} +0%	M_{20} +10%	M_{20} +20%	M_{20}+ 30%	M_{20} +40%	M_{20} +50%
3days	11.28	13.19	15.98	17.54	14.21	10.51
7days	17.57	19.39	21.97	23.08	20.42	16.02
28days	27.85	29.59	31.96	33.62	30.63	26.54
56days	32.64	34.91	37.68	39.74	36.29	32.68

6.3Compressive Strength of M_{30}

Age (Days) mpa	M_{30} +0%	M_{30} +10%	M_{30} +20%	M_{30}+ 30%	M_{30} +40%	M_{30} +50%
3days	13.88	15.92	17.77	19.81	14.37	11.91
7days	27.42	29.66	31.55	33.51	30.46	26.69
28days	41.70	43.63	45.66	47.83	44.62	40.27
56days	46.34	48.62	50.96	52.85	49.41	45.92

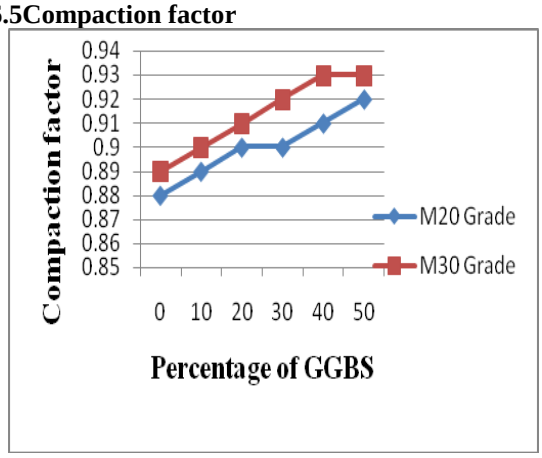
Graphs:

6.4Slump test:



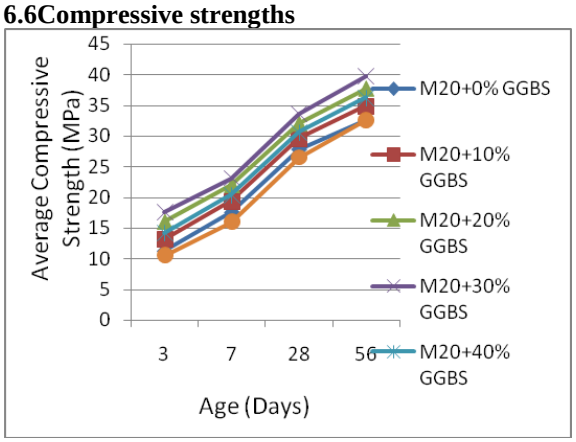
Graph I Variation of Slump for M20 & M30 grade concretes

6.5Compaction factor

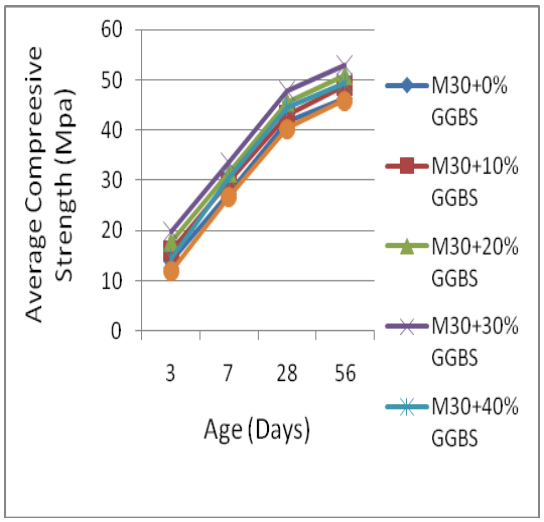


***Graph II** Variation of Compaction factor for M20 & M30 grade concretes*

6.6Compressive strengths



***Graph III** Variation of Compressive strength of M20 grade concrete*



Graph IV Variation of Compressive strength of M30 grade concrete

VII. RECOMMENDATIONS FOR FUTURE INVESTIGATIONS

1. Studies on Creep and Shrinkage properties may be carried out.
2. Studies on replacement of cement by any other pozzolanic material and fine aggregate by manufactured sand can be made.
3. Studies on high volume replacement of GGBS in place of cement, i.e., more than 50% can be made.
4. Studies on partial replacement of GGBS in place of cement along with geo polymer fibers can be made.
5. Studies on replacement of high volume GGBS along with different percentages of fly ash, silica fume, metakaolin and rice husk ash may be carried out.

VIII. CONCLUSION

- It gives good strength when compared to normal mix
- Partial replacement of GGBS decrease the environmental pollution such as ground pollution, water pollution etc
- Partial replacement of GGBS increase the strengths at 10%,20%,30% as well as decrease the strength at 40%,50%.
- It also reduce the cost of construction.

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BS CODE

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