Research Paper Engineering

Experimental Investigation on Strength of High Performance Concrete with GGBS and Crusher Sand

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ABSTRACT

Concrete has been the major instrument for providing stable and reliable Infrastructure. Deterioration, long term poor performance, and inadequate resistance to hostile environment, coupled with greater demands for more sophisticated architectural form, led to the accelerated research into the microstructure of cements and concretes and more elaborate codes and standards. As a result, innovations of supplementary materials and composites have been developed. 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. 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 M35 concrete with partial replacement of cement with Ground Granulated Blast furnace Slag (GGBS) and sand with the Crusher sand . The cubes and cylinders are tested for both compressive and tensile strengths. It is found that by the partial replacement of cement with GGBS and sand with Crusher sand helped in improving the strength of the concrete substantially compared to normal mix concrete.

Keywords : Compressive Strength, Split Tensile Strength, GGBS, Crusher Sand.

INTRODUCTION

Creating quality concrete in the present climate does not depend solely on achieving a high strength property. Improving the durability of the concrete to sustain a longer life span and producing a greener concrete are becoming one of the main criteria in obtaining quality concrete. By using industrial by-products such as Ground Granulated Blast-furnace Slag (GGBS) as mineral admixture partially replacing Ordinary Portland Cement (OPC) in the concrete, the amount of greenhouse gas produced in making the concrete and the energy required to produce the concrete are reduced. GGBS is a by-product formed when molten iron blast furnace slag is rapidly chilled by immersing it in water. When finely ground and mixed with OPC, it will produce binding properties. The production of slag is more environmentally friendly compared to the production of OPC, thus producing a more environmentally friendly concrete than the OPC concrete.

This paper presents the study of compressive strength and split tensile strength of M35 conventional concrete by replacing the 0 to 30% of sand with Crusher sand and 30 to 50% of cement with GGBS. Tests were conducted on concrete cubes and cylinders to study compressive and split tensile strengths. The results are compared with the normal conventional concrete.

MATERIALS:

CEMENT:

Ordinary Portland cement of 53 grade confirming to IS 12269-1987. The properties of cement given in Table No. 1.

Bulk density	1400 kglm^3
Specific Gravity	3.15
Initial Setting Time	120
Final setting Time	170
Le-Chatelier Soundness test	1 %

Compressive strength of mortar cubes (70.6mm size), N/mm^2	3 Days	7 Days
	29.49 MPa ≥ 27 MPa	39.80MPa ≥ 37 MPa)

FINE AGGREGATE:

Fine Aggregate is from Bodeli near Vadodara. The Properties of Fine Aggregate is given in Table no.2.

Gradation	Falls in Zone I
Moisture Content	1.8 %
Fine Modulus	3.27
Specific Gravity	2.4
Slit Content	0.30%
Bulk Density	1720 kg/mm^2
Moisture Content	1.88%

COURSE AGGREGATE:

Aggregate is from Timba-Savli near Vadodara. The Properties of Course Aggregate is given in Table no.3.

Aggregate Impact value	10.7
Aggregate Crusher Value	11.9
Aggregate Abrasion Value	16.1
Gradation	Falls in 20 mm size
Flakiness Index,	14.2 %
Elongation Index	12.4 %
Specific Gravity	2.9
Bulk Density	1625 kg/mm^2

CRUSHER SAND:

Crusher Sand is From Source. The Properties of Crusher Sand is given in Table no.4.

Specific Gravity	2.6
Moisture Content	1.8%

GGBS:
Ground-granulated blast-furnace slag (GGBS or GGBFS) is obtained by quenching molten iron slag (a by-product of iron and steel-making) from a blast furnace in water or steam, to produce a glassy, granular product that is then dried and ground into a fine powder. The chemical composition of a slag varies considerably depending on the composition of the raw materials in the iron production process. Silicate and aluminate impurities from the ore and coke are combined in the blast furnace with a flux which lowers the viscosity of the slag.

The Properties of GGBS is given in table no 5.

Characteristics	Requirement as per BS: 6699	Test Result
Fineness(M^2/Kg)	275 (min)	400
Soundness Le-Chatelier Expansion (mm)	10.0 (max)	Nil
Initial Setting Time(min) Not less than OPC	Min. 30 Minutes	220
Insoluble Residue(%)	1.5 (max)	0.05
Magnesia content(%)	14.0 (max)	9.5
Sulphide sulphar(%)	2.00(max)	0.6
Sulphite content(%)	2.50(max)	0.1
Loss on Ignition(%)	3.00(max)	0.3
Manganese Content(%)	2.00(max)	0.06
Chloride content(%)	0.10 (max)	0.003
Moisture content(%)	1.00 (max)	0.005
Glass content(%)	67 (min)	94
Compressive strength (N/mm²) After 7 days After 28 days	 12.0 (min) 32.5(min)	 34 53
$CaO+MgO+SiO_2$ $CaO+MgO+SiO_2$ CaO/SiO_2	66.66 (min) >1.0 <1.40	84 1.3 1.05

Compressive strength soundness and initial setting time on blend of 70% GGBS: 30% OPC.

ADMIXTURES:
A locally available admixture by the name CONFLOW SP-1 has been used to enhance the workability of the concrete.

MIX DESIGN:
The concrete mix is designed as per IS 10262 – 1982, IS 456-2000 and SP 23 for the conventional

concrete and finally 0 to 30% river sand has been replaced by ROBO sand and 30 to 50% cement replaced with GGBS by volume. The water cement ratio is 0.42. The mix proportions of M30 concrete are 1:1.73:2.47.

TEST SPECIMENS AND TEST PROCEDURE:
The concrete cubes of 150mm size, cylinders of size 150mm diameter and 300mm length were used as test specimens to determine the compressive strength of concrete and split tensile strength of concrete for the both cases i.e. normal concrete and modified concrete. The ingredients of concrete were thoroughly mixed till uniform consistency was achieved. The cubes and cylinders were compacted on a vibrating table. The properties of fresh concrete were measured according to IS 1199 – 1959.

RESULTS AND DISCUSSIONS:
Experiments were conducted on normal concrete and modified concrete by replacing sand with Crusher sand and cement with GGBS. It is observed that the workability of concrete decreases with increase in percentages of ROBO sand.

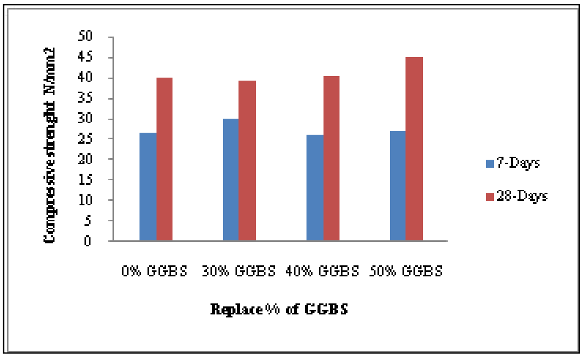

Fig:1. Compressive Strength of Concrete at 7 and 28 days.

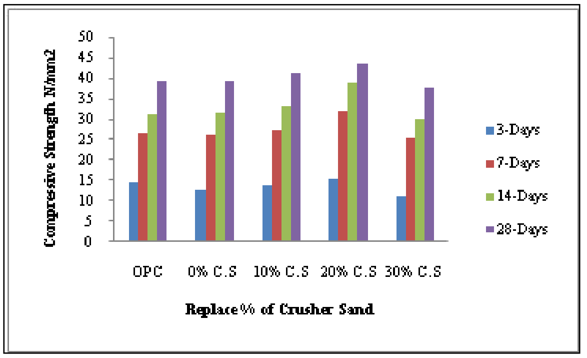

Fig.2. Compressive Strength of Concrete with various replacement level of Crusher Sand.

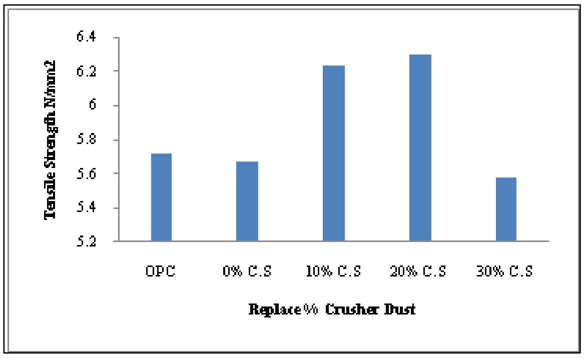

Fig no.3 Split Tensile strength of Concrete at 28 Days.

CONCLUSIONS
From the above experimental results it is proved that, Crusher sand can be used as alternative material for

the fine aggregate i.e. sand. Based on the results the compressive and split tensile strengths are increased as the percentage of Crusher sand increased. GGBS can be used as one of the alternative material for the cement. From the experimental results 50% of cement can be replaced with GGBS. The percentage increase of compressive strength of concrete is 10.04 and 16.54% at the age of 7 and 28 days by replacing 40% of cement with GGBS and 20% of sand with Crusher sand.

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