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UTILIZATION OF BLAST FURNACE SLAG IN CONCRETE - REVIEW

Amol B. Sawant[1], Dr. C. S. Patil[2] , Pranav Hinge[3]
[1]*Research Scholar, Sanjay Ghodawat University, Atigre (Assistant Professor, KITCOE, Kolhapur)*
[2] *Associate Professor, Department of Civil Engineering, Sanjay Ghodawat University, Atigre*
[3] *PG Student, Department of Civil Engineering, KITs College of Engineering (Autonomous), Kolhapur*
Corresponding Author Orcid ID : 0000-0002-2109-1613

ABSTRACT
The impact of silica fume on the strength development rate and durability of binary concretes containing low reactivity slag. Results show that silica fume moderately improves strength gain but significantly enhances durability and water demand. The use of blast furnace slag and fine aggregate in construction materials for cold weather conditions. It found that GBFS aggregate increased compressive strength, frost resistance, and enhanced resistance against sulfuric acid attacks, demonstrating its potential for use in cold weather construction. The durability and strength of coal gangue-based geopolymer concrete, revealing that proper GBFS content and alkali activator modulus can improve freeze-thaw resistance. Alkali activated Self-Compacting Geopolymer Concrete (SCGC) using Ground Granulated Blast Furnace Slag (GGBS) incorporated with 2% nano silica. The mix design with 16M alkaline solution and 500 Kg/m3 binder content exhibited the highest compressive, flexural, and split tensile strength at 90 days. The corrosion performance of recycled aggregate concrete, focusing on water to binder ratios and the impact of 50% ground granulated blast furnace slag. Showed that the addition of ground granulated blast furnace slag increased surface resistivity to 88 kΩcm and decreased carbonation resistance. This increased potential and decreased corrosion rate, indicating that the inclusion of ground granulated blast furnace slag in recycled aggregate concrete mixes enhances corrosion resistance. The impact of waste beverage glass on the performance of ground granulated blast furnace slag concrete mixes. Results show that waste beverage glass reduces workability but improves mechanical properties, while increasing water absorption.

1. INTRODUCTION
Concrete is the most widely used construction material in the world. Due to its adaptability, durability, and fire resistance, concrete is the most often utilized material in building and civil engineering applications. Every day there is more demand for concrete as a building material. The key ingredients in concrete are cement, aggregates, water, and additives. Among that Aggregates, which account for 60% to 75% of the total volume of concrete. About 40 million tons Blast Furnace slag is produced in India. It is the byproduct of the iron-making process in a Blast Furnace .The substantial volume of slag generated in industrial plants is often disposed of in close proximity to the facility, leading to both the wasteful use of land and the contamination of surface and groundwater resources.

2. REVIEW
1. Ali Reza Bagheri, Hamed Zanganeh, Mohamad Mehdi Moalemi, **"Mechanical and durability properties of ternary concretes containing silica fume and low reactivity blast furnace slag"** Cement & Concrete Composites 34 (2012) (page no. 663–670) ISSN 0958-9465
The study investigates the use of silica fume and slag in enhancing the properties of concretes containing low reactivity slags. The research found that using grade 80 slag at 15% replacement level of cement caused a small reduction in strength properties at all ages. However, for increasing slag

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contents of 30% and 50%, strength reductions compared to the control were significant at all ages. The addition of silica fume made up for the strength decline of the mix containing 15% slag at 28 days and increased its later age strengths. For situations requiring equal 28 strength compared to the control mix, the slag content in ternary mixes cannot be far in excess of 15%. Ternary mixes based on silica fume with various amounts of slag showed improvements in durability over control at 28 days and at later ages. Using ternary mixes with high contents of low reactivity slags will provide a high durability concrete with added environmental and energy savings benefits if achieving equal 28 day strength to the control mix is not crucial.

2. Ahmad Alzaza , Katja Ohenoja, Faiz Uddin Ahmed Shaikh, Mirja Illikainen " **Mechanical and durability properties of C–S–H-seeded cement mortar cured at fluctuating low temperatures with granulated blast furnace slag as fine aggregates** " Journal of Building Engineering 57 (2022) 104879.

The study aimed to enhance the sustainability of winter construction works in cold regions by increasing the utilization of blast furnace slag as a binder and fine aggregate. The study assessed the effects of incorporating different contents of granulated blast furnace slag (GBFS) fine aggregate on the strength development and durability properties of Portland cement/ground granulated blast furnace slag (GGBFS) binary mortar. The effects depend on the curing time and GBFS aggregate content. The study found that substituting natural sand (NS) with GBFS fine aggregate increased compressive strength in the early curing period and a negligible reduction thereafter. GBFS aggregate also increased mortar's resistance against sulfuric acid (H2SO4) attacks, which is directly proportional to the GBFS aggregate content. The optimal substitution level depends on the intended use and surrounding conditions. In residential areas, NS can be volumetrically substituted with 50% GBFS fine aggregate for enhanced frost resistance with a negligible decrease in compressive strength. In industrial areas and sewage pipes, NS can be fully substituted with GBFS aggregate.

3. Bo Zhang, Bingqian Yan, Yutao Li, "**Study on mechanical properties, freeze–thaw and chlorides penetration resistance of alkali activated granulated blast furnace slag-coal gangue concrete and its mechanism**" Construction and Building Materials 366 (2023) ISSN 0950-0618.

The study examines the fluidity, strength, durability, and microstructure evolution of alkali-activated GBFS-CG concrete. The optimal performance was found to be S50-M13 in mechanics and frost resistance. The fluidity of GBFS-CG increases with larger alkali activator modulus, and increasing GBFC wt% has little positive effect on fluidity. The addition of GBFS results in the formation of C-A–S–H gel, C–S–H gel, and N-A–S–H gel, providing additional strength and compactness. The freeze-thaw resistance of geopolymer concrete can be improved by over two times with proper GBFS content and alkali activator modulus. The DRCM of concrete shows a linear increase with increasing GBFS content, with a 50% increase in chloride resistance when GBFS content reaches 50% (S50-M13). The effect of GBFS on pore development is more evident than the alkali activator modulus. Pore surface fractal dimension can depict pore evolution subjected to freeze-thaw attack, with a good linear relationship between freeze-thaw cycles and DPS.

4. Guneet Sainia, Uthej Vattipalli, **"Assessing properties of alkali activated GGBS based self-compacting geopolymer concrete using nano-silica"** Case Studies in Construction Materials 12 (2020) ISSN 2214-5095

The molarity of sodium hydroxide solution and GGBS content significantly affect the workability, mechanical, and durability properties of SCGC. Increased concentration boosts geopolymerisation reactions, reducing filling and passing ability but increasing strength and durability. The addition of 2% nano silica improved workability, mechanical, and durability performance in SCGC. The compressive strength of SCGC increased from 53.47 MPa to 67.20 MPa for mixes with GGBS content of 450 Kg/m3 and molarity of solution varying from 10 M to 16 M. The addition of nano silica resulted in strength gains ranging between 17.65%–18.94% at different ages of testing. The higher molarity of mixes improved the split tensile strength performance of SCGC, with the highest split tensile strength observed for 16 M samples at the age of 90 days. Flexural strength also increased with rise in molarity, GGBS content, and addition of 2% nano silica. The durability performance of SCGC improved with higher molarity and GGBS content, with the control mix M0 showing inferior performance compared to mix M6 with 2% nano silica.

5. Uma Shankar Biswal, Pasla Dinakar, **"Evaluating corrosion resistance of recycled aggregate concrete integrating ground granulated blast furnace slag"** Construction and Building Materials 370 (2023) ISSN 0950-0618

The study examined the corrosion performance of RAC concretes using recycled aggregates (GGBS) as a partial cement replacement. The results showed that GGBS concretes had lower early age strength than control concretes, but increased strength with prolonged curing time. The resistivity of recycled aggregate concretes increased with age and decreased with the increase in weight/bundle (w/b). GGBS-based concrete mixes showed high resistivity between 40 and 90 kΩcm, while Portland cement-based concrete mixes had 20 to 50 kΩcm resistivity. The inclusion of GGBS affected chloride migration coefficients, increasing resistance with decreasing weight/bundle. GGBS also increased carbonation depths, but these values were still within the limits suggested in codes. The corrosion potentials decreased with increasing weight/bundle, and half-cell potential increased with GGBS inclusion. The study concluded that using recycled materials and GGBS as a partial cement replacement can enhance the corrosion properties of concretes, especially when used in general structural applications.

6. Vinod Tanwar, Kunal Bisht, K.I. Syed Ahmed Kabeer, P.V. Ramana, **"Experimental investigation of mechanical properties and resistance to acid and sulphate attack of GGBS based concrete mixes with beverage glass waste as fine aggregate"** Journal of Building Engineering 41 (2021) ISSN 2352-7102

The paper explores the use of waste glass as a substitute for river sand in GGBS-based cement composites. The study found that the workability of concrete mixes decreases with waste glass incorporation, due to the angular shape of GGBS and sharp corners of waste glass. The compressive strength test showed that 45% of cement can be replaced with GGBS and 10% of river sand can be replaced with waste glass. The composites showed a denser microstructure with 10% river sand substitution. The increase in flexural strength is related to better bonding between constituents, enhancing the ITZ of GGBS-based concrete mixes. The microstructure showed that voids increased with waste glass substitution beyond 10%, but the penetration of water under uniform pressure was medium. The weight and compressive strength of waste glass-incorporated GGBS-based cement concrete cubes slightly changed after exposure to acidic and sulphate environments, mainly due to the sacrificial behaviour of waste glass, retaining the weight and compressive strength of concrete specimens at higher substitution levels.

CONCLUSION

Addressing the significant challenge of foundry slag disposal in the Kolhapur region, our focus lies on repurposing foundry or blast furnace slag by incorporating it into concrete with a Mix Design of M30 grade. Our research involves comprehensive testing of blast furnace slag, both in its raw form and as part of the concrete mix, encompassing assessments of both fresh and hardened concrete to check the suitability of available blast furnace slag and well as additional tests that are not taken into account in our referred research work, like Chemical Analysis of Blast Furnace Slag, Rapid Chloride Permeability Test and Oxygen Permeability Test. Furthermore, we aim to conduct a cost analysis comparing conventional concrete with concrete where aggregates are replaced by slag.

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