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INVESTIGATION ON PARTIAL REPLACEMENT OF CEMENT BY GGBS

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Abstract

The usage of cement in the building sector increases CO2 emissions, which can be reduced by using additives instead of cement. Ground granulated blast furnace slag is made by quenching molten iron slag from a blast furnace in water, drying it, and grinding it into a fine powder that is highly cementitious and rich in CSH (calcium silicate hydrates), which boosts the strength and durability of concrete. Another supplemental cementitious ingredient is metakaolin. It is not a byproduct of an industrial process. It is made by heating Kaolin to temperatures ranging from 600 to 900 degrees Celsius. In this investigation, conventional Portland cement complying to IS 8112-1989, fine and coarse aggregate conforming to IS 383 (2011), GGBS, and metakoalin were utilised. The materials utilised are GGBS and metakaolin individually with a water-cement ratio of 0.45 and M25 grade concrete to replace cement content by 20, 30, 40, and 50% of the weight of cement. Compressive tests and split tensile strength adhering to IS516 (1964) and flexural strength conforming to ASTM C78 were performed on hardened concrete at 7, 14, and 28 day intervals.

1. Introduction

To meet the needs of globalisation, Asian countries have taken a serious initiative in developing infrastructures such as categorical highways, power lines, and industrial structures, among other things. In the construction of buildings and alternative structures, concrete plays an important role, and a large quantity of concrete is used. The use of cement in the housing business would raise carbonic acid gas emissions, which can be mitigated by adding additives in situ of cement. The most costly and energy-intensive component of concrete is cement. The cost of concrete is decreased by partially replacing company effluents that are high in pozzolanic elements.[8,9]

The research employed a concrete cube of 150 x 150 x 150 metric linear units, a cylinder with a diameter of 150 mm and a depth of 300 metric linear units, and a prism measuring 100 x 150 metric linear units. Mechanical properties and sturdiness tests were carried out on the specimens. Compressive strength, split endurance, and flexural strength were all tested. Marble mud, silicon oxide fume, phospogypsum, metakaolin, GGBS, Rice husk ash, fly ash, and other commercial wastes rich in pozzolanic elements can be used in concrete to reduce severe environmental difficulties. [10]

2. Materials & its Properties

i) Cement

Cement has the ability to bond all of the essential ingredients needed in the manufacture of concrete. Cement is a substance made by combining oxide, clayey, and carbonate components and crushing them into a fine powder. Typically, OPC and PPC are used in the production of concrete. The principal ingredients of OPC and PPC are typically lime, silica, alumina, iron oxide, magnesia, alkalis, and sulphur tri compound. The production of OPC and PPC cement is fairly simple and is based on the use of abundant raw materials. An intimate combination, often of stone and clay, that is baked in an extremely oven between 1400 and 1600 degrees Celsius, which is the temperature at which the two materials react with chemicals to generate metal silicates. Table 1 illustrates the properties of cement.

Table 1. Properties of Cement

Property of Cement	Values
Fineness Of Cement	8%
Grade Of Cement	53
Specific Gravity	3.15
Initial Setting time	30 minutes
Final Setting Time	600 minutes

ii) Course Aggregate

The important element for concrete strength is coarse mixture, which is obtained from the quarry. According to IS 383:1970, coarse aggregates are particles larger than 4.75 mm and range in size from 9 mm to 38.5 mm. The project employed aggregates that passed a 25 mm sieve and were maintained on a twenty metric linear unit sieve.

Aggregates are utilised as cost-effective filler and typically provide concrete with greater dimensional stability and wear resistance. In concrete, arduous shattered granite stones were employed as a rough mixture. Aggregates must be tough and durable, free of unwanted contaminants, and chemically stable in order to achieve an honest concrete quality. Table 2 illustrates the properties of course aggregate.

Table 2. Properties of Course Aggregate

Properties	Values
Specific Gravity	2.80
Size Of Aggregates	20 mm
Fineness Modulus	7.17

iii) Fine Aggregate

Fine aggregates rectangular degree usually includes watercourse sand and beaten stones that rectangular degree passing through 9.5 mm sieve. Fine aggregates rectangular degree sieved with the aid of using 5 mm sieve and additionally the debris passing thru the sieve rectangular degree taken. Fine aggregates rectangular degree usually divided into sector I to IV in step with their grain length distribution and additionally the specs rectangular degree as according to IS 383:1970. Course sand is regularly used as affordable filler, aggregates usually deliver concrete with better balance and put on resistance. To get a correct concrete quality, aggregates have to be arduous and robust, free of unwanted impurities, and with chemicals stable. The aggregate that passes through 4.75mm sieve is adopted. Table 3 illustrates the properties of fine aggregate.

Table 3. Properties of Fine Aggregate

Properties	Values
Specific Gravity	2.74
Fineness Modulus	2.805

iv) GGBS

Blast furnace with ground granules Slag is formed by evaporating molten iron slag from a furnace in water or steam, resulting in a glassy, granular product that is dried and ground into a fine powder. GGBS is a building material with a high CSH content that could be used to improve the strength, sturdiness, and appearance of concrete. CaO (30–50 percent), SiO2 (28–38 percent), Al2O3 (8–24 percent), and MgO (1–18 percent) are the most common components in furnace dross. When the CaO content of the dross is increased, it usually results in enhanced dross basicity and compressive strength. On the one hand, the MgO and Al2O3 content exhibit a similar trend up to severally 10–12 percent and Bastille Day, on the other hand, no improvement is seen. Many integrative ratios or dubious hydraulic indices are commonly used to link dross composition to hydraulic activity, with the latter being mostly determined by the binder compressive strength. Glass content of slag suitable for mixing with OPC ranges from 90 to 100 percent, depending on the cooling technique used and the temperature at which cooling begins. The proportions of network-forming components like Si and Al over network modifiers like Calcium and Magnesium, and to a lesser extent, the proportions of network modifiers like Calcium and Magnesium, determine the glass structure of quenched glass. Table 4 illustrates the properties of GGBS

Table 4. Properties of GGBS

Properties	Values
Bulk density	1 t/m^3
Relative density	2.91
Surface area	515 m^2/kg

3. Test Results

i) Test for fresh concrete

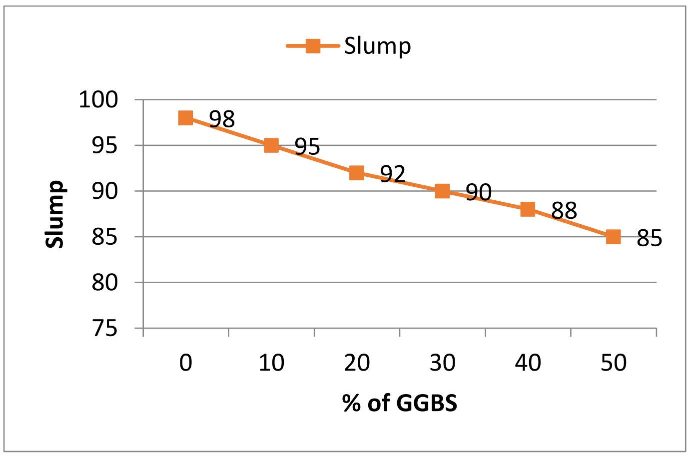
a) Slump flow test

Slump cone test was conducted to find out the workability of fresh concrete. Table 5 illustrates the slump value of fresh concrete.

Table 5. Slump Vaue

Mix	Value
M30	98
10 % GGBS	95
20 % GGBS	92
30 % GGBS	90
40 % GGBS	88
50 % GGBS	85

Fig 1. Slump Value



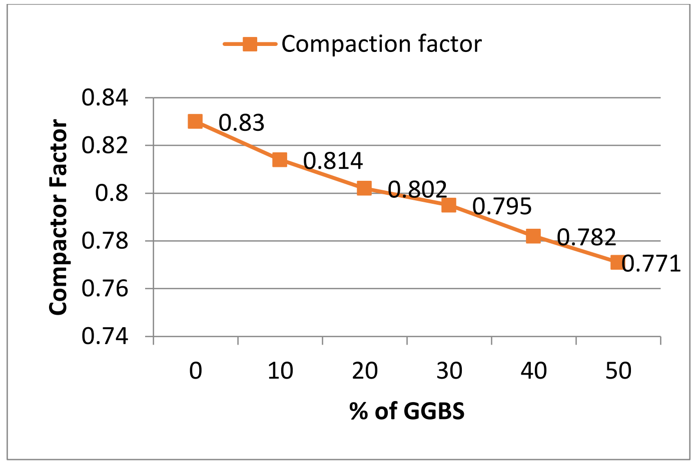
b) **Compaction factor test results**

Compaction factor test was conducted to find out the workability of fresh concrete. Table 6 illustrates the compaction factor of fresh concrete.

Table 6. Compaction factor

Mix	Partially compacted concrete (kg)	Fully compacted concrete (kg)	Compaction factor
M30	10.28	12.54	0.83
10 % GGBS	12.40	15.2	0.814
20 % GGBS	12.75	14.92	0.802
30 % GGBS	12.56	15.52	0.795
40 % GGBS	12.35	15.41	0.782
50 % GGBS	12.23	15.29	0.771

Fig 2. Compaction factor



ii) Harden Concrete Test

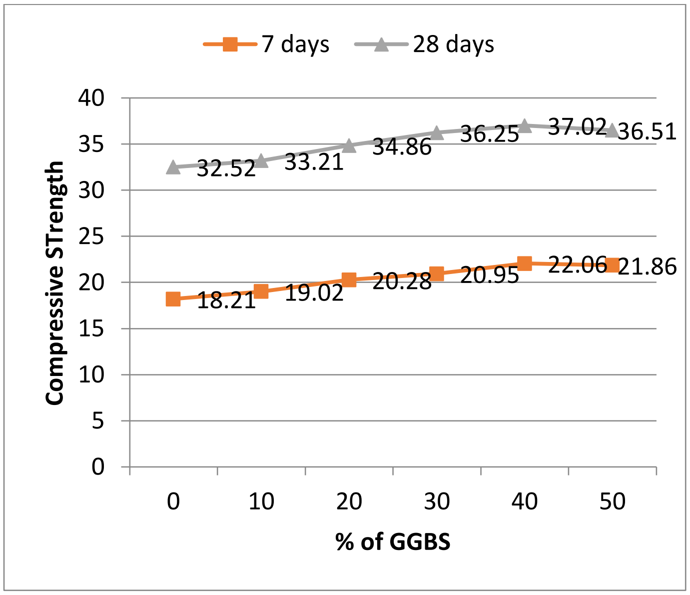
a) Compressive strength test

Compressive strength results of the concrete mixtures tested with and without GGBS. Table 7 illustrates the compressive strength of harden concrete.

Table 7. Compressive strength

Mix	7 days	28 days
M30	18.21	32.52
10 % GGBS	19.02	33.21
20 % GGBS	20.28	34.86
30 % GGBS	20.95	36.25
40 % GGBS	22.06	37.02
50 % GGBS	21.86	36.51

Fig 3. Compressive strength



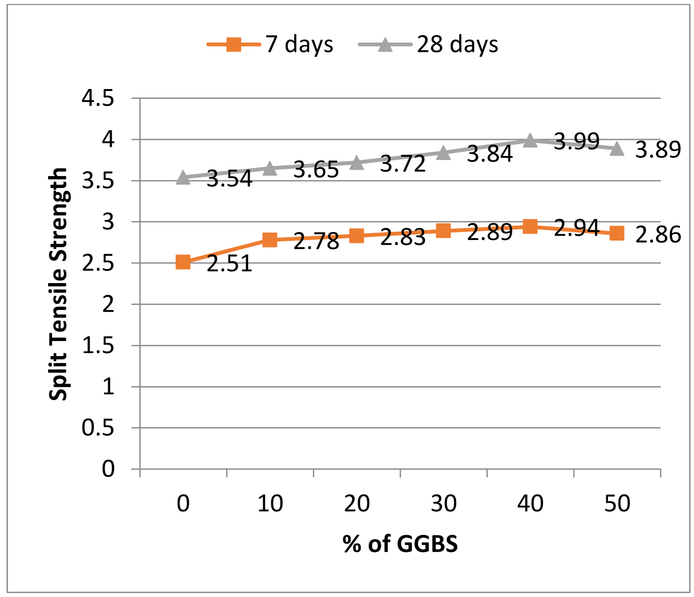
b) **Split tensile strength test**

Split tensile strength test results of the concrete mixtures tested with and without GGBS. Table 8 illustrates the split tensile strength of harden concrete.

Table 8. Split tensile strength

Mix	7 days	28 days
M30	2.51	3.54
10 % GGBS	2.78	3.65
20 % GGBS	2.83	3.72
30 % GGBS	2.89	3.84
40 % GGBS	2.94	3.99
50 % GGBS	2.86	3.89

Fig 4. Split tensile strength



4. Conclusion

- The workability of the fresh concrete of conventional mix is more when compared to the addition of GGBS. When GGBS increases the workability of the concrete goes on decreasing.
- Compressive strength observes at 28 days for 40% GGBS gives better results compared to conventional; mix and other propositions of the GGBS.
- Split tensile strength observes at 28 days for 40% GGBS gives better results compared to conventional mix and other propositions of the GGBS.

5. Reference

[1] . Ismail, S.A. Bernal, J.L. Provis, R. San Nicolas, S. Hamdan, J.S.J. van Deventer, Modification of phase volution in alkali-activated blast furnace slag by the incorporation of fly ash, Cem. Concr. Compos. 45 (2014) 125–135.

[2] P. Prochon, Z. Zhao, L. Courard, T. Piotrowski, F. Michel, A. Garbacz, Influence of Activators on Mechanical Properties of Modified Fly Ash Based

ISSN- 2394-5125 VOL 7, ISSUE 17, 2020

Geopolymer Mortars, Materials (Basel). 13 (2020) 1–24, https://doi.org/10.3390/ma13051033.

[3] G.M. Zannerni, K.P. Fattah, A.K. Al-Tamimi, Ambient-cured geopolymer concrete with single alkali activator, Sustain. Mater. Technol. 23 (2020), https://doi.org/10.1016/j.susmat.2019.e00131 e00131.

[4] X. Dai, S. Aydin, M.Y. Yardimci, K. Lesage, G. de Schutter, Influence of water to binder ratio on the rheology and structural Build-up of Alkali-Activated Slag/Fly ash mixtures, Constr. Build. Mater. 264 (2020)120253,https://doi.org/10.1016/j.conbuildmat. 2020.120253.

[5] I. Ismail, S.A. Bernal, J.L. Provis, R. San Nicolas, S. Hamdan, J.S.J. van Deventer, Modification of hase evolution in alkali-activated blast furnace slag by the incorporation of fly ash, Cem. Concr. Compos. 45 (2014) 125–135.

[6] R.P. Venkatesan, K.C. Pazhani, Strength and durability properties of geopolymer concrete made with Ground Granulated Blast Furnace Slag and Black Rice Husk Ash, KSCE J Civ Eng 20 (6) (2016) 2384–2391.

[7] N.R. Rakhimova, R.Z. Rakhimov, Alkali-activated cements and mortars based on blast furnace slag and red clay brick waste, Mater. Des. 85 (2015) 324–331.

[8] A.K. Priya, M. Nithya, M. Rajeswari, P.M. Priyanka, R. Vanitha, Experimental investigation on developing low cost concrete by partial replacement of waste sludge, Int. J. ChemTech Res. CODEN (USA): IJCRGG 9 (1) (2016) 240–247.

[9] M. Nithya, A.K. Priya, R. Muthukumaran, G.K. Arunvivek, Properties of concrete containing waste foundry sand for partial replacement of fine aggregate in concrete, Indian J. Eng. Mater. Sci. 24 (2017) 162–166.

[10] T. Baskaran, R. Vanitha, A.K. Priya, P.M. Priyanka, Experimental analysis on recycled plastic reinforced concrete, Int. J. Adv. Eng. Technol. 7 (2) (2016) 1027–1029.