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Experimental Investigation of Sustainable Concrete Production using Blast Furnace as A Cement Substitute- A art of Review

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Abstract: *The pursuit of sustainable construction practices has led to a growing interest in alternative materials that can reduce the environmental impact of traditional concrete production. This experimental study focuses on the utilization of blast furnace slag as a substitute for cement in concrete, aiming to assess its mechanical properties, environmental impact, and overall sustainability. The primary objectives of this research are threefold. Firstly, the study seeks to evaluate the mechanical properties of concrete by varying the content of blast furnace slag in the mix, with a specific emphasis on strength, durability, and structural performance. This involves conducting a comprehensive analysis of the concrete's compressive strength, flexural strength, and other relevant mechanical characteristics. Secondly, a life cycle assessment (LCA) will be employed to analyze the environmental impact of the concrete mixtures. This assessment will compare carbon dioxide (CO2) emissions, energy consumption, and overall sustainability of the concrete produced with varying percentages of blast furnace slag. The LCA will provide valuable insights into the environmental implications of using slag as a cement substitute, aiding in the identification of eco-friendlier concrete production practices. Lastly, the research aims to assess the environmental impact of blast furnace slag itself when employed as a cement substitute. This involves examining the production, transportation, and incorporation of blast furnace slag into the concrete mix, providing a holistic view of its sustainability across the entire life cycle. The experimental approach involves the meticulous design of concrete mixes with different percentages of cement replaced by blast furnace slag. The varying mix designs will be tested for mechanical properties, and the data obtained will be used to draw correlations between slag content and concrete performance. In summary, this research endeavors to contribute to the body of knowledge surrounding sustainable concrete production by exploring the mechanical, environmental, and sustainability aspects of utilizing blast furnace slag as a cement substitute. The findings of this study are anticipated to provide valuable insights for the construction industry to adopt more environmentally friendly practices while maintaining or enhancing concrete performance.*

Keywords: sustainable construction practices

I. INTRODUCTION

Concrete, widely employed as an introductory construction material due to its numerous advantages such as high strength, ample mold capacity, durability, resistance to various climatic conditions, and resilience to furnace heat, is also renowned for its cost-effectiveness. Notably, recent years have witnessed a surge in the adoption of ground granulated blast furnace slag (GGBS) in both residential and commercial construction, serving as a building material. In response to growing environmental concerns linked to cement production, there has been a concerted research and development focus on identifying alternative and more sustainable materials to either partially or entirely replace cement in concrete formulations. Among these alternatives, blast furnace slag has garnered attention due to its cementitious properties, leading to an increased exploration of its potential as a substitute for traditional Portland cement. Incorporating blast furnace slag in concrete production offers several advantages, including the mitigation of carbon emissions, enhanced durability, and improved strength properties. An investigation of the characteristics and

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performance of concrete compositions containing blast furnace slag in different proportions, this research endeavors to make a scholarly contribution to the expanding field of sustainable building materials. the study encompasses a thorough examination of the qualities of concrete mixes, both fresh and hardened, including workability, durability, compressive strength, and environmental effect evaluations.

1.1 Sustainable Concrete Production

The sustainable concrete production is shaped by global trends and practices that emphasize environmentally responsible construction methods. there is a growing awareness of the need for sustainable development, leading to increased adoption of eco-friendly construction practices. This includes the use of alternative materials, such as Blast Furnace Slag and slag, to reduce the carbon footprint associated with traditional concrete production. challenges persist in traditional concrete production, primarily due to the high energy consumption and emissions associated with cement production, a key component of concrete. Addressing these challenges requires innovations in technology, increased use of recycled materials, and a shift towards more energy-efficient production methods to create a concrete industry that aligns with long-term environmental sustainability goals.

Fig 1 Industrial Dust Forms and Accumulation

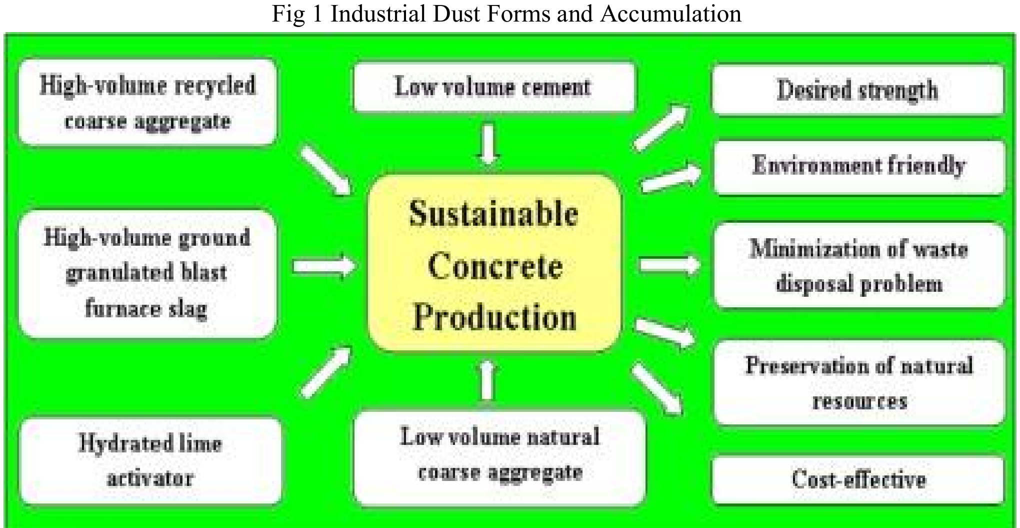

Fig 2 Sustainable Concrete Production

1.2 Blast Furnace Slag as a Cement Substitute

Blast furnace slag (BFS) is a byproduct of the iron-making process in blast furnaces, and its use as a cement substitute has gained significant attention in the construction industry. This versatile material offers environmental and technical advantages, making it a sustainable alternative to traditional Portland cement. Here, we explore the characteristics, benefits, and applications of blast furnace slag in the realm of construction.

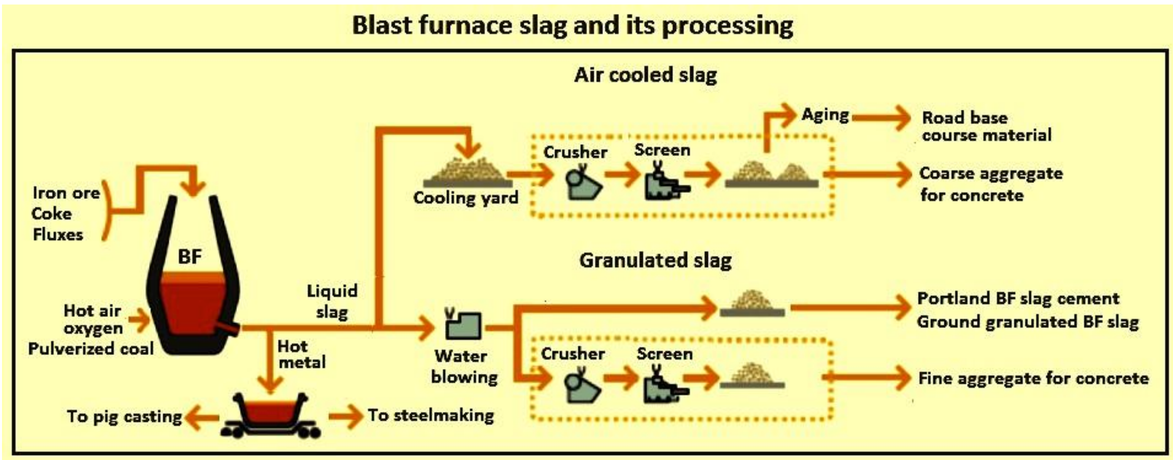

Fig 3 Blast furnace slag and its processing

Table 1 Composition of BF slag

Sl. No.	Component	Unit	Range
1	SiO2	%	30.5-40.8
2	CaO	%	30.9-46.1
3	CaO (free)	%	0.3-2.4
4	Al2O3	%	5.9-17.6
5	MgO	%	1.7-17.3
6	FeO	%	0.1-4.7
7	Fe2O3	%	1.5-3.8
8	MnO	%	0.1-3.1
9	Mn2O3	%	0.01- 0.28
10	TiO2	%	0.1-3.7
11	Na2O	%	0.1-1.7

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12	K2O	%	0.1-1.5
13	Na2O equivalent	%	0.2 – 2.6
14	SO3	%	0-0.9
15	S	%	0.4-2.3
16	Insoluble residue	%	0.03-4.1
Note: Na2O equivalent = Na2O + 0.658 x K2O			

Table 2 Minerals of air cooled BF slag

Sl. No.	**Mineral**	**Mineral formula**
1	Monticellite	CaO.MgO.SiO2
2	Akermanite	2CaO.MgO.2SiO2
3	Merwinite	3CaO.MgO.2SiO2
4	Anorthite	CaO.Al2O3.2SiO2
5	Gehlenite	2CaO.Al2O3.SiO2
6	Wollastonite	CaO.SiO2
7	Di-calcium silicate	2CaO.SiO2

Table 3 Physical properties of granulated slag

Sl. No.	**Property**	**Unit**	**Value**
1	Glass content	Vol. %	60 -100
2	True density	g/cc	2.8-3.1
3	Apparent density	g/cc	2-2.84
4	Bulk density	g/cc	0.69-1.43
5	Porosity	Vol. %	2.5-31.2

6	Sieve size (Less than 0.5 mm)	Wt. %	3.6-78.6
7	Sieve size (Less than 3.2 mm)	Wt. %	81.1-100

Characteristics of Blast Furnace Slag:

- **Formation:** Blast furnace slag is generated during the production of pig iron in blast furnaces. It is composed primarily of silicate and aluminate compounds and is rapidly cooled through water or air quenching, leading to its unique physical and chemical properties.
- **Composition:** The composition of blast furnace slag includes compounds such as silica, alumina, calcium oxide, and magnesium oxide. It is characterized by its amorphous structure, which contributes to its pozzolanic reactivity.
- **Types:** There are two main types of blast furnace slag - granulated blast furnace slag (GBFS), produced by rapid quenching, and air-cooled blast furnace slag (ACBFS). Both types exhibit pozzolanic properties, but GBFS is often preferred for its enhanced reactivity.

Benefits of Blast Furnace Slag as a Cement Substitute:

- **Reduced Environmental Impact:** The utilization of blast furnace slag in cement helps reduce the carbon footprint of the construction industry. By using a byproduct that wouldotherwise be treated as waste, the environmental impact associated with traditional cement production is mitigated.
- **Enhanced Durability:** Incorporating blast furnace slag into cement improves the durability and long-term performance of concrete structures. The slag's finer particles fill voids in the concrete matrix, reducing permeability and enhancing resistance to chemical attack and sulfate exposure.
- **Strength Development:** Blast furnace slag contributes to the strength development of concrete over time. Its pozzolanic and hydraulic properties result in improved compressive and flexural strength, making it an effective partial replacement for Portland cement.
- **Workability and Pumpability:** Concrete mixes containing blast furnace slag often exhibit improved workability and pumpability. The slag's fine particles act as a lubricating agent, facilitating the placement and consolidation of concrete during construction.
- **Heat of Hydration Reduction:** The incorporation of blast furnace slag helps mitigate the heat of hydration during the curing process. This is particularly beneficial in large concrete structures, where excessive heat generation can lead to thermal cracking.

Applications:

- **Ready-Mix Concrete:** Blast furnace slag is commonly used in ready-mix concrete applications, where its benefits in terms of strength, durability, and workability are readily realized.
- **Road Construction:** The use of blast furnace slag in road construction provides improved resistance to freeze-thaw cycles, deicing chemicals, and overall enhanced performance in various climatic conditions.
- **Precast Concrete Products:** Precast concrete products, such as beams, columns, and panels, often incorporate blast furnace slag to achieve the desired mix properties and enhance the performance of the final product.
- **Sustainable Construction:** As a byproduct of industrial processes, blast furnace slag contributes to sustainable construction practices by reducing the demand for primary raw materials and lowering the environmental impact of cement production.

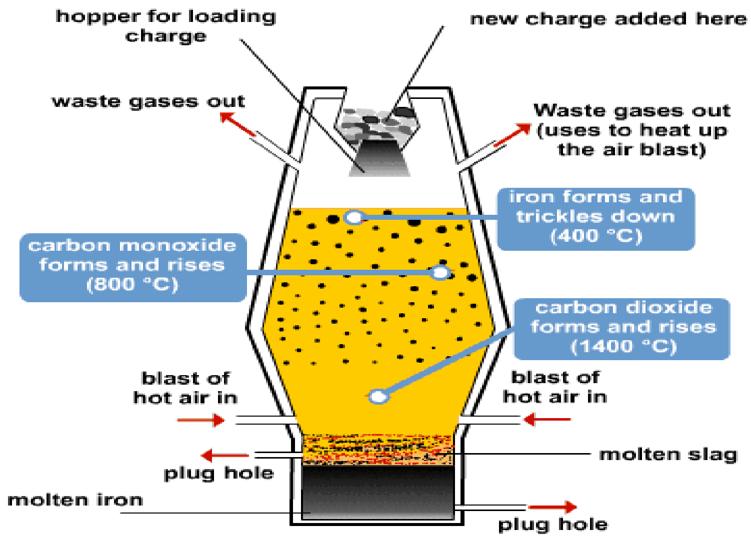

Fig 4 Blast Furnace Slag application

1.3 Overview of Blast Furnace Slag

The history of sustainable concrete production using blast furnace slag (BFS) as a cement substitute is intertwined with the broader evolution of sustainable construction practices and the quest for environmentally friendly alternatives in the concrete industry. Slag from blast furnaces, a leftover from the production of iron, has been used in building for millennia. It was formerly seen of as a waste material, but as time went on, scientists discovered its pozzolanic and hydraulic capabilities, which led to its use in concrete mixes to improve qualities like workability and durability. Concerns over the effects of conventional concrete manufacturing technologies on the environment gained prominence throughout the 20th century as environmental consciousness increased.

Alternative cementitious materials were investigated by scientists and engineers in an effort to lessen the dependency on Portland cement, the main binder in traditional concrete. Among these materials were industrial wastes with potential advantages for performance and environmental effect, such as Blast furnace slag, silica fume, and BFS. Because of its pozzolanic and latent hydraulic qualities, blast furnace slag became popular as a cement alternative. It was discovered to lessen the carbon footprint associated with the manufacture of concrete while enhancing its strength, longevity, and resistance to sulphate attack.The significance of integrating sustainable practices into the building sector was acknowledged by regulatory agencies and standardisation organisations, including ASTM International and the European Committee for Standardisation (CEN).

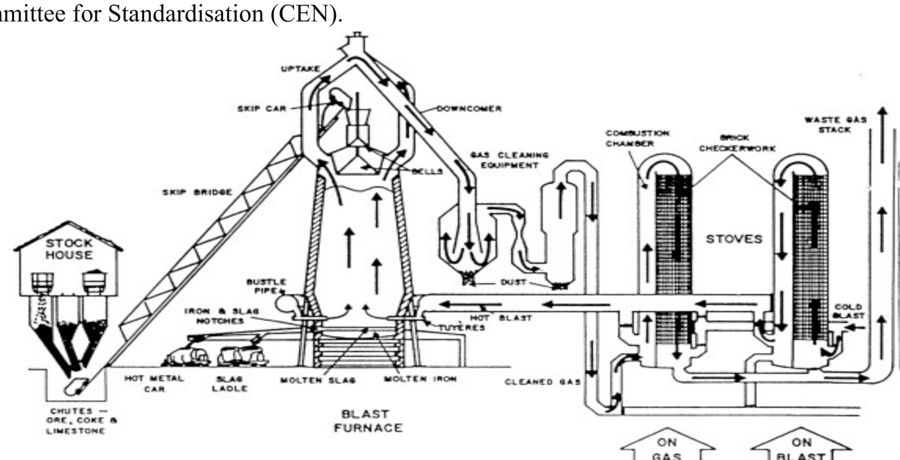

Fig 5 Overview of Blast Furnace.

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To promote the use of BFS and other supplemental cementitious ingredients in concrete mixes, standards and recommendations were created. he widespread use of BFS in the manufacture of concrete was made possible by improvements in concrete technology and manufacturing procedures. Concrete mixtures with improved environmental credentials are now more adaptable and customisable because to innovations like blended cements, which combine Portland cement and BFS.To maximise the use of BFS in the manufacturing of concrete, government agencies, industry consortia, and academic research institutes have invested in research and development projects.

1.4 Role of Blast Furnace Slag

Properties and Characteristics Blast furnace slag, a byproduct of iron production, exhibits unique properties that make it a valuable component in sustainable concrete production. One of its key characteristics is its pozzolanic nature, meaning it can react with calcium hydroxide to form additional cementitious materials. This contributes to improved long-term strength and durability of concrete structures. blast furnace slag is known for its latent hydraulic properties, allowing it to partially replace Portland cement in concrete mixtures without compromising performance. The fine particle size and glassy structure of the slag enhance workability and reduce permeability, resulting in concrete with enhanced resistance to chloride ion penetration and sulfate attack. Additionally, the incorporation of blast furnace slag in concrete not only reduces the demand for traditional raw materials but also mitigates greenhouse gas emissions associated with cement production. Overall, the unique properties of blast furnace slag make it a key player in fostering sustainable and resilient concrete solutions.

1.5 Types of Blast Furnace Slag

Blast furnace slag (also called fine granulated blast furnace slag [GGBFS]) is a material that we call as one of the supplementary cementitious materials. Ground granulated blast furnace slag is the glassy material formed from molten slag produced in blast furnaces as an industrial by-product from the production of iron used in steelmaking.

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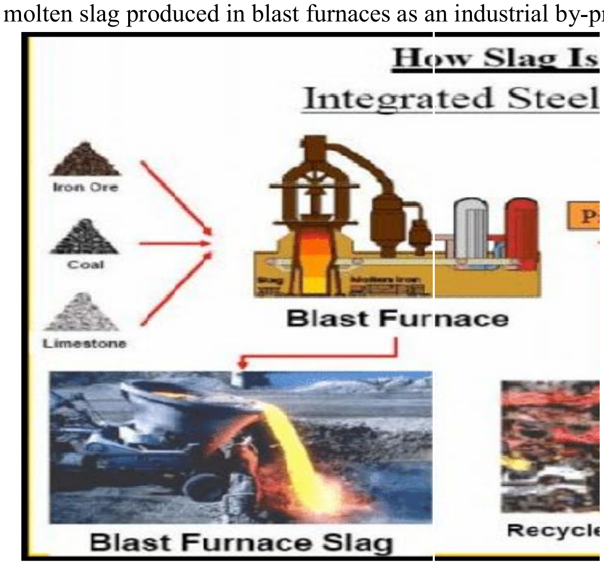

The two primary types of blast furnace slag are

Granulated Blast Furnace Slag (GBFS):

Formation: Produced by quenching molten iron slag from a blast furnace in water or steam.

Characteristics: Rapid cooling leads to a glassy, granular product with sand-sized particles.

Usage: Widely used in the production of cement and concrete due to its hydraulic properties, which contribute to increased durability and strength.

Air-Cooled Blast Furnace Slag (ACBFS):
Formation: Slow cooling of molten blast furnace slag in ambient air.
Characteristics: Solidifies into a dense, rock-like material with a crystalline structure.
Usage: Primarily used as aggregates in construction, such as in road base, asphalt mixtures, and concrete.

1.6 Importance of Concrete in Construction and Environmental Concerns Related to Cement Production

Concrete serves as the backbone of construction, offering strength and durability. However, traditional cement production, a primary component of concrete, generates significant environmental concerns due to high carbon emissions and energy consumption. Cement manufacturing contributes to approximately 8% of global CO2 emissions, exacerbating climate change. Addressing these concerns is crucial as the construction industry, heavily reliant on concrete, seeks eco-friendly alternatives to mitigate its environmental impact, making the exploration of sustainable materials, like blast furnace slag, vital for reducing the carbon footprint while maintaining structural integrity.

1.7 Cement Replacement Using Blast Furnace Slag

Cement is replaced by slag from different steel mills, both blast furnace and ladle furnace slag. Cement substitution using blast furnace slag has received a lot of interest in the building sector as an ecologically responsible and economically effective option. Blast furnace slag, a byproduct of the iron-making process, has pozzolanicthat help to build long-lasting, high-performance concrete. Blast furnace slag, when used as a partial substitute for Portland cement, not only decreases the total carbon footprint associated with cement manufacture, but it also improves the strength, durability, and chemical resistance of the concrete. The use of blast furnace slag in concrete mixes reduces the environmental effect of typical cement manufacture, making it a viable building alternative.
Additionally, using BFS helps to significantly lower carbon dioxide emissions related to the production of cement, which is in line with sustainability objectives.Concrete mixes may obtain better workability, increased long-term strength, and increased resistance to sulphate attack and alkali-silica reaction by partly replacing Portland cement with BFS.Blast furnace slag (BFS) has pozzolanic and hydraulic qualities that make it a valuable substitute for cement in the making of concrete. This adaptable material is a mainstay of ecologically conscious building methods since it not only improves the functionality and longevity of concrete structures but also encourages resource efficiency by reusing a leftover of the steel-making industry**.**

Fig 7 EHC process from source to final preparation to mix

Fig 8 BFS process from source to final preparation to mix

II. LITERATURE REVIEW

B. Mangamma (2016) An Experimental Study on Behavior of Partial Replacement of Cement with Ground Granulated Blast Furnace Slag, Concrete has occupied an important place in construction industry in the past few decades and it is used widely in all types of constructions ranging from small buildings to large infrastructural dams or reservoirs. GGBS is obtained from making of iron. It Is no use for other things. It pollutes the environmental such as land pollution, water pollution etc. When we use the GGBS in partial replacement of cement it increases the strengths of the cubes as well as

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decrease the pollution of the environmental. In my investigation GGBS used at 10%,20%,30%,40%,50% for M20 and M30 43 grades. It is gives increase strength values at 10%,20% and 30% compared to normal mixes.

Khote Krushna Raghunath (2023) Experimental Study On Eco-friendly and Cost Effective Concrete by Utilizing Blast Furnace Slag and Demolition Waste with Other Alternative Materials, the purpose of this study is to make cost effective eco-friendly concrete. This concrete has been made by conventional material such as Ground granulated blast furnace (GGBS) with small amount cement as binding material The construction industry is the one of the contributing factor to the environmental related problem; this problem will be minimized by the utilization of the waste material or Industrial by product from various industries as an alternative source for conventional concrete material. It can be substitute of conventional concrete materials, the use of material lead to sustainability in construction sector and conserve the natural resources. There are many environmental related problems created by Cement manufacturing.

Ashok K Sahani (2018) An Experimental Study on Strength Development of Concrete with Optimum Blending of Blast Furnace Slag and Granulated Blast Furnace Slag, the present work experimentally investigated the influence of partially replacing Blast Furnace Slag (FA) as binder and granular blast furnace slag (GBFS) as fine aggregate separately and in combined form on the fresh and hardened properties of concrete. Eight series of concrete mixes were prepared as control mix, single blended mixes and combined blended mixes by weight batching. Single blended concrete mixes were prepared by different percentages of FA (20%, 30% and 40%) and 50% GBFS while combined blended concrete mixes by 50% GBFS with 20, 30 and 40% of FA respectively. Concrete mixes were evaluated for workability and compressive strength, split tensile strength and flexure strength after 7, 28 , 60 and 90 days, respectively.

Vaibhav S Pawar (2022) Experimental Investigation of Granulated Blast Furnace Slag as Fine Aggregate in Concrete, Concrete is a mixture of cement, aggregates and water which are economically available. Sand is a most important material used for preparation of mortar as well as concrete. In India, natural river sand (fine aggregate) is commonly used in mortar and concrete. Manufactured sand is somewhat different from natural river sand. The difference is that its surface characteristics are different from that of natural sand. Generally artificial sand is irregular and also it is more porous. Grading varies over a wide range which results in the internal porosity and reduction in workability of concrete.

Ashenaf Tofu Chofore (2022) Experimental Investigation on Bond, Microstructure and Durability of Expired Hardened Cement Blended with Ground Granulated Blast Furnace Slag as Partial Replacement of Cement in High-Strength Concrete, The current study aimed to investigate the infuence of the expired hardened cement blended with ground granulated blast furnace slag on the bond, microstructure, and durability of high-strength concrete (HSC). Five concrete mixes are prepared; the first mix is taken as a control, and the remaining four mixes are used as experimental blends. HSC characteristics are evaluated by compressive, fexural, splitting tensile, bond, and durability tests. Furthermore, the ultrasonic pulse velocity and microstructural characteristics tests are carried out to check concrete quality. The synergistic action of blends (expired harden cement with GGBS) on the strength test results was found to increase with an increase in blends up to 20%.

Jawad Ahmad (2022) A Comprehensive Review on the Ground Granulated Blast Furnace Slag (GGBS) in Concrete Production, this study delves into GGBS's characteristics, its impact on fresh concrete, mechanical strength, durability, and suggests optimal usage between 10-20% for enhanced performance, offering insights and suggestions for future concrete applications. The expansive growth of the concrete industry has seen various binding material adoptions. To alleviate eco-friendly challenges tied to cement production, using industrial waste like ground-granulated blast-furnace slag (GGBS) can notably reduce landfill waste. GGBS, offering improved mechanical, durability, and thermal properties, presents a sustainable solution for cement and concrete. Besides environmental advantages, its use minimizes economic impact. However, research on GGBS in concrete lacks cohesion, requiring deeper exploration for a comprehensive understanding.

A. Aljobbory (2021) Replacement of cement with industrial by-products in cement mortar: An experimental investigation, the manufacture of cement has been described as a significant exporter of carbon gases pollution and other contaminants, with (1000) kilograms of Cement reportedly producing one ton of Carbon gases. The effects of these gases in the atmosphere on public health and the atmosphere are negative impacts. As a result, industrials by-products become more eco-friend and sustainable comparing with Portland cement in terms of cement use and emissions of carbon gases. The effect of partial substitution in mortar by ground granulated blast furnace slag (GGBS) and coal Blast Furnace Slag (CFA) is the subject of this investigation. three separate GGBS and CFA blends have been utilized, and they have been checked at 7 days, 14 days, and 28 days curing age. to investigate the mechanical properties of the three mixtures, the compression test has been utilized.

Gulden Cagin Ulubeyli (2015) Sustainability for Blast Furnace Slag: Use of Some Construction Wastes, in the present study, the effects of ceramic, brick, and marble wastes used as fine/coarse aggregates on the properties of blast furnace slag investigated. Thus, the contribution of these wastes on the sustainability of blast furnace slag concrete was presented in a detailed manner. Consequently, construction waste aggregates and blast furnace slag can be used to improve the mechanical properties, workability, and chemical resistance of the conventional concrete mixtures. Since the construction waste and blast furnace slag wastes are available in vast amounts in Turkey, it is economically and environmentally suitable to use these materials as aggregates in the production of more durable concrete mixtures. Blast furnace slag is a by-product from blast furnaces which is used to produce iron. Blast furnace slag has been used extensively as a successful replacement material for Portland cement in concrete materials to improve durability, produce high strength and high performance concrete, and brings environmental and economic benefits together, such as resource conservation and energy savings. Construction wastes define as relatively clean and heterogeneous building materials which are generated from various construction activities. Among them, ceramic, brick, and marble wastes can be included.

Prof. Ashok Admute (2017) Experimental Study On Green Concrete, Conventional concrete is responsible for amount of carbon-dioxide emission to some Extent. So to reduce the emission, various types of concrete are developed using waste products from industries and agricultural use like blast furnace slag, silica fume, Blast Furnace Slag which requires low Amount of energy and also because least harm to the environment. Green concrete is a new technology developed now days to reduce the effect on environment by production of cement. Cement contains high amount of carbon-di-oxide which harms the environment drastically, so by replacing the cement by various materials which causes harm to the environment we not only reduce the problem of disposal of these materials but we reduce the emission of carbon-dioxide from cement and as a result of which we reduce the negative effect on environment.

J. Selwyn Babu (2014) Experimental Studies on Concrete Replacing Fine Aggregate with Blast Furnace Slags, in this present study blast furnace slag from two sources were replaced with fine aggregate and the properties of concrete were studied. The optimum percentages of replacement of these materials were found out. The result obtained encourages the use of these materials as a replacement material for fine aggregate. In our world today, concrete has become ubiquitous. It is hard to imagine modern life without it. Approximately five billion tonnes of concrete are used around the world each year. The increasing popularity of concrete as a construction material is placing a huge burden on the natural sand reserves of all countries. In view of the environmental problems faced today considering the fast reduction of natural resources like sand and crushed granite aggregate, engineers have become aware to extend the practice of partially replacing fine aggregate with waste materials.

Prof. JayeshkumarPitroda (2015) experimental investigations on partial replacement of cement with Blast Furnace Slag in design mix concrete, this research work describes the feasibility of using the thermal industry waste in concrete production as partial replacement of cement. The use of Blast Furnace Slag in concrete formulations as a supplementary cementitious material was tested as an alternative to traditional concrete. The cement has been replaced by Blast Furnace Slag accordingly in the range of 0% (without Blast Furnace Slag), 10%, 20%, 30% & 40% by weight of cement for M-25 and M-40 mix. Concrete mixtures were produced, tested and compared in terms of compressive and split strength with the conventional concrete. These tests were carried out to evaluate the mechanical properties for the test results for compressive strength up to 28 days and split strength for 56 days are taken. The advancement of concrete technology can reduce the consumption of natural resources and energy sources and lessen the burden of pollutants on environment. Presently large amounts of Blast Furnace Slag are generated in thermal industries with an important impact on environment and humans.

Amit S. Kharade (2013) An Experimental Investigation of Properties of Concrete with Partial or Full Replacement of Fine Aggregates Through Copper Slag, this paper presents the results of an experimental investigation carried out to evaluate the mechanical properties of concrete mixtures in which fine aggregate (sand) was replaced with Copper Slag. The fine aggregates (sand) was replaced with percentages 0% (for the control mixture), 10%, 20%, 30%, 40%, 50%, 60%, 80%, and 100% of Copper Slag by weight. Tests were performed for properties of fresh concrete and Hardened

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Concrete. Compressive strength and Flexural strength were determined at 7, 28 and 56days. The results indicate that workability increases with increase in Copper Slag percentage. Test results indicate significant improvement in the strength properties of plain concrete by the inclusion of up to 80% Copper slag as replacement of fine aggregate (sand), and can be effectively used in structural concrete. Also as percentage of Copper Slag increased the density of concrete increased. The workability of concrete increased with increase in percentage of copper slag. Toughness of copper slag is found to be more, which increases the compressive and flexural strength of concrete.

Gaurav Singh (2015) Study of Granulated Blast Furnace Slag as Fine Aggregates in Concrete for Sustainable Infrastructure, in this study an attempt is done to understand the variation in compressive strength of concrete with GBFS content. Along with that cost analysis is also done to suggest the most optimized percentage of GBFS to be used in various conditions. Growing environmental restrictions to the exploitation of sand from river beds leads to search for alternatives particularly near the larger metropolitan areas. This has brought in severe strains on the availability of sand forcing the construction industry to look for alternative construction materials without compromising the strength criteria of concrete. Granulated blast furnace slags are one of the promising sustainable solutions as they are obtained as solid wastes generated by industry. Hence it reduces the solid waste disposal problem and other environmental issues. Present experimental work explores the possibility of using GBFS as replacement of natural sand in concrete.

Yogendra O. Patil (2013) This paper presents an experimental study of compressive and flexural strength of concrete prepared with Ordinary Portland Cement, partially replaced by ground granulated blast furnace slag in different proportions varying from 0% to 40%. It is observed from the investigation that the strength of concrete is inversely proportional to the % of replacement of cement with ground granulated blast furnace slag. It is concluded that the 20% replacement of cement is possible without compromising the strength with 90 days curing. The production of cement results in emission of many greenhouse gases in atmosphere, which are responsible for global warming. Hence, the researchers are currently focussed on use of waste material having cementing properties, which can be added in cement concrete as partial replacement of cement, without compromising on its strength and durability, which will result in decrease of cement production thus reduction in emission in greenhouse gases, in addition to sustainable management of the waste.

Rakesh Sakale (2016) Experimental Investigation on Strength of Glass Powder Replacement by Cement in Concrete with Different Dosages, in this experimental work, the effect of partially replacing of glass powder in concrete is studied. The cement in concrete is replaced by waste glass powder in steps of 10% 20%, 30%& 40% respectively by volume of cement and its effects on compressive strength, split tensile strength, workability and flexural strength are determined. It is found that the compressive, flexural and split tensile strengths of concrete increase initially as the replacement percentage of cement by glass powder increases become maximum at about 20% and later decrease. The workability of concrete reduces monotonically as the replacement percentage of cement by glass powder increases. The replacement of cement up to about 20% by glass powder can be done without sacrificing the compressive strength.

NaraindasBheel (2018) Experimental Study on Recycled Concrete Aggregates with Rice Husk Ash as Partial Cement Replacement, this research was conducted on recycled cement concrete aggregates of demolished structures and Rice Husk Ash (RHA). The purpose of this experimental study is to analyze the mechanical properties of concrete; when cement is partially replaced with RHA and natural aggregates by recycled aggregates (RA). In this study, the cement was replaced by RHA up to 10% by weight of cement. For experimental purpose, total 135 concrete specimens were prepared, cured and tested in Universal Testing Machine (UTM). Finally, laboratory results were compared in terms of compressive and splitting tensile strength made with normal and recycled coarse aggregates. All the specimens were prepared at 1:1.5:3 with 0.50 w/c ratio and tested at 7, 14, 21, 28 and 56 days curing ages. It is observed from experimental analysis that the workability of fresh normal concrete is 7% and 10% greater than recycled aggregates concrete blended with 10% RHA and only recycled aggregates concrete without RHA respectively. The compressive strength increases up to 6%, whilst splitting tensile strength increases 4% at 56 days curing, when the cement is replaced 10% by RHA. It is, further, concluded that with more than 10% RHA replacement with cement, the compressive strength decreases. This study would help the construction experts to use such wasted concrete into useable production of new concrete projects.

Ankit Agarwal (2020) Experimental Investigation on Recycled Aggregate with Laboratory Concrete Waste and Nano-Silica, In the research laboratories a huge amount of concrete specimens is thrown away after their testing or due to some flaws which results in large amount of material loss not only in the initial stage but also after the end result. Therefore, a need to reuse these waste specimens by recycling them into coarse aggregates and then further using it to make concrete will turn into a sustainable option. This paper deals with the study of Recycled aggregate concrete made from laboratory concrete waste replacing Natural Aggregate(NA) and Nano Silica(NS) as partial replacement with cement. In this paper we investigated the compressive strength, split tensile strength, flexural strength for mechanical properties and water sorptivity and rapid chloride penetration to evaluate durability characteristics of control concrete i.e., with natural aggregate as well as 20%, 40% and 60% replacement of NA with Recycled Aggregate (RA). Also, we compared the above results with concrete specimens prepared by replacing 1%, 3% and 5% of cement with Nano silica for each of the 20%, 40% and 60% RA concrete mix.

III. NEEDS OF THE STUDY

3.1 AIM

To investigate the effect of Blast Furnace Slag concrete and influence of this on the Strength of concretes made with different admixtures.

3.2 OBJECTIVES

The objectives of this study are as follows

- To investigate the best mix proportion of the effect of Blast Furnace Slag concrete in concrete by the value of strength per weight ratio of sample specimen.
- To investigate the feasibility of the partial replacement of material in concrete by determining its compressive strength and split tensile strength.
- Based on the test results, to suggest most approximate level of adding Blast Furnace Slag.
- To study the strength parameters of the Blast Furnace Slag mixed specimens and to compare it with conventional specimens.

3.3 PROBLEM STATEMENTS

In India, waste disposal is one of the factors contributing the environmental problem and increasing dramatically year by year. According to Antara News (2011), In India, the egg consumption of the Indian people which is still low. In Indian the per capita egg consumption of the people was recorded at one egg per week while in Indian the per capita egg consumption was noted at three per day.

3.4 SCOPE OF STUDY

An investigation the effect on the performance of the eggshell powder as in additive in concrete mixed. In eggshell concrete production, Portland composite cement, coarse aggregate, fine aggregate, water, and eggshell. Blast Furnace Slag can be used as a partial replacement for Portland cement in concrete production, which reduces the amount of cement needed and thus lowers the cost and carbon footprint of concrete. Additionally, concrete made with Blast Furnace Slag is stronger, more durable, and less permeable than concrete made without it. Blast Furnace Slag can be used to stabilize soil, which makes it more resistant to erosion and better suited for construction. Blast Furnace Slag can also neutralize acidic soils, which can improve crop yields. The experiments will use to investigate are compressive strength, tensile test and flexural test. Thus, the amount of eggshell waste can be used as additive in concrete production. Besides that, it also will decrease the construction cost and landfill. Some test and experiments are proposed to be performing to determine the performance concrete strength and eggshell ash. These eggshells must be grinded into fine powder. This test will be tested at 7 days, 14 day and 28 days to get the strength.

IV. METHODOLOGY

4.1 Introduction

The experimental investigation involves assessing the practicality of sustainable concrete manufacturing through using blast furnace slag as a replacement for standard cement. The process is systematically altering the proportion of blast furnace slag in concrete mixes to examine the impact on important parameters such compressive strength, durability, and workability. Standard testing techniques are used to compare the performance of sustainable concrete to conventional concrete. This comprehensive technique attempts to give suggestions for the ideal blast furnace slag mix for improved sustainability without harming the structural integrity of the concrete.

Table 4 Material used:

Step	Description	Calculation/Action
1.	**Materials Used**	-
	- Cement 43 grade (M20, M30)	-
	- GGBS (Ground Granulated Blast Furnace Slag)	-
	- Sand	-
	- Coarse Aggregates	-
	- FosrocConplast SP 430 (Admixture)	-
	Coarse Aggregate	-
	- Definition: Aggregate retained above 4.75 mm IS sieve	-
	- Type: Used 12.5 mm to 15mm size Angular Shape Coarse Aggregate	-
Mix Design Procedure		
2.	**Calculate Water Content**	-
	- Water-Cement Ratio (W/C) = 0.45	-
	- Weight of Cement (C) = 380 kg/m³	-
	- Water Content (W) = W/C Ratio x Weight of Cement	-
3.	**Calculate Cement Content**	-
	- Determine the volume of coarse and fine aggregates	-
	- Assume 40% fine aggregates and 60% coarse aggregates by volume	-
	- Volume of Fine Aggregates (V_fine) = 0.4 m³	-
	- Volume of Coarse Aggregates (V_coarse) = 0.6 m³	-
4.	**Calculate Weight of Aggregates**	-
	- Assume bulk density: 1600 kg/m³ (Fine Aggregates) and 1500 kg/m³ (Coarse Aggregates)	-
	- Weight of Fine Aggregates = Volume of Fine Aggregates x Density	-
	- Weight of Coarse Aggregates = Volume of Coarse Aggregates x Density	-
5.	**Calculate Total Mix Weight**	-
	- Total Mix Weight = Weight of Cement + Weight of Fine Aggregates + Weight of Coarse Aggregates + Water	-
	- Total Mix Weight = 380 kg + 640 kg + 900 kg + 171 kg	-

4.2 Materials Used

- Cement 43 grade(M20,M30)
- Ggbs(ground granulated blast furnace slag)
- Sand
- Coarse aggregates
- Fosrocconplastsp 430(admixture)

Fig 9 Cement

Coarse Aggregate

The aggregate which retains above 4.75 mm IS sieve is termed as coarse Aggregate.

The crushed stone or metal, called khadi or gitti comes under coarse aggregate. We used 12.5 mm to 15mm size Angular Shape Coarse Aggregate.

Ground Granulated Blast Furnace Slag*:* It is obtained from making of iron. This is one type of blast furnace slag. GGBS and finely ground pelletized slag are marketed separately to the concrete producer and used as a partial replacement for portland cement.

Sources of GGBS*:* Blast furnace slag is by-product from the blast furnaces used to make iron. These operate at a temperature of 1500 oc and are fed with a carefully controlled mixture of iron ore, coke and lime stone. The iron-ore is reduced to iron and the remaining materials form a slag that floats on top of the iron.

Fosrocconplastsp 430*:* It is admixture used in this experiment. Admixtures are used to give special properties to fresh or hardened concrete. Admixtures may enhance the durability, workability and strength characteristics of a given concrete mixture. Admixtures are used to overcome difficult construction situations such as hot or cold weather placements, pumping requirements, early strength requirements or very low water-cement ratio specifications.

V. CONCLUSION

The conclusion of a systematic review on "Experimental Investigation of Sustainable Concrete Production Using Blast Furnace as a Cement Substitute" would likely summarize the findings of multiple studies on the topic. It may indicate whether using blast furnace slag as a cement substitute in concrete production is a viable and sustainable option. The conclusion may highlight any trends, patterns, or inconsistencies observed across the studies, along with potential recommendations for future research or practical applications.

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