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Detail Study of High Performance Concrete using GGBS

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Abstract **–**Concrete occupies unique position among the modern construction materials. Concrete is a material used in building construction, consisting of a hard, chemically inert particulate substance known as aggregate that is a bond by cement and water. This paper presents an experimental investigations carried out to study the effects of Ground Granulated Blast Furnace Slag(GGBS) on strength development of concrete and optimum use of slag in concrete. Cement is partially replaced with three percentage (10%, 20%, and 30%)of slag by weight of high grade concrete. Test results shows that concrete with GGBS gives more strength than normal concrete.

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I. INTRODUCTION

In the last decade the design and use of High Performance Concretes (HPC) has increased to a significant extent in India. This has been facilitated by the setting up of a large number of Ready Mix Concrete (RMC) plants that allow for high levels of quality control and ease of manufacture of concrete as per a given mix design. HPC is expensive to manufacture as it requires greater quantity of cement, use of special admixtures like super plasticizers to improve workability and high quality aggregates (Coarse and Fine). Also quality control is of utmost importance with such concretes in order to meet the twin goals of High Strength and High Durability.

In an effort to reduce cost and improve strength and durability of concrete, the cement is replaced in part by mineral binder materials such as fly ash, microsilica, metakaolin, ground

granulated blast furnace slag(GGBS) and other pozzolanic materials. These materials are cheaper than cement and while they have no cementitious properties of their own, they have a smaller particle size and remove the calcium hydroxide formed in the water-cement reaction, thereby accelerating it.

This paper analyses characteristics and properties of mixtures with ground granulated blast furnace slag (GGBS) and Silica fumes.

II. IMPORTANCE AND SCOPE

Construction is an ancient industry as old as Civilization itself. It takes care of one of Man‘s Basic needs i.e. Shelter. Some sort of cementitious materials were used by the Egyptians, Romans and Indians in their ancient constructions. It is believed that the early Egyptians mostly used cementitious materials obtained by burning gypsum while the early Greeks and Romans used cementitious materials obtained by burning limestone.

High Performance Concrete (HPC) is concrete meeting special combinations of performance and uniformity requirements that cannot always be achieved routinely using conventional constituents and normal mixing, placing and curing practices as defined by the American Concrete Institute (ACI).

HPC is a specialized series of concrete designed to provide several benefits in the construction of concrete structures that cannot be always achieved routinely using conventional ingredients, normal mixing and curing practices.

Use of High Performance Concrete has allowed the cost-effective construction of demanding projects like High-rise Buildings, Bridges, Dams, Nuclear Power Plants, Docks and so on. HPC using HRM can be used for construction of Environmentally Friendly Buildings that are also designed to be durable.

It is required when the structural design requires the Concrete to resist high load values.
It may also be used due to its early gain of Strength and other durability criteria like reduced permeability and improved wear and tear resistance. It improves most of the desirable mechanical properties of Concrete and thus may find preference over normal concrete when timeframe of project is small.
In such a concrete it is important to consider not only performance in terms of design goals like strength and durability, but also the economy, workability and consistency of results.

III. METHODOLOGY

The principle point of this work is to examine the properties superior cement with the mineral admixtures (GGBS and silica exhaust) supplanting conventional Portland concrete by a known rate to comprehend the adjustment in properties of HPC. The normal portland bond is supplanted by (GGBS10+sf3/6/9), (GGBS20+sf3/6/9), (GGBS30+sf3) rate and super plasticizers is likewise added to get workability. All out seven blend plans are readied and the properties are checked in new state and solidified state. Also, the test outcomes are contrasted with reference with the writing review. New concrete are thrown into 3D shapes, barrels and pillars. The tests are directed at 7,28,56,90 day curing for solidified concrete.

IV. MATERIALS AND PROPERTIES

4.1. Mineral admixtures

4.1.1 GGBS - ground granulated blast-furnace slag is a non metallic product consisting essentially of silicates and aluminates of calcium and other bases. The molten slag is rapidly chilled by quenching in water to form glassy sand like material. The granulated material when further ground to less than 45 micron will have specific surface about 400 to 600m2/kg. The chemical composition of blast furnace slag is similar to that of cement clinker. In this investigation, ggbs is brought from steel work at bellary. Specific gravity of ggbs is 2.62 and its chemical composition is shown in table.

Sr.no.	Parameter	Quantity(%wt)
1	Insoluble residue	0.83
2	Manganese oxide	0.25
3	Magnesium oxide	10.13
4	Sulphide sulphur	0.75
5	$CaO+MgO+1/3Al_2O_3$ $SiO_2+2/3Al_2O_3$	1.10
6	$CaO+MgO+Al_2O_3$ SiO_2	1.84

4.1.2 Silica Fumes - silica fume is a highly efficient pozzolanic material and has considerable potential for use in concrete.specific gravity is 2.15.

Sr.no.	Parameter	Value	ASTM-C-1240
1	SiO_2	91.9%	Min 85%
2	LOI	2.8%	Max 6%
3	Moisture	0.3%	Max 3%
4	Pozz.Activity index	133%	Min 105%
5	Specific surface area	22 m^2/gm	Min 15 m^2/gm
6	Bulk density	601	550-700
7	+45 microns	0.2%	Max 10%

v. Mix proportion-

To deliver HPC, the real work includes planning a suitable blend extent and assessing the properties of the solid along these lines got.

Furthermore h demonstrates great execution in compressive quality test and can satisfy other development needs since its extent has contemplated the necessities in the auxiliary configuration. The elements for HPC are like other plasticized concrete. It comprises of concrete, coarse total, fine total, water, and mineral and substance admixtures.

VI. EXPERIMENTAL PROGRAMME

The quantity of cement, fine and coarse aggregates, fly ash, silica fume, water and Super plasticizer for each batch of proportion is prepared as mentioned in design of SCC. Then the mixing process is carried out by electric mixer machine.

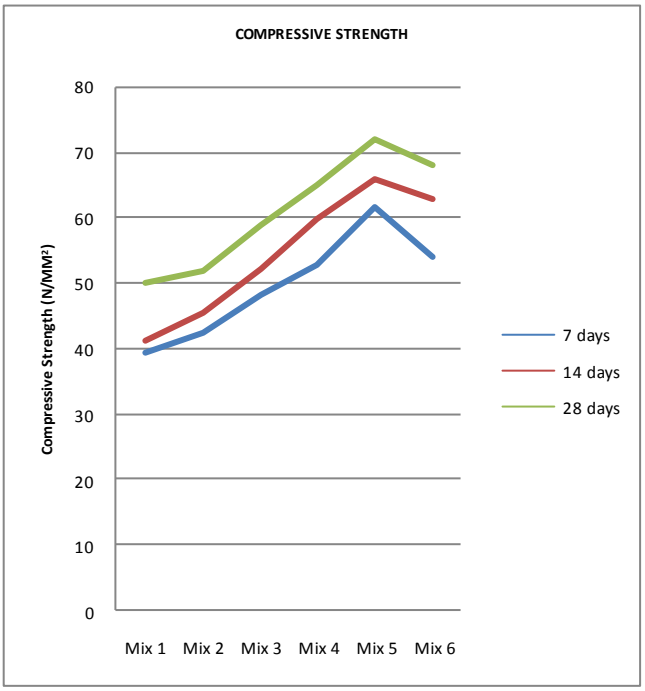
VII. MECHANICAL PROPERTIES TESTS –

To determine the hardened properties of concrete standard tests like compression test on cubes for compressive strength, split tensile test on cylinders for tensile strength and flexural test on beams for flexural strength of concrete were carried out at 28days and 56days of curing.

7.1. Compression Test -

Pressure quality of cement is characterized as the heap, which causes the disappointment of a standard example. The test of compressive quality ought to be made on 150mm size solid shapes. Place the 3D square in the pressure testing machine. The green catch is squeezed to begin the electric engine. At the point when the heap is connected continuously, the cylinder is lifted up alongside the lower plate and in this manner the example utilization of the heap ought to be 300 KN every moment and can be controlled by burden rate control handle. Extreme burden is noted for every example. The discharge valve is worked and the cylinder is permitted to go down. The qualities are classified and counts are finished.

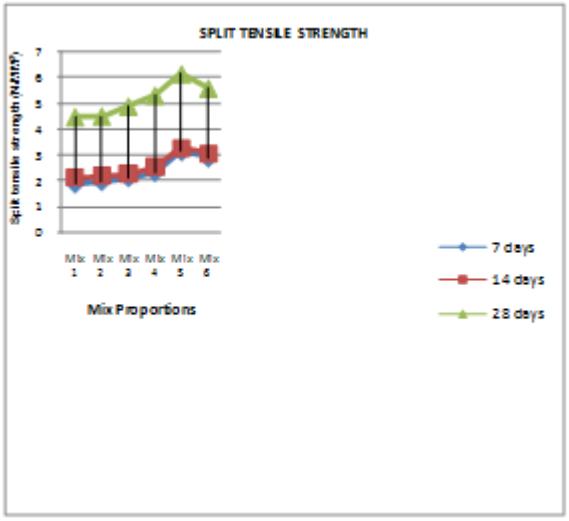
Mix	COMPRESSION STRENGTH (N/MM^2)		
	7 DAY	14 DAY	28 DAY
Mix 1	39.44	41.2	49.91
Mix 2	42.5	45.56	51.77
Mix 3	48.22	52.05	58.68
Mix 4	52.72	59.63	64.82
Mix 5	61.5	65.86	71.89
Mix 6	53.93	62.71	67.97



7.2 Split Tensile –

Test A concrete cylinder of size 150mm dia×200mm height is subjected to the action of the compressive force along two opposite edges, by applying the force in this manner .The cylinder is subjected to compression near the loaded region and the length of the cylinder is subjected to uniform tensile stress.

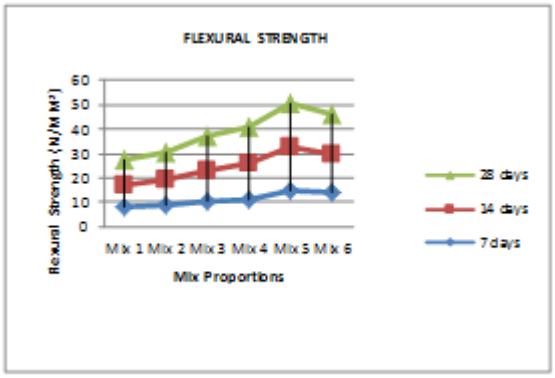
Mix	Split tensile Strength (n/mm^2)		
	7 Days	14 Days	28 Days
Mix 1	1.86	2.1	4.44
Mix 2	1.95	2.12	4.47
Mix 3	2.1	2.25	4.85
Mix 4	2.3	2.5	5.27
Mix 5	3.1	3.25	6.1
Mix 6	2.86	3.05	5.55



7.3. Flexural Test

Flexure test or modulus of rupture carried out on the beams of size (100mm×100mm×500mm), by considering the material to be homogeneous .The beam should be tested on a span of 400 mm for 100mm specimen by applying two equal loads placed at third points .To get these loads, a central point load is applied on a beam supported on steel rollers placed at third point. The rate of loading shall be 1.8 KN/minute for 100 mm specimens the load should be increased until the beam failed. Note the type of failure, appearance of fracture and fracture load.

Mix	Flexural strength (n/mm^2)		
	7 Days	14 Days	28 Days
Mix 1	8.2	8.96	10.5
Mix 2	9.1	10.1	11.5
Mix 3	10.58	12.36	14
Mix 4	11.03	14.89	15.25
Mix 5	14.7	17.75	18
Mix 6	14.3	15.56	16.5



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CONCLUSION

According to the test results, it can be concluded that M70 grade of concrete can be produced by partial replacement of cement by silica fumes & GGBS. The strength of M70 grade concrete is definitely increased by using admixtures.

1: The maximum compressive strength in M70 grade of concrete is 71.89 N/mm^2 for the replacement of cement by 20% GGBS & 6% SF mix.

2: Maximum split tensile strength is achieved is 6.1 N/mm^2 in M70 grade concrete for 28 days & for the replacement of cement by 20% GGBS & 6% SF mix.

3: Replacement of 20% GGBS & 6% SF mix gives maximum flexural strength of about 18 n/mm^2 for 28 days .

From all above it can be concluded that replacement of 20% GGBS works best for all tests than any other.

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