Effect of Concrete Behaviour by Replacing Cement with GGBS (Ground Granulated Blast Furnace Slag)

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Abstract— Cement is one of the most extensively used versatile material in construction industry. Manufacturing of ordinary Portland cement is an energy intensive process and releases large amount of greenhouse gases into atmosphere, which affect the earth's ecosystem. This situation leads to think all people working in construction industry to do research work on cement replacing material and use of it. GGBS (ground granulated blast furnace slag) will satisfy all the requirements of such replaceable. Properties of GGBS is similar to properties of cement. Use of GGBS as cement replacement will simultaneously reduce the cost of concrete and help to reduce the rate of cement consumption. One of the important aim of this project is to evaluate the behaviour of concrete with GGBS as an admixture in different proportions with respect to age of concrete by means of compressive strength, slump cone test.

Key words: Ordinary Portland Cement, Admixture, GGBS (Ground Granulated Blast Furnace Slag), GGBS In Concrete, Compressive Strength

I. INTRODUCTION

Concrete is a mixture of cement, sand, coarse aggregate, fine aggregate. It plays a predominant role in structural engineering. In now a days production of cement is increasing rapidly, more economical and is expensive because manufacturing of cement consumes more lime. When water added to cement, releases more heat of hydration and have greater more risk of alkali-silica reaction, sulphate reaction and discharge more greenhouse gaseous like CO_2.As we know that emission of CO_2 is very harmful which creates lot of changes to the environment. One tonne of CO_2 is estimated to be released to the atmosphere when one tone of ordinary Portland cement is manufactured. So the problem is related to the environment and cost minimization but as civil engineer will give the proper solutions by analysing the properties of concrete made by using industrial waste material. GGBS means ground granulated blast furnace slag is a waste by-product from the blast furnace of iron and steel industries. In India 7.8 million tonnes of ground granulated blast furnace slag is produced. It is a non-metallic product consisting essentially of silicates and aluminates of calcium and other basis. The molten slag has composition close to the chemical composition of ordinary Portland cement. GGBS is available in powdered form as well as crystalline form. When cement can be replaced by GGBS in concrete in order to meet the requirements of admixture. This in turn reduces the consumption of cement and also saves lot of natural resources and energy. This paper presents the various studies of workability of concrete with GGBS as replacement material for cement. Workability is one of the important factors of fresh concrete.

II. LITERATURE REVIEW

1) Dr C.Natarajan and Mr. M Sudhakar (2013) conducted an experiment on geo polymer concrete to compare the compressive strength of concrete by using flyash and GGBS,
2) Sonali L.Godpalliwar, R.s Deotale and Abhijeeth R.Narde(2013) conducted experiment to increase the compressive strength by using GGBS in replacement of cement in concrete
3) International Journal of Research in Engineering and Technology(IJRIT) journals on concrete.
4) European Journal of Scientific Research ISSN 1450-216X Vol.88 No-1 October 2012
5) karam muzaffar khan(2004) Had conducted an experiment on concrete having GGBS in different proportions, comparison was made on compressive strength, slump test, fineness test, setting time.
6) Pazhani. K, Jeyaraj. R, Study on durability of high performance concrete with industrial wastes, ATI Applied Technologies & Innovations volume 2,issue 2,August 2010 p. 19-28.

III. MATERIALS USED

A. Cement:

The cement used for experimental purpose is ordinary Portland cement of 53 grade.

s.no.	Description of test	result
1.	Fine ness of cement	1.01%
2.	Consistency test	32%
3.	Setting time 1.Intial setting time test 2.Final setting time test	 30 mins 60 hrs
4.	Specific gravity	2.99

Table 1: Test on ordinary portland cement

B. GGBS:

The composition of GGBS is close to the composition of cement

S.NO	Description	Result
1.	Cao	30-50%
2.	Sio2	28-38%
3.	Al2O3	8-24%
4.	MgO	1-18%
5.	MnO	0.68%
6.	TiO2	0.58%

Table 2: chemical composition of GGBS

C. AGGREGATES:

1) Coarse aggregate:

Crushed stone were used as aggregates, fractions from 20 mm
to 4.75 mm are used as coarse aggregate. The Flakiness Index and Elongation Index were maintained well below 15%.

s.no	Description	Result
1.	Particle size, shape	Angular,20 mm
2.	Bulk density	1560
3.	Specific gravity	2.87
4.	Water absorption	0.54%
5.	Surface moisture	Nil

Table 3: physical properties of coarse aggregate

2) Fine aggregate:

locally available sand was used as fine aggregates. Those fractions from 4.75 mm to 150 µ of aggregate is used.

s.no.	Description	Result
1	Particle size, shape	Round,4.75mm down
2	Bulk density	1660
3	Specific gravity	2.65
4	Bulking of sand	4.10%
5	Surface moisture	Nil

Table 4: physical properties of fine aggregte

3) Water:

water is an important constituent of concrete as it actually participate in the chemical reaction with cement.

a) Mix design for M_{20} grade concrete:

The mix proportion for M_{20} grade concrete is as follows

Cement	Coarse aggregate	Fine aggregate	water
9	27.176	13.59	4.56
1	1.49	3	0.55

Table 5: Mix design proportion

D. Tests on concrete:

1) Compressive strength test:

Cube compression test was performed on concrete in standard cube of 150mm×150 mm×150mm after curing at the age of 28 days. Compressive strength of concrete is calculated by using the formula

$$f'_C = P/A$$

where P=compression load in KN

A= area of the specimen, mm^2

2) Workability of concrete:

Materials are weighed in proper way and as required for mixing. Then it is mixed in nominal mix method

Results:

s.no	% of GGBS	Results
1	0%	13.5 N/mm^2
2	20%	16.22N/mm^2
3	30%	18.00N/mm^2
4	40%	16.82N/mm^2

Table: 6 Compressive strength of concrete with different percentages of GGBS over ordinary Portland cement at 7 days

s.no.	% of GGBS	Result
1	0%	
2	20%	27.82 N/mm^2
3	30%	34.44 N/mm^2
4	40%	29.49 N/mm^2

Table 7: compressive strength of concrete with different percentage of GGBS over cement at 14 days

s.no	% of GGBS	Results
1	0%	24.44 N/mm^2
2	20%	26.88N/mm^2
3	30%	38.95 N/mm^2
4	40%	33.95 N/mm^2

Table 8: Compressive strength of concrete with different percentages of GGBS over ordinary Portland cement at 28 days

IV. CONCLUSIONS

1) When GGBS as replaced with cement in M20 grade concrete in different proportions degree of workability of concrete is increases for 20% and 30%, 40%
2) By replacing GGBS with cement in different proportions, it releases less heat of hydration by which we control the risk of thermal cracking.
3) From the above results, we say that the compressive strength of concrete by replacing cement with GGBS, it decreases in early stages but increases in later stages
4) By replacing cement with GGBS in concrete, it reduces the consumption of cement, thus it results in decreasing the cost of cement.

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