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Research Article

Investigation On High Strength Concrete By Using GGBS and Polycarboxylate Ether - An Experimental Approach

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Concrete is a mixture of cement, fine gravel, coarse gravel and water. Concrete plays an important role in the development of infrastructure such as buildings, industrial structures, bridges and roads. On the other hand, the price of concrete is attributed to the scarcity and cost of its materials by the use of economically alternative materials in its production. This need to find new alternatives to concrete material has caught the attention of researchers. The current technical report focuses on the research properties of concrete, the partial replacement of cement with ground granulated blast furnace slag (GGBS) and the complete replacement of R-sand with M-sand. This topic explains the use of GGBS and the advantages and disadvantages of using it in concrete. This use of GGBS serves as an alternative to the already declining traditional building materials and as a by-product in recent years as well as an eco-friendly way to keep production from falling to the ground. Polycarboxylate ether is used here to reduce the percentage of water. Trials are done in 7 days, 14 days, and 28 days.

Keywords: GGBS, Polycarboxylate, CO2 emissions, building material.

1. Introduction

With a production of nearly six billion tons per year, concrete is probably the most widely used building material in the world. Only water per capita consumption follows. However, environmental sustainability is at risk in terms of damage from raw material extraction and CO_2 emissions during cement manufacturing. This put pressure on researchers to partially replace cement with complementary materials to reduce cement consumption. These materials can occur naturally, be industrial waste or low energy by-products.

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These substances (known as pozzellonas) exhibit semantic properties when mixed with calcium hydroxide. Commonly used are pozzolanous fly ash, silica fume, metacoline, ground granulated blast furnace slag (GGBS). GGBS as a potential partial replacement material for cement. Among the various methods used to improve the durability of concrete and to obtain high performance concrete, the use of GGBS is a relatively new approach; The main problem is its high sensitivity and high water requirement when mixed with ordinary Portland cement. Where R-sand is completely (100%) replaced with M-sand. Cement 30%, 35%, 40%, 45%, 50%, 55% is replaced with GGBS and chemical compounds (polycarboxylate ethers) are used in 0.4%. Tests are done in 7 days, 14 days and 28 days.

2. Literature review

Shariq et al.(2008) studied the effect of the curing process on the compressive strength development of cement mortar and induction ground granulated blast furnaces slag. Tests for the development of compressive strength of cement mortar with 20, 40 and 60 percent replacement of GGBFS for different types of sand and development of strength of concrete with 20, 40 and 60 percent replacement of GGBFS over two grades of concrete. Is Test results show that it is important to increase the compressive strength of the mortar after 28 days and 150 days to have 20% and 40% GGBFS, respectively.

Peter et al. (2010) studied BS 15167-1, which has a minimum specific surface area of GGBS of 2750 cm^2 / g (BS 15167-1: 2006). In China, GGBS is classified into three grades; they are S75, S95 and S105. GB / T18046 requires a surface area of 3000 cm^2 / g for grade S75 GGBS, 4000 cm^2 / g for grade S95 and 5000 cm^2 / g for grade S105, which meets BS EN (GB / T18046- 2008) requirements). More slag GGBS concrete with a specific surface area between 4000 cm^2 / g and 6000 cm^2 / g is reported to greatly improve performance.

3. Materials

3.1. Cement

Cement is used as a binding material. Two types of cement were used during the pilot test: 1. Typical Portland cement 53 grade (brand: Dalmia) compliant with IS: 12269-1987 in terms of control mixture. IS: 269/4831. According to the physical properties of the cement obtained after conducting appropriate tests.

Table 1 : Physical properties of cement

Type of cement	OPC 53
Standard consistency	29%
Initial setting time (in mins)	124
Final setting time (in mins)	299
Specific gravity	3.15

3.2. GGBS

Ground-granulated blast-furnace slag (GGBS or GGBFS) molten iron slag (a by-product of the manufacture of iron and steel) by steam cooling in water or blast furnace to produce glass, drying the particle product and finely drying Grind. GGBS is a by-product of the aluminum industry, although GGBS's application is a key factor in reducing overall costs. GGBS usage can reduce CO2 emissions by 80%.

Table 2 : Physical properties of GGBS

Description	Value
Standard consistency	35%
Initial setting time (in mins)	126
Final setting time (in mins)	362
Specific gravity	0.19%
Water absorption	2.85

Fig.1. Ground Granulated Blast slag

3.3. Polycarboxylate ether

The first dispersing compounds came from the 1930s; but it was not until the 1960s that sulfonated melamine formaldehyde was developed in Germany. New compounds based on polycarboxylate ethers were developed in the late twentieth century, with structural properties that provide more liquid concrete, and greater resistance to separation and exudation than those previously known with super plastics. For these reasons, polycarboxylate composites are now being introduced into cement systems to replace melamine and naphthalene based composites.

Fig.2. Polycarboxylate Ether

4. Concrete mix design

For the current work, M60 grade concrete was adopted and the control mix concrete (without mixture) mixing ratio was obtained according to the IS method described in IS 10262. A similar mixing ratio was adopted for concrete with different PCE based water reducing compounds. The calculation is completed and finally the mixing ratio is selected, which gives the required 28 days compressive strength with minimum cement content and the required working capacity of 100 mm is selected.

Cement	446 Kg/m3
Water	156 litre
Fine aggregate	856 Kg/m3
Coarse aggregate	1171 Kg/m3
Chemical admixture	1.784 Kg/m3
Water-cement ratio	0.35

MIX RATIO 1:1.92:2.62:0.35

5. Results and Discussion

5.1. Comparison of compressive strength at 7 days,14 days & 28 days

S.No	Type of Concrete	Compressive Strength (N/mm^2)		
		7 days	14 days	28 days
1	Conventional	36.98	42.25	49.91
2	GGBS (30%)	41.98	53.06	58.26
3	GGBS (35%)	42.74	55.26	61.15
4	GGBS (40%)	45.09	55.53	64.86
5	GGBS (45%)	46.04	57.73	68.92
6	GGBS (50%)	41.27	52.97	56.26
7	GGBS (55%)	40.50	51.72	54.63

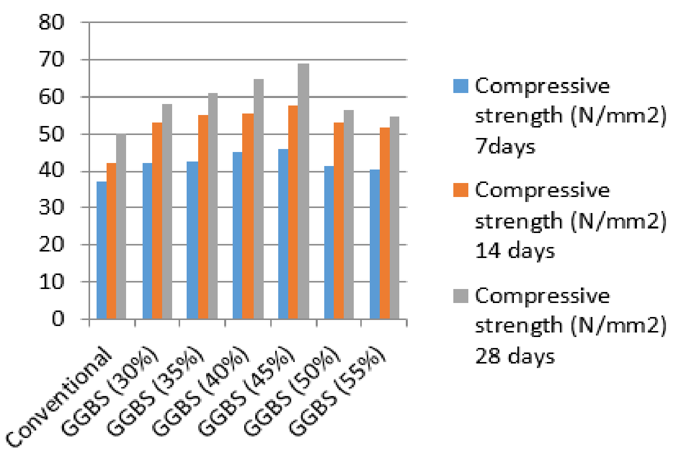

Fig.3. Comparison of Compressive Strength

5.2. Comparison of Flexural strength at 7 days,14 days & 28 days

S.No	Type of Concrete	Flexural Strength (N/mm^2)		
		7 days	14 days	28 days
1	Conventional	8.93	9.30	10.8
2	GGBS (30%)	9.03	10.7	11.54
3	GGBS (35%)	9.23	11.5	13.05
4	GGBS (40%)	10.5	12.4	14.4
5	GGBS (45%)	12.7	13.5	15.08
6	GGBS (50%)	9.20	11.7	12.7
7	GGBS (55%)	9.05	11.32	12.1

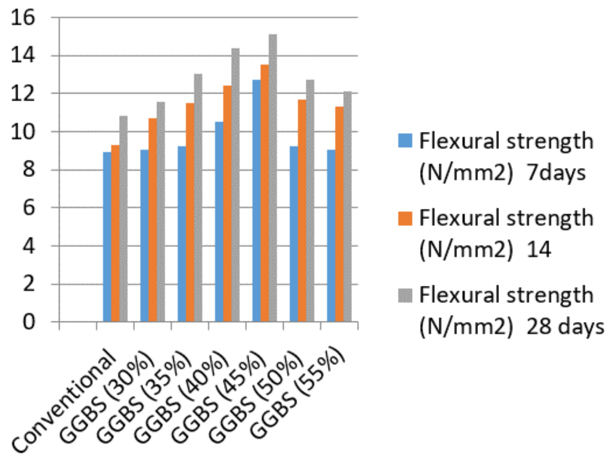

Fig.4. Comparison of Flexural Strength

5.3. Comparison of Split tensile strength at 7 days,14 days & 28 days

S.No	Type of Concrete	Split tensile Strength (N/mm^2)		
		7 days	14 days	28 days
1	Conventional	2.16	2.93	3.3
2	GGBS (30%)	2.57	3.42	4.03
3	GGBS (35%)	2.61	3.57	4.17
4	GGBS (40%)	2.74	3.65	4.23
5	GGBS (45%)	2.83	3.79	4.51
6	GGBS (50%)	2.44	3.26	3.45
7	GGBS (55%)	2.32	3.15	3.23

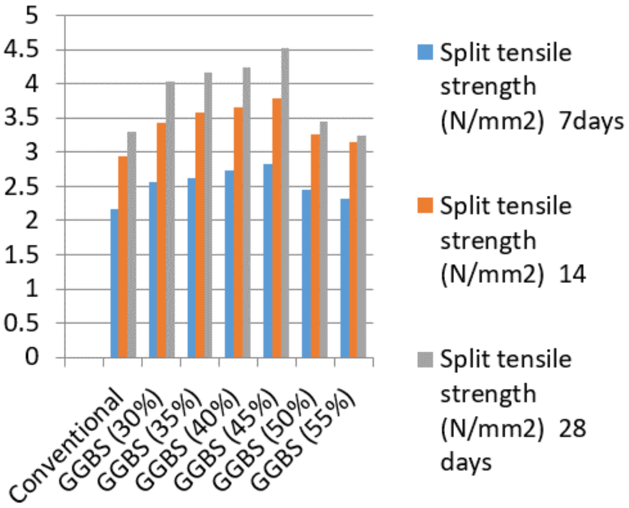

Fig.5. Comparison of Flexural Strength

6. Conclusion

In this project, mix designs for M60 concrete grades using GGBS (30%, 35%, 40%, 45%, 50%, 55%) and different percentage replacement levels of chemical compounds (polycarboxylate ethers). The strength, tensile strength and flexural strength of concrete are 45% higher than normal concrete with GGBS replacement. The introduction of M Sand has reduced the demand for natural sand, as it provides more strength and is more economical. Concrete can be obtained by reducing the volume of water by adding super plasticizers. This experimental test work can be used in subsequent experiments on the potential of ground granulated blast furnaces slag as an alternative to cement for concrete.

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