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Suitability & Performance of Concrete With The Addition of Ggbs As Partial Replacement of Cement

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ABSTRACT

The usage of supplement cementation materials is well accepted, since it leads to several possible improvements and enhancement in the concrete composites, as well as the overall economy. The production of cement results in emission of many green house gases in atmosphere. The concrete industry is constantly looking for supplementary cementitious material with the objective of reducing the solid waste disposal problem which may be used as partial replacement of cement in concrete like GGBS. Due to its cementing properties This article represents an study of compressive strength of concrete prepared with Ordinary Portland Cement (Ultratech) 53grade, partially replaced by ground granulated blast furnace slag (GGBS) in different proportions varying from 0%,10%,20% and 30% and local jewargi sand is used as fine aggregate and basalt is used as coarse aggregate . The optimum GGBS replacement as cementation material is characterized by high compressive strength, improved Suitability, low heat of hydration, resistance to chemical attack and workability performance of M25 grade concrete. It has been observed that, the optimum replacement of Ground Granulated Blast Furnace Slag Powder to cement without changing much the compressive strength is 20% in M25 grade concrete.

KEYWORDS OPC, aggregates, GGBS Suitabilty, compressive strengths.

I INTRODUCTION:

The Manufacturing and production of cement is an energy exhaustive process, resulting in emission of green house gases which unfavourably impact on the environment. At the same the cost of manufacturing of cement is increasing at distressing rate and natural resources giving the raw stuff for its manufacturing are depleting. The use of waste material having cementations properties as a replacement of cement in cement concrete has become the driving force area for construction material experts and researchers. The main focus now a days is on search of waste material or bye product from manufacturing processes, which can be used as partial replacement of cement in concrete, without compromising on its desired strength. The ground granulated blast furnace slag (GGBS) is a waste product from the iron manufacturing industry, Blast furnace slag is a by-product of iron manufacturing industry. Iron ore, coke and limestone are fed into the furnace, and the resulting molten slag floats above the molten iron at a temperature of about 1500oC to 1600oC. The molten slag has a composition of 30% to 40% silicon dioxide (SiO2) and approximately 40% CaO, which is close to the chemical composition of Portland cement. After the molten iron is tapped off, the remaining molten slag, which mainly consists of siliceous and aluminous residues is then rapidly water- quenched, resulting in the formation of a glassy granulate which may be used as partial replacement of cement in concrete due to its inherent cementing properties. In the country like India, where the development of the infrastructures projects such as large irrigation, road and building projects are either being constructed or in completion of their planning and design stage, such uses of waste material in cement concrete will not only reduce the emission of green house gases but also will be the sustainable way of management of waste. ground-granulated blast furnace slag used separately or in combination. The strength, durability and other characteristic of concrete depends on the properties of its ingredients, proportion of mix, method of compaction and other controls during placing and curing. For concretes, a combination of mineral and chemical admixtures is always essential to ensure achievement of the required strength using M25 Grade concrete with the addition of GGBS as partial replacement in OPC 53 grade cement. The percentage of GGBS is vary as 0% 10% 20% and 30% in ordinary Portland cement (OPC).

Benefits Of Using GGBS In Concrete

Sustainability:

It has been reported that the manufacture of one tonne of Portland cement would require approximately 1.5 tonnes of mineral extractions together with 5000 MJ of energy, and would generate 0.95 tonne of CO2 equivalent . As GGBS is a by-product of iron

Manufacturing industry.

Ground granulated blast furnace slag is off-white in colour. This whiter colour is also seen in concrete made with GGBS The more aesthetically pleasing appearance of GGBS concrete can help soften the visual impact of large structures such as bridges and retaining walls. GGBS)(sonali k. gadpalliwar, r.s.deotale, abhijeet r.narde 2014) .Cement, The second most consumed product in the world, contributes nearly 7% of the global carbon dioxide emission. Several efforts are in progress to reduce the use of Portland Cement in concrete in order to

address the global warming issues, Geo polymer concrete is a cement less concrete. It has the potential to reduce globally the carbon emission that lead to a sustainable development its high structural strength and stability. The concrete industry is constantly looking for supplementary cementitious material with the objective of reducing the solid waste disposal problem. Ground granulated blast furnace slag (and growth of the concrete industry. In this study, geo polymer concrete is prepared by incorporating ground granulated blast furnace slag (GGBS) (S. Subbaraj T Anantha Shagar 2014). concrete when subjected to serve environments its durability can significantly decline due to degradation. Degradation of concrete structures by corrosion is a serious problem and has major economic implication. In this study, an attempt has been made to study the durability of concrete using admixtures like fly ash and ground granulated blast furnace slag (GGBS) for M25 grade concrete .Cubes.

II. LITERATURE REVIEW:

The optimum level of ground granulated blast- furnace slag(GGBS) on compressive strength of concrete .GGBS was added according to the partial replacement method in all mixtures. A total of 32 mixtures were prepared on four groups according to their binder content. Eight mixes were prepared as control mixes (a.oner and s. akyuz2006). Concrete is the most widely used construction material in civil engineering industry because of specimens were casted and immersed in normal water, sea water, of various concentrations and were tested(s.p.s ramya and a.m.n. kashayap 2014). Concrete is a mixture of cement, fine aggregate, coarse aggregate and water. Concrete plays a vital role in the development of infrastructure Viz., buildings, industrial structures, bridges and highways etc. leading to utilization of large quantity of concrete. High Performance Concrete (HPC) is a concrete meeting special combinations of performance and uniformity requirements that cannot be always achieved routinely by using conventional constituents and normal mixing. This leads to examine the admixtures to improve the performance of the concrete. On the other side, cost of concrete is attributed to the cost of its ingredients which is scarce and expensive, this leading to usage of economically alternative materials in its production. This requirement is drawn the attention of investigators to explore new replacements of ingredients of concrete. The present paper focuses on investigating characteristics of M25 concrete with partial replacement of cement with Ground Granulated Blast furnace Slag (GGBS). (Venu Malagavelli and P.N.Rao 2010) The production of cement results in emission of many green house gases in atmosphere, which are responsible for global warming. Hence, the researchers are currently focussed on use of waste material having cementing properties, which can be added in cement concrete as partial replacement of cement, without compromising on its strength and durability, which will result in decrease of cement production thus reduction in emission in green house gases, in addition to sustainable management of the waste. The ground granulated blast furnace slag is a waste product from the iron manufacturing industry, which may be used as partial replacement of cement in concrete due to its inherent cementing properties. This paper presents an experimental study of compressive and flexural strength of concrete prepared with Ordinary Portland Cement, partially replaced by ground granulated blast furnace slag in different proportions Yogendra O.Patil (2013).

III.MATERIAL AND METHOD

The GGBS is a by-product in the production of iron and the amounts of iron and slag obtained are of the same order. Iron ore, coke and limestone are fed into the furnace and the resulting molten slag floats above the molten iron at a temperature of about 1500°C to 1600°C. After the molten iron is tapped off, the remaining molten slag, which consists of mainly siliceous and aluminous residue is then water-quenched rapidly, resulting in the formation of a glassy granulate. This glassy granulate is dried and ground to the required size, which is known as GGBS. The GGBS required in this study obtained from Ispats steel plant Surat. The GGBS which is used passes, 90% through 90 micron sieve.And the basaltic coarse aggregate are used from local.And Jewargi sand is used as fine aggregate. The aim of this work is to ascertain the performance of concrete mix containing GGBS as replacement of OPC and to compare it with the plain concrete mix of M25 grade.

The chemical composition of GGBS is obtained from X-ray analysis at laboratory and is shown in Table – 1.

TABLE-1: Chemical composition of GGBS :

Constituents	Percentage
SiO_2	34.4
Al_2O_3	21.5
Fe_2O_3	0.2
CaO	33.2
MgO	9.5
K_2O	0.39
Na_2O	0.34
SO_3	0.66

The cement is a material that has cohesive and adhesive properties in the presence of water, consist primarily of silicates and aluminates of lime. The OPC (53 Grade) is used for this study. The fine aggregate are material passing through an IS sieve that is less than 4.75 mm gauge beyond which they are known as coarse aggregate. The fine aggregate uses in this study is locally available river sand which conforms to zone II as per IS 10262 The coarse aggregate form the main matrix of the concrete, where as fine aggregate form the filler matrix between the coarse aggregate. The maximum size of aggregate used in this study is 20 mm. The coarse aggregate is confirmed by IS 383:1977 and is 20 mm maximum size. The cement, fine and coarse aggregates required for experimentation are tested in the laboratory and the results are shown in Table – 2.

TABLE - 2: Properties

Properties	Value
(a) Cement	
Specific gravity	3.10
Initial setting time	75 min
Final setting time	360 min
(b) Fine Aggregate	
Specific gravity	2.61
Water absorption	1%
Fineness modulus	4.84
(c) Coarse Aggregate	
Specific gravity	2.72
Water absorption	0.5%
Fineness modulus	2.83

IV. EXPERIMENTAL PROGRAMS:

The cement concrete mix is prepared as per the procedure given in the IS 10262:2009. For optimal dosage selection of GGBS in concrete mix, modified cubes (percentage ranging from (0% 10% 20% and 30%) are prepared and compared with plain cement concrete cubes .And mix proportions are (1:1.77:3.01) The replacements of OPC with GGBS are made on an equal weight basis. The w/c ratio is taken 0.5% for all

the mixes. The result of mix design of the concrete is shown in Table – 3.

TABLE - 3 : Mix specification for 1m³ concrete

Particulars	Plain concrete mix	10%	20%	30%
Cement in kg/m3	383.32	344.84	306.53	268.21
Sand in kg/m3	680.37	680.37	680.37	680.37
Coarse aggregate in kg/m3	1156.87	1156.87	1156.87	1156.87
GGBS in kg/m3	00.00	38.32	76.63	114.94
Water in kg/m3	191.58	191.58	191.58	191.58

In this investigation 36 cubes are tested. The Cubes with the dimension of 150 x 150 x 150 mm are prepared for each batch of mixes to measure compressive strength of concrete respectively at the age of 3 days, 7 days and 28 days of curing.

All the specimens are kept in water tank for curing and thereafter tested as per IS norms and standard. All the cube specimens are tested for compressive strength in compression testing machine (CTM)

V. RESULT:

The compressive strength of cement concrete containing various percentage of GGBS at the age of 3,7 and 28 days with M-25 grade concrete in ultratech OPC 53 grade are given in Table 4.

TABLE - 4: Results

Concrete Types	Compressive Strength		
	3 Days N/mm²	7 Days N/mm²	28 Days N/mm²
0%GGBS 100%OPC	17.13	23.21	32.03
10%GGBS 90%OPC	16.09	21.93	29.84
20%GGBS 80%OPC	16.04	20.04	31.18
30%GGBS 70%OPC	15.18	19.52	26.07

VI. RESULTS AND DISCUSSION:

The main aim of the study is to obtain the suitability of GGBS as replacement of OPC in concrete. The results of compression test is shown in fig. It may be observed from the plots that the properties of concrete can be maintained with GGBS as partial replacement of cement from 0% 10% 20% and 30%.Hence the results shows that maximum suitability can be attained at 20% of GGBS which is partially replaced by OPC cement as compare to plain concrete (100% OPC). The optimum replace -ment of Ground Granulated Blast Furnace Slag Powder to cement without changing much the compressive strength is 20% in M25 grade concrete.

VII. CONCLUSION:

- The increase in Percentage of GGBS results in decrease in strength of concrete. But at 20% GGBS the compressive strength is nearer to plain concrete mix,at the age of 28 days curing.
- The reduction in the cost of concrete at the current market rate is 14%, in the case of GGBS as replacement of OPC by 30%.

The partial replacement of OPC in concrete by GGBS, not only provides the economy in the construction but it also facilitates environmental friendly disposal of the waste slag which is generated in huge quantities from the steel industries.

The optimum GGBS replacement as cementation material is characterized by high compressive strength, Suitability, low heat of hydration, resistance to chemical attack and better workability performance of M25 grade concrete.

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