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Study experimental analysis on glass wool concrete with ground granulated Blast furnace slag

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ABSTRACT

Use of waste material in concrete is important for environmental aspect. Granulated Blast Furnace Slag is a waste product of steel foundry. Our experimental study is to investigate the impact of Ground Granulated Blast Furnace Slag in to the concrete by partial substitution of cement content and at the same time the effect of introducing glass wool into the concrete. In this work cement is partially replaced with GGBFS (0%10%20%40%) by weight in the glass wool mixed (0.1% of the weight of cement) concrete. The grade of concrete is M25 and water cement ratio is 0.47 taken as a reference. Cubes, cylinders and prisms are cast and tested for 7, 14 and 28 days. The GGBFS have fineness about 96% and specific gravity 2.98. One effective way to reduce the environmental impact is to use mineral admixtures, as a partial replacement both in concrete and mortar, which will have the potential to reduce costs, conserve energy, and minimize waste emission. Also it requires checking various properties of concrete like compression test, flexural test with variation of GGBFS and constant dosage of glass wool. Mineral admixtures are found in various forms in nature, including blast furnace slag, fly ash, and silica fume. The use of mineral admixtures improves the compressive strength, pore structure and permeability of concrete and mortar because the total porosity decreases with increasing the hydration time. Recycling of waste material saves natural resources, saves energy, reduces solid waste, reduces air and water pollution and reduces greenhouse gases.

Index terms: GGBS, Fly ash, Silica fume, Waste material

INTRODUCTION

Large quantities of waste materials and by-products are generated from manufacturing processes, service industries, municipal solid waste, etc. As a result, solid waste management has become one of the major environments, scarcity of land-fill space and due to its ever increasing cost, waste materials and by-products utilization has become an attractive alternate to disposal. Blast furnace slag is a large scale waste product in the steel industry. So the effective utilization of this product by introducing as a partial substitute for cement in concrete structures will help to reduce the difficulties of waste disposal and also to reduce the production of cement considerably. Reduction of cement production reduces the exploitation of mineral sources and also the generation of toxic gases and fumes. In addition to effective waste utilization, we are introducing micro fibers of glass fibre reinforced polymer into the concrete, in addition to its usual ingredients, to impart the capacity to take tensile stresses to some extent. The objective of this work was the unit cost of concrete can be reduced by partial replacement of cement with ground granulated blast furnace slag. Concrete making with conventional material is becoming

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costlier day by day. Moreover concrete suffers little resistance to cracking. These problems are overcome by inclusion of GGBFS and glass wool in concrete.

AIMS AND OBJECTIVES

- Compressive strength of normal concrete and glass wool GGBFS concrete.
- Tensile strength of normal concrete and glass wool GGBFS concrete.
- Flexural strength of normal concrete and glass wool GGBFS concrete.

METHODOLOGY

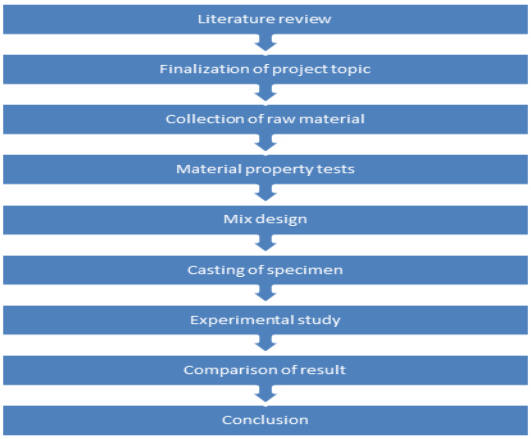

Fig1.Chart showing the methodology

MATERIAL PROPERTIES

Cement

Table 1. Cement standard value

Properties	Standard Value (IS 12269-1987)
Fineness of cement	1.3%
Standard consistency	30%
Specific gravity	3.03
Initial setting time	160 minute
Cement mortar cube strength	50.31N/mm2

Coarse Aggregate

Table 2. Permissible value of coarse aggregate

Properties	Permissible range (is 15658 – 2006)
Sieve analysis	5.73%
Specific Gravity	2.83

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Water

Water used for mixing is to be fresh and free from any organic and harmful solution, which will lead to deterioration in the properties of the mortar. Salt water is not acceptable but chlorinated drinking water can be used. Potable water is generally considered as been acceptable, hence potable clean water is used for casting as well as for curing of the test specimen.

Ground granulated blast furnace slag

GGBFS is used to make durable concrete structures in combination with ordinary Portland cement. GGBFS has been widely used in Europe, and increasingly in the United States and in Asia for its superiority in concrete durability, extending the life span of buildings from 50 years to 100 years.

Table 3. Ground granulated blast furnace slag

Composition	Proportion (%)
SiO_2	35.34
Al_2O_3	11.59
Fe_2O_3	0.35
CaO	41.99
MgO	8.04

MIX PROPORTION W.R.T. REPLACEMENT OF CEMENT WITH PERCENTAGE GGBS

Table 4. Mix Proportion Replacement of cement

Ingredient	0%	10%	20%	40%
Cement	336 kg.	302.4 kg.	268.8 kg.	201.6 kg.
Glass wool	0.336 kg.	0.336 kg.	0.336 kg.	0.336 kg.
Water	158 lt.	158 lt.	158 lt.	158 lt.
GGBFS	0	33.6 kg.	67.2 kg.	134.4 kg.
Admixture	1.344kg.	1.344kg.	1.344kg.	1.344kg.
Fine Aggrt.	717 kg.	717 kg.	717 kg.	717 kg.
Coarse Aggrt.	1303 kg.	1303 kg.	1303 kg.	1303 kg.

RESULTS

Slump cone test result

Mix	Slump
M25 Control mix Without glass wool	110
M25 Control mix With glass wool	105
M25 with 10% GGBFS	105
M25 with 20% GGBFS	100
M25 with 40% GGBFS	100

COMPRESSIVE STRENGTH RESULT

Mix	7 days	14 days	28 days
M25 Control mix Without glass wool	15.75	21.00	26.5

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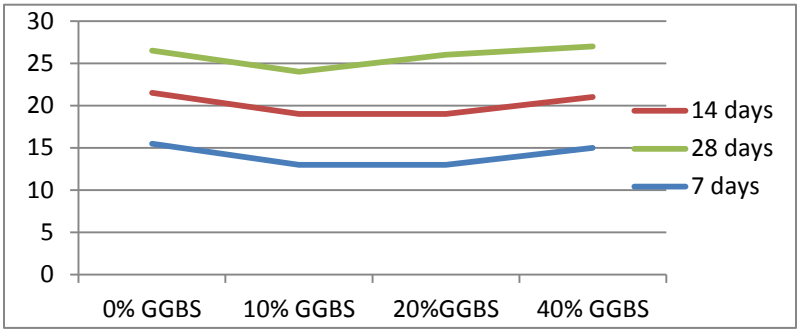
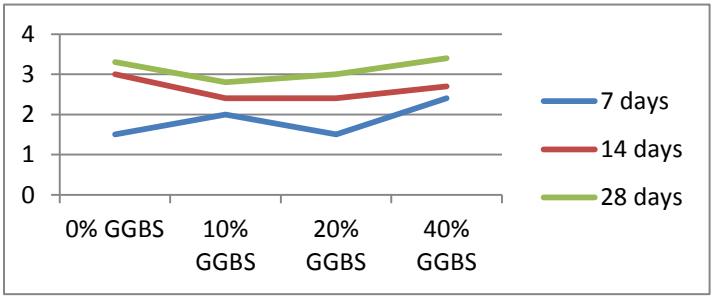
M25 Control mix With glass wool	15.50	21.50	26.5
M25 with 10%GGBFS	13.0	19.0	24.0
M25 with 20%GGBFS	14.5	19.0	26.0
M25 with 40%GGBFS	15.0	21.0	27.0



COMPRESSIVE STRENGTH V/S PERCENTAGE GGBS

Split tensile strength result

MIX	7 days	14 days	28 days
M25 Control mix Without glass wool	1.0	2.8	3.1
M25 Control mix With glass wool	1.5	3.0	3.3
M25 with 10% GGBFS	2.0	2.4	2.8
M25 with 20% GGBFS	1.5	2.4	3.0
M25 with 40% GGBFS	2.4	2.7	3.4



Split tensile strength v/s percentage GGBS

MIX	FIRST CRACK FORMATION	FLEXURAL STRENGTH
M25 Control mix Without glass wool	3.8	4.7
M25 Control mix	4.5	4.8

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With glass wool		
M25 with 10%GGBFS	4.3	4.5
M25 with 20%GGBFS	4.5	4.6
M25 with 40%GGBFS	4.5	4.7

CONCLUSION

Studied by investigating that the partial replacement of cement by ground granulated blast furnace slag up to 40%, the strength of concrete remains more or less same with slight variations at varying percentages. From this we can understand that the replacement up to 40% of costly cement can be done with an industrial waste product like blast furnace slag without affecting the strength and durability of concrete. The use of cementations material GGBS replaced concrete emits less CO_2 emissions in to environment than the cement based concrete. The production of blast furnace slag is increasing in every year and these are very hazardous and threat to the living being. It pollutes the air and soil. So these materials should properly be disposed. Hence by using this material in construction industry will reduce the harmful impact on environment. By the introduction of glass wool in the concrete, the tensile load carrying capacity of the concrete is increased. It is seen from the flexural strength test that failure crack is formed early before the failure of the specimen in which glass wool is not mixed with, where as in the specimen with glass wool, failure crack is formed just before the failure of specimen. From this we can understand that the addition of glass wool in the concrete reduces the crack formation to some extent.

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