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To effect on strength properties of concrete of by using GGBS by Partial Replacing cement and addition of GGBS without replacing cement

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ABSTRACT The aim of this study is to evaluate the performance of Ground-granulated blast-furnace slag (addition & as partial replacement) a mineral admixture in concretewhen it is mixed in cement concrete for workability, durability and strength of concrete using OPC (43 grade). Efforts for improving the performance of concrete over the past few years suggest that cement replacement materials along with mineral & chemical admixtures can improve the strength, workability and durability characteristics of concrete. Ground-granulated blast-furnace slag is pozzolanic materials that can be utilized to produce highly durable concrete composites. In this study Ground-granulated blast-furnace slag has been used to OPC which varies from 5% to 25% at interval of 5% by total weight of OPC and similarly partial replacement of OPC (43 grade) by Ground-granulated blast-furnace slag which varies from 5% to 25% at interval of 5% by total weight of OPC. A total twelve mixes (trial mix, control mix and variation mix) were prepared for M25 concrete. This study investigates theperformance of concrete mixture in terms of slump, compressive strength for 7days and 28 days, Flexural strength of beam 28 days and Splitting tensile strength of Cylinder for 28 days respectively. Total number of specimens for cubes 45, cylinders 20 and beams 20 which were casted for testing to study influence of Ground-granulated blast-furnace slag on concrete. These Concrete specimens were deep cured in water under normal atmospheric temperature. On the basis of result that Ground-granulated blast-furnace slag concrete was foundto increase in all strength (Compressive, Flexural & Splitting Tensile strength) and durability of variational mix of concrete on all age when compared to normal concrete its use should be promoted for better performance as well as for environmental sustainability.

Key Words:- Concrete, Ground-granulated blast-furnace slag, Workability, Compressive Strength, Flexural Strength, Splitting Tensile Strength

1. INTRODUCTION

Concrete is a mixture of cement, natural sand, coarse aggregate and water. Its success lies in its versatility as can be designed to withstand harsh environment while taking on the most inspirational forms. Engineers and scientists are further trying to increase its limits with the help of innovative chemical admixtures and various supplementary cementations materials SCMs. More recently, strict environmental pollution controls and regulations have produced an increase in the industrial wastes and sub graded by-products which can be used as SCMs such as Ground-granulated blast-furnace slag, fly ash, silica fume, etc. The use of SCMs in concrete constructions not only prevent these materials to check the pollution but also to enhance the properties of concrete in fresh and hydrated states. Ground-granulated blast-furnace slag can also be utilized as a high range water reducer to improve compressive strength or as a super workability aid to improve flow. Ground-granulated blast-furnace slag is known to produce a high strength concrete and is used in two different ways as a cement replacement, in order to reduce the cement content (usually for economic reasons) and as an additive to improve concrete properties (in both fresh and hardened states). Nowadays, most concrete mixture contains supplementary cementitious material which forms part of the cementitious component. These materials are by-products from other processes. The main benefits of SCMs are their ability to replace certain amount of cement and still able to display cementitious property, thus reducing the cost of using Portland cement. The fast growth in industrialization has resulted in tons and tons of by-product or waste materials, which can be used as SCMs such as Ground-granulated blast-furnace slag, fly ash, silica fume, steel slag etc. The use of these by-products not only helps to utilize these waste materials but also enhances the properties of concrete in fresh and hydrated states.

Selection of Cement

World is occupied by construction and infrastructure by the means of cement or steel structure but mostly cement is used due to its economical and low maintenance cost and for high and earlier strength, Many investigators and researchers have used mostly OPC (Ordinary Portland Cement) and then only few have used PPC (Portland Pozzolana Cement) for their research because of its durability, high strength (more than 80- 85 % strength is achieved within 28 days as compare to that of PPC which only achieves 70-75 % maximum within 28 days) and exact result couldn't be found due to presence of fly ash in portland pozzolana cement (because manufacturers do not specify the percentage of fly ash used which is present in the cement) during test.OPC is perfect to take into use for work and also minimize the quantity of cement when it is designed for mix proportion with superplasticizer and no doubt, PPC is eco-friendly, economical but does not receive high strength quickly, but make durable at later stages

Selection of Admixture A material other than water, aggregates, or cement that is used as an ingredient of concrete or mortar to control setting and early hardening, workability, or to provide additional cementing properties. There are mainly two types of admixture, one mineral admixture and other is chemical admixture. Ground-granulated blast-furnace slag is a mineral admixture. Ground-granulated blast-furnace slag are major mineral admixture use for basically concreting. There are some properties of Ground granulated blast furnace slag.

Table 1.1 Properties of Ground-granulated blast-furnace slag

Properties	**Range / Ground-granulated/ blast-furnace slag**
Bulk Density (kg/m)^3	750-850
Surface Area(cm /gm)	8000
Particle Shape	Irregular
Particle Size	N/A
Specific Gravity	2.9
CaO (%)	30-34
Al_2O_3 (%)	18-25
Fe_2O_3 (%)	0.8-3.0
SO_3 (%)	0.1-0.4
MgO (%)	06-10
SiO_2 (%)	30-36

2. EXPERIMENTAL PROGRAM

Mix Proportioning Mix proportion is process for mixing of cement, sand, coarse aggregate and water mainly in which it is required to keep balance of mixing ratio and mix has been conducted for trial mix, control mix & control mix with Ground-granulated blast-furnace slag which are given below

Trial Mix Trials have been made on a concrete mix of standard ratio given in IS 456:2000 for M25 to know the exact strength of concrete. There have also been trials on three concrete mixes without using admixture and two trials taken with admixture (naphtha based super plasticizer) as per IS 10262:2009 for M25.

Control Mix Control mix was designed as per IS 10262:2009 specification and recommendation which are given below

Table 2.1 Control Mix Proportion For M25 (For 1 Cum. of Concrete)

S. NO	**Materials**	**Weight (Kg/m)^3**	**Slump (mm)**
1	Cement(OPC-43)	357	115mm
2	Coarse Aggregate(20mm)	694	
3	Coarse Aggregate(10mm)	482	
4	Fine Aggregate	721	
5	Water	168	
6	Admixture @ 1% of cement	3.57	
7	W/C Ratio	0.47	

III-RESULTS AND ANALYSIS

In this chapter, the results of experimental work have been analyzed and all blends/mixes in which there were lot of variations in result of different mixes. Results have been tabulated and have also been graphically presented for details. There have been various mixes of different type i.e. two variations with cement had been made. First one was to add few percentage of Ground-granulated blast-furnace slag to cement which varies from 0% to 25% at interval of 5% and second one was to replace few percentage of cement with Ground-granulated blast-furnace slag which varies from 0% to 25% at interval of 5% for both concrete mixes of M25. Tests had been conducted for result of slump, density, compressive strength, flexural strength & splitting tensile strength.

Workability Test Result

Workability shows the behavior of the fresh concrete during time of mixing, handling, delivery and placement at the point of placement of concrete and then at time of compaction and finishing of the surface. It is a measurement for the deformability of the fresh concrete. Slump of all mixes are taken and shown in tabulated form and graphical form. Design is done on the basis of slump 100mm-120mm and the slump was found 115mm for M25 grade concrete

Teble3. 1: comparison of shump on addition & replacement for M2 grade

S.No	Percentage of Ground-granulated blast-furnace slag	Addition (mm)	Replacement (mm)
1	0	115	115
2	5	145	127
3	10	138	142
4	15	130	146
5	20	125	150
6	25	120	152

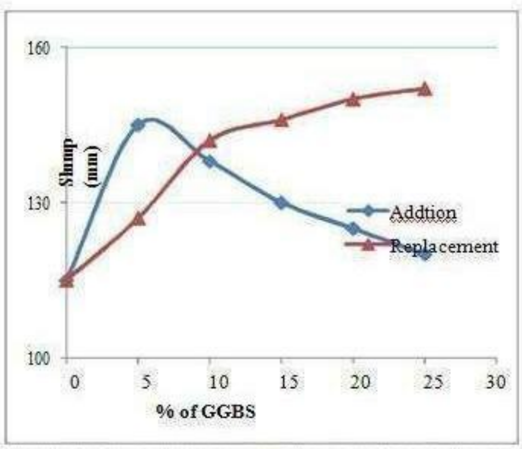

Fig-3.1 Effect of Ground-granulated blast-fumace slag on Slump of Concrete (M-25) on Addition & Replacement

Table 3.2 Density of Hardened Concrete on **Addition** of Ground-granulated blast -furnace slag into OPC & Replacement of OPC by Ground-granulated blast-furnace slag fro M25

S.NO	Percentage of Ground Granulated blast- furnace	Density of Hardened Concrete (Kg/m)	
		Addition	Replacement
1	0	2415	2415
2	5	2436	2417
3	10	2427	2423
4	15	2445	2443
5	20	2450	2443
6	25	2452	2450

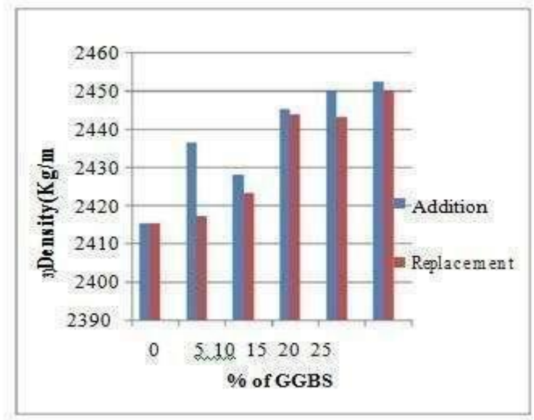

Fig-3.2 Effect of Ground-granulated blast-fumace slag on Density of Hardened Concrete (M-25) on Addition & Replacement

Flexural Strength

The Flexural strength of GGBS mixes was measured with beam specimen of size 700mm(length) x 150mm(width) x 150mm(depth).The specimens were tested after curing for 28 days fully immersed in water tank as per IS 516:1959 for method of tests for strength of concrete. The centre point loading method was used for this testing.

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Table-3.5 Comparison of Flexural Strength for 28 days on Addition Replacement For M25 Grade

S.NO	Percentage of Ground Granulated blast-furnace slag	Addition	Replacement
1	0	4.72	4.72
2	5	4.95	4.85
3	10	5.13	4.97
4	15	5.74	5.56
5	20	5.76	5.49
6	25	5.78	5.33

Table-3.6 Comparison of Splitting Tensile Strength for 28 days on Addition Replacement for M25 Grade

S.NO	Percentage of Ground Granulated blast-furnace slag	Addition	Replacement
1	0	2.48	2.48
2	5	2.71	2.54
3	10	3.11	2.61
4	15	3.27	2.76
5	20	3.36	2.78
6	25	3.41	2.65

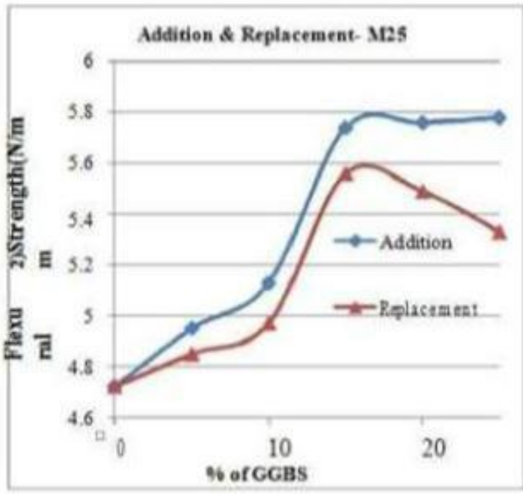

Fig-3.5 Effect of Ground-granulated blast-furnace slag on Concrete of M25 Grade on Addition & Replacement for 28 Days Flexural Strength of Beam

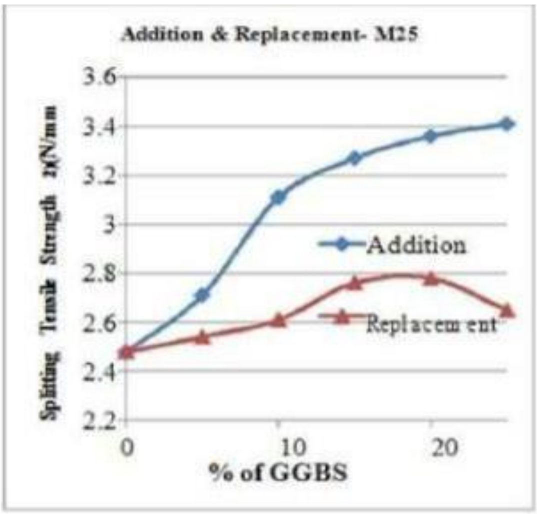

Fig-3.6Effect of Ground-granulated blast-furnace slag on Concrete of M25 Grade on Addition & Replacement for 28 Days Splitting Tensile Strength of Cylinder

Splitting Tensile Strength

The split tensile strength of GGBS mixes was measured with cylinder specimen of size 300mm(length) x 150mm(diameter).The specimens were tested after curing for 28 days fully immersed in water tank as per IS 5816:1999 for method of test splitting tensile strength of concrete.

CONCLUSION

By evaluating the results of Slump test, Density test, Compressive Strength test, Flexural Strength test and Splitting Tensile Strength test. Following conclusions have been drawn

Slump & Density

By addition of (0% to 25% with increment of 5%) Ground granulated blast furnace slag into OPC, Slump of the concrete mix was increased initially (at 5%) as compared to the slump of control mix concrete due to low water demand of Ground granulated blast furnace slag than OPC at initial stage which tends to increase in slump but the slump gradually decreased and came closely equal to the slump of control mix at 25% addition due to water demand of Ground granulated blast furnace slag was increased because increase in its particle size area which tends to decrease the slump gradually for mixes M25.

On partial replacement of (0% to 25% with increment of 5%) cement by Ground granulated blast furnace slag, the slump of the concrete mix was gradually increased up to 25 % replacement for mixes M25 due to low water demand and micro particle size of Ground granulated blast furnace slag than OPC at initial stage.

Higher slump was found as 152 mm in M25 on replacement of cement by Ground granulated blast furnace slag.

Compressive Strength

Compressive strength of concrete was increased in mixes M25, when Ground granulated blast furnace slag was added (0% to 25% with increment of 5%) to OPC. Maximum compressive strength was observed in M25- 38.44 N/mm ^{2} (21.64% greater than control mix M25),Similarly compressive strength of concrete was increased in mixes M25 when Ground granulated blast furnace slag was replacing (0% to 25% with increment of 5%) to OPC.Maximum compressive strength was observed in M25 -234.69 N/mm (7.94% greater than control mix M25) On 25% addition of Ground granular blast furnace slag into OPC for M25 grade compressive strength was nearly equal to target strength of M30 grade..

Flexural Strength

Flexural strength of concrete was increased in mixes of M25 when Ground-granulated blast-furnace slag was added (0% to 25% with increment of 5%) to OPC. Maximum flexural strength was observed M25-5.78 N/mm ^{2} (22.45% greater than control mix M25), Flexural strength of concrete was increased in mixes of M25 when Ground-granulated blast-furnace slag was replacing (0% to 25% with increment of 5%) to OPC. Maximum flexural strength was observed M25-5.49 N/mm ^{2} (17.29% greater than control mix M25),

Splitting Tensile Strength.

Splitting tensile strength was increased in mixes of M25 when Ground-granulated blast-furnace slag was added to (0% to 25% with increment of 5%) OPC. Maximum splitting tensile strength was observed M25-3.41 N/mm ^{2} (37.50% greater than control mix M25) Splitting tensile strength was increased in mixes of M25 when Ground-granulated blast - furnace slag was replacing to (0% to 25% with increment of 5%) OPC. Maximum splitting tensile strength was observed M25-2.78 N/mm ^{2} (12.09% greater than control mix M25)

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