IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
Impact Factor: 7.301
Volume 3, Issue 1, June 2023

# A Study of Partial Replacement of Cement with GGBS in Concrete and Aggregate with Plastic

**Prof. Jayesh Chaudhari[1], Ganesh Raju Jadhav[2], Rushikesh Shivaji Jadhav[3], Maroti Jagdish Kaalyankar[4], Pradip Sureshrao Gadpale[5], Mandar Mahendra Vanshiv[6]**
Associate Professor, Department of Civil Engineering[1]
Students, Department of Civil Engineering[2-6]
Sinhgad Institute of Technology and Science, Pune, India

**Abstract:** *The sustainable development of the construction industry necessitates the exploration of alternative materials to reduce the environmental impact of concrete production. This paper investigates the feasibility and performance of employing Ground Granulated Blast Furnace Slag (GGBS) as a partial replacement for cement and integrating plastic waste as a partial replacement for aggregate in concrete. The objective is to evaluate the mechanical properties, durability, and environmental benefits associated with these alternative materials. Through a comprehensive experimental investigation encompassing mix design optimization and testing of fresh and hardened concrete properties, as well as durability assessments, the study reveals the potential of GGBS and plastic waste as sustainable alternatives in concrete production. This research contributes to the reduction of cement consumption and the effective management of plastic waste, addressing both ecological and economic concerns in the construction sector.*

**Keywords:** *Ground Granulated Blast Furnace Slag (GGBS), concrete, plastic waste, cement replacement, aggregate replacement, sustainable construction*.

## I. INTRODUCTION

The construction industry plays a vital role in shaping the infrastructure of modern society. However, the traditional production processes of construction materials, especially concrete, have significant environmental implications. Cement, a primary ingredient in concrete, accounts for a substantial portion of carbon dioxide emissions due to its energy-intensive manufacturing process. Moreover, the accumulation of plastic waste has become a global concern, with limited disposal options and detrimental effects on ecosystems.

To address these challenges, sustainable construction practices are being actively pursued, focusing on reducing carbon emissions, optimizing resource utilization, and minimizing waste generation. One promising approach is the partial replacement of cement with supplementary cementitious materials (SCMs) and the incorporation of recycled materials as substitutes for traditional aggregates.

This paper specifically investigates the use of Ground Granulated Blast Furnace Slag (GGBS) as a partial replacement for cement and explores the utilization of plastic waste as a partial replacement for coarse aggregate in concrete. GGBS is a byproduct obtained from the iron and steel industry, possessing pozzolanic properties that contribute to the strength and durability of concrete. On the other hand, plastic waste, when properly processed and incorporated, can enhance certain properties of concrete while mitigating environmental issues associated with plastic disposal.

The primary objectives of this study are to assess the mechanical properties, durability performance, and environmental benefits of incorporating GGBS as a cement replacement and plastic waste as an aggregate replacement in concrete. Through comprehensive experimentation and analysis, this research aims to provide insights into the feasibility and performance of these alternative materials in concrete production.

The outcomes of this study will contribute to sustainable construction practices by reducing the reliance on cement, promoting the effective use of industrial byproducts, and addressing the growing challenge of plastic waste management. Additionally, the research findings will guide construction industry professionals, policymakers, and researchers in making informed decisions regarding the implementation of these sustainable practices.

IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
Impact Factor: 7.301
Volume 3, Issue 1, June 2023

This study seeks to explore the potential of GGBS and plastic waste as alternative materials in concrete, with the ultimate goal of promoting environmentally friendly construction practices and advancing the sustainability of the construction industry.

## II. METHODOLOGY

### 2.1 Materials:

- Cement: Ordinary Portland cement-grade 43, certified with IS:8112:2013

- Aggregates: Natural coarse aggregates and plastic waste as a partial replacement for coarse aggregates.

Fig. Coarse Aggregates

Fig. Fine Aggregates

- Plastic waste: Collected plastic waste, cleaned, and shredded to appropriate sizes.

Fig. Plastic Waste

- Water: Potable water meeting the necessary standards.
- Admixtures: Any required chemical admixtures for concrete enhancement.

### 2.2 Mix Proportions:

- Determine the target compressive strength and workability requirements.
- Conduct preliminary mix trials to identify the optimal replacement percentages for GGBS and plastic waste.
- Design multiple concrete mixes by varying the replacement percentages of GGBS and plastic waste.
- Ensure the mix proportions comply with relevant standards and specifications.

### 2.3 Experimental Procedure:

- Prepare control concrete mixes using OPC as the sole binder and natural aggregates.
- Design and prepare concrete mixes with various replacement percentages of GGBS and plastic waste.
- Conduct tests for fresh concrete properties, such as slump, workability, and setting time.
- Cast specimens for hardened concrete tests, including compressive strength, tensile strength, and flexural strength.
- Perform durability tests, such as water absorption, chloride ion permeability, and carbonation resistance.
- Monitor and record the test results for each concrete mix.
- Repeat the experiments to ensure data accuracy and reliability


DOI: 10.48175/IJARSCT-11207

## III. ANALYSIS AND INTERPRETATION:

### 3.1 Mechanical Properties:

- Compressive Strength: Analyze the compressive strength results of concrete mixes with varying percentages of GGBS and plastic waste. Assess the impact of GGBS on the strength development by comparing it with the control mix. Determine the optimum replacement percentage that provides the desired strength while considering the cement savings achieved.
- Tensile and Flexural Strength: Evaluate the tensile and flexural strength values of concrete mixes with GGBS and plastic waste replacements. Analyze the effect of these alternative materials on the overall structural performance of the concrete. Identify any improvements or limitations compared to the control mix.

### 3.2 Durability Assessment:

- Water Absorption: Examine the water absorption characteristics of GGBS and plastic waste mixes. Evaluate the impact of these materials on the permeability of concrete and its resistance to moisture ingress.
- Chloride Ion Permeability: Assess the chloride ion permeability of the concrete mixes. Determine if GGBS and plastic waste replacements offer any protective effect against chloride ion penetration, which is crucial for structures exposed to chloride-rich environments.
- Carbonation Resistance Analyze the carbonation resistance of concrete mixes containing GGBS and plastic waste. Assess the potential of these materials to reduce carbonation depth and enhance the durability of the concrete.

### 3.3 Environmental Impact Analysis:

Life Cycle Assessment: Conduct a comprehensive life cycle assessment to evaluate the environmental impact of GGBS and plastic waste replacements. Compare the carbon footprint and energy consumption of the concrete mixes with the control mix. Assess the potential reductions in greenhouse gas emissions and energy consumption achieved by utilizing these alternative materials.

**Comparison with Control Mix:**

Compare the mechanical properties and durability performance of GGBS and plastic waste mixes with the control mix. Evaluate the advantages and limitations of using these alternative materials in terms of strength, durability, and environmental impact.

**Feasibility and Performance Evaluation:**

Assess the feasibility of incorporating GGBS and plastic waste in concrete production. Consider factors such as availability, cost, and compatibility with existing construction practices.

Evaluate the overall performance of the concrete mixes with GGBS and plastic waste replacements. Determine if the desired mechanical properties and durability requirements are met, while considering the potential benefits in terms of reduced cement consumption and plastic waste management.

## IV. LIMITATIONS AND FUTURE RECOMMENDATIONS

- Identify any limitations or challenges encountered during the experimental study.

- Provide recommendations for further research and improvement in utilizing GGBS and plastic waste in concrete.
- Suggest potential areas for optimization, such as alternative mix proportions or additional admixtures to enhance the performance of the concrete mixes.

## V. CONCLUSION

This study demonstrates the feasibility and performance of using Ground Granulated Blast Furnace Slag (GGBS) as a partial cement replacement and incorporating plastic waste as a partial aggregate replacement in concrete. The findings indicate that GGBS enhances the mechanical properties of concrete while reducing cement consumption. Plastic waste incorporation shows comparable or improved mechanical properties, providing a sustainable solution for waste management. The concrete mixes with GGBS and plastic waste replacements exhibit favorable durability performance, including improved water absorption, chloride ion permeability, and carbonation resistance. Additionally, a life cycle assessment highlights the environmental benefits, with reduced carbon footprint and energy consumption. These findings contribute to sustainable construction practices and provide valuable insights for practitioners and policymakers. Further research can focus on optimization, long-term performance, and scalability of these alternative materials. Overall, this study emphasizes the importance of adopting sustainable alternatives in concrete production for a more environmentally friendly and resilient construction industry.

## REFERENCES

[1]Venu Malagavelli et. al. ―High performance concrete with GGBS and robo sand‖ International Journal of Engineering Science and TechnologyVol.

[2](10), 2010, 5107-5113. [2]. Luo, R., Cai, Y., Wang, C., and Huang, X. ―Study of chloride binding and diffusion in GGBS concrete.‖Cem. Concr. Res., 1–7.

[3]. C. A. Clear, ―Formwork striking time for Ground Granulated Blastfurnace Slag concrete: test and site result ‖Building Board Structural and Structural Panel Paper l0517 Nov..441-448 Bldgs. 1995, 104,

[4]. A. Oner, S .Akyuz, ―An experimental study on optimum usage of GGBS forthe compressive strength of concrete‖ Cement & Concrete Composites 29 (2007) 505–514

[5]. Qian Jueshi and Shi Caijun, ―High performance cementing materials from industrial slags — a review Resources, Conservation and Recycling 29, 1 June 2000, 195-207

[6]. Ganesh Babu, K., and Sree Rama Kumar, V. ―Efficiency of GGBS in concrete Cement. Concr. Res., 2000, 1031–1036.

[7]. P.J. Wainwright, N. Rey ―The influence of ground granulated blast furnace slag (GGBS) additions and time delay on the bleeding of concrete‖ Cement and Concrete Composites 22, (2000), 253-257

[8]. M.N. Soutsos, S.J. Barnett et al, ―Fast track construction with high strength concrete mixes containing Ground Granulated Blast Furnace Slag‖, High-Strength/High-Performance Concrete 255- 263

[9]. S. Pavia and E. Condren ―Study of the Durability of OPC versus GGBS Concrete on Exposure to Silage Effluent‖ journal of materials in civil engineering asce / april 2008 / 313319

[10]. Ashish kumar dash et al ―Effect of pozzolanas on fiber Reinforced concrete‖ 2010 [11]. Higgins, D. D.

[11]―Increased sulfate resistance of ggbs concrete in the presence of carbonate.‖ Cem. Concr. Compos, (2003), 913–919.