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Utilization of Waste Materials (GGBS+FLY ASH) in Concrete

Shivanshu Gumasta[1], Deepak Garg[2], Rakesh Patel[3]
P. G. Scholar[1], Assistant Professor[2], H.O.D.[3]
Department of Civil Engineering, Oriental Institute of Science and Technology, Bhopal, Madhya Pradesh, India

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ABSTRACT

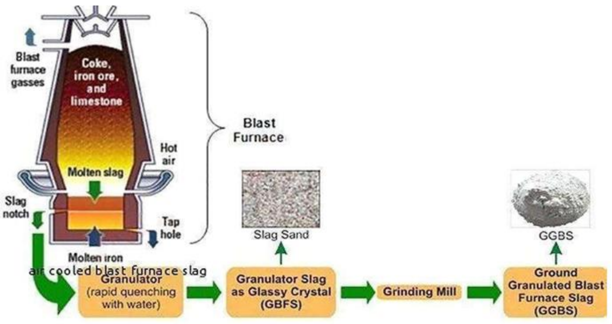
Concrete is an extensively used material in the construction industry. Normally the concrete is made up of cement, sand and coarse aggregate at the appropriate ratio as per the requirements. The cement used in the preparation of concrete has its own detrimental effect on health and the environment. Sand is a natural building material that depletes fast due to excessive usage. Sand mining done for construction purposes has its own impact on the environment. As a result, a concentrated effort has been made to use alternative technologies to replace cement and sand. As such, the main goal of this research is to suggest alternative approaches to address the issues of excessive sand utilization by agricultural wastes and industrial wastes and by-products.

Keywords : Fly Ash, GGBS, Fresh and Hardened Test on Concrete, Reducing Emissions.

I. INTRODUCTION

Among the most significant contributors to a nation's social and economic development today is the construction sector. The majority of infrastructure, including residential homes, tall buildings, dams, bridges, and retaining walls, has been built using concrete by the construction industry. The most predominately used binder in concrete is blended cement. Today, public and private organizations have been giving considerable importance to different construction materials on account of their environmental behavior. The increasing use of cement-based concrete in construction projects, along with the ensuing release of toxic chemicals into the atmosphere, results in a notable increase in global temperature. The amount of carbon dioxide (CO2) produced by a thousand kg of cement is almost equal. According to an estimate, around 6–8% of the total CO2 globally emitted comes from ordinary cement production. The concrete has been investigated currently in favor of depleting carbon dioxide emissions and enhancing the performance eventually reducing in the cost of construction. Keeping in view eco-friendly approaches and utilization of industrial solid waste or by-product materials as replacement of cement has been considered under construction for the generation of cement and concrete because it shares less amount of consumption of natural resources.

The by-product of producing iron and steel in a blast furnace that is turned into granular form is called granulated blast furnace slag. The term "blast-furnace slag" refers to a non-metallic product that is formed of calcium silicates and aluminosilicates, along with other bases, that can be formed in a blast furnace when iron or steel is molten. When used as an aggregate in concrete, blast furnace slag has both financial and environmental advantages. As an alternative to sand, GGBS is supplied by numerous steel mills in India.



Fog 1: Production of GGBS

Objectives behind the Research

1. The examination of concrete's strength characteristics, such as split tensile strength, flexural strength, and compressive strength
2. To ascertain the ideal proportion of fly ash and GGBS to be used in concrete as a partial substitute for cement, hence reducing the fly ash disposal issue when using concrete.
3. To propose an alternative building martial that could reach requirements of good building material.
4. And also to arrive at a solution for the problem of imbalance between the availability and the demand of conventional building materials.

II. LITERATURE REVIEW

Sonar (2023) objective of the research paper was to investigate the behavior of Self Compacting Concrete uses GBFS cubes, cylinders, and beams under compressive, flexural and tensile loading Conventional concrete cubes, beams and cylinders are cast for the comparison with Self Compacting Concrete using GBFS. Observations were concentrated on Filling Ability and Passing Ability of concrete, tensile strength, compressive, flexural strength. The mix proportion was prepared by replacing fine aggregate by 5%, 10%, 15%, 20% and 25% with GBFS and Fly Ash respectively. Observation results concluded that SCC helps to improve the environment of the construction locations by reducing noise produced in the plants and construction fields and reducing the requirement of skilled labourers. where concrete is being casted and also reduced the time period of the project construction. The SCC is an ideal type of concrete that can be used for narrow spaces of reinforcement and architecturally demanding sections, or for all structural applications where higher efforts in order to gain sufficient compaction. and also reduced time period of the project construction. Reduction in the cost of construction with the usage of GBFS, which is cheap and easily available.

Wani and Goel (2022) The usefulness of copper slag as fine aggregate in high strength concrete flexural members (beams) was investigated experimentally and reported in the study article. Copper slag replacement to natural sand at 25%, 50%, 75%, and 100% in M40, M60, and M80 grades were the factors taken into consideration. For Rigid pavement (concrete samples of rectangular cross section were cast five boxes in each grade with similar reinforcement and of same sizes, tested under uniformly increasing static applied load at 1/3rd points. The load– deflection curve at mid-span and Moment–Curvature based on deflection under the loads and at mid-span were analysed.

Materials and Experimental Setup:

Cement in general can be defined as a material which possesses very good adhesive and cohesive properties which make it possible to bond with other materials to form compact mass. The following tests have been completed in accordance with IS:8112-1989 using locally accessible Ordinary Portland cement of grade 53 from the ACC cement Branch that complies with ISI criteria. Tables 4.1 and 4.2 display the physical characteristics and chemical compositions of OPC.

FLY ASH It is most commonly used as a pozzolan in PCC applications. Pozzolans are siliceous or siliceous and aluminous material, which in a finely divided form and in the presence of water, react with calcium hydroxide at ordinary temperatures to produce cementitious compounds. Particle size of fly ash varies from 1μm to 100μm in diameter with more than 50% under 20μm.

GROUND GRANULATED BLAST FURNACE SLAG (GGBS) Molten iron slag, a byproduct of producing steel and iron, is quenched in water or steam in a blast furnace to create glassy, granular material that is subsequently dried and ground into a fine powder. This process yields ground-granulated blast-furnace slag, also known as GGBFS or GGBS. The table that follows displays the chemical composition (%) and physical characteristics of ground granulated blast furnace slag (GGBS).

III. TEST & RESULTS

Slump Cone:

Mix id	Slump (mm)
M0	71.85
M1	82.55
M2	80.03
M3	83.02
M4	94.38
M5	85.07
M6	87.36
M7	84.44
M8	73.23
M9	79.72

Inference- The mixed fresh concrete workability was measured immediately after mixing of the concrete according to IS: 1199 1959. It is clearly can be observed that the slump of OPC concrete specimen was 70 mm, whereas 100, 90 and 90 mm for specimens M4, M6 and M7, which are higher than controlled one respectively. The specimens with more coal Fly Ash have better workability because of the spherical shape of coal Fly Ash particles. The spherical particles of Fly Ash caused to deplete the internal friction between the ingredients of concrete that likely influence a considerable fluidity of mix concrete. The M1, M2 and M8 lose the workability collapse to lowest slump of 80, 85 and 75 mm. This may be attributed to the weight of slag affect the slump.

COMPRESSIVE STRENGTH TEST

The compressive strength of concrete for cubes, all mixes at 7 and 28 days of curing is presented in table below.

Avg Compressive Strength in N/mm2		
Mix id	7 Days	28 Days
M0	16.87	24.65
M1	17.23	25.93
M2	18.14	27.05
M3	19.32	28.12
M4	20.22	28.96
M5	20.93	29.14
M6	21.56	30.56
M7	22.65	31.07
M8	22.17	32.22
M9	23.43	33.45

Inference- the Compressive strength increased with addition of fly ash up and the most favorable results were visible for the sample M9 and further additions of GGBS and fly ash will tend to reduce the strength of concrete. an increment of 34.5% percent is visible in increase of compressive strength for the sample M9 when compared the the compressive strength achieved from the conventional M25 grade concrete. It is represented in Fig. above which shows the

Comparison and Effect of curing on compressive strength of M25 Grade.

SPLIT TENSILE STRENGTH

The split tensile strength of concrete for cylinders, all mixes at 28 days of curing is presented in table Only 3 cylinders were casted for various percentage replacements of cement by FA and GGBS.

Mix id	Tensile Strength, N/mm2
M0	3.47
M1	3.56
M2	3.64
M3	3.71
M4	3.76
M5	3.77
M6	3.86
M7	3.901
M8	3.97
M9	4.04

Inference- The Split Tensile strength of Cylinders are increased with addition of fly ash up to 10% and GGBS up to 20% replace by weight of cement and further any addition of FA and GGBS the Split Tensile strength decreases. the maximum strength is achieved for the sample M 9 and further addition of any combination of Fly Ash and GGBS to the cement will decrease its strength It is represented in figure above which shows the effect of curing on split tensile strength of M25Grade.

FLEXURAL STRENGTH

The flexural strength of concrete for prisms, all mixes at 28 days of curing is presented in table Only 3 prisms were casted for various percentage replacements of cement by FA and GGBS.

Mix id	Flexural Strength, N/mm2
M0	3.451
M1	3.63
M2	3.787
M3	3.936
M4	4.05
M5	4.07
M6	4.27
M7	4.34
M8	4.51
M9	4.68

Inference- The flexural strength of prisms are increased with addition of fly ash up to 10% and GGBS up to 20% replaced by weight of cement and further any addition of FA and GGBS the flexural strength decreases. There is an increase of 24.5% in the impressive strength of sample M9 when compared to results achieved from the conventional concrete M25. It is represented in Figure above which shows the Effect of curing on Flexural strength of M25 Grade.

Conclusion:

This research analyzes the compressive strength qualities of concrete by partially replacing cement in concrete with Ground Granular Blast Furnace Slag (GGBS) and Fly Ash.

The rising demand for cement in the building sector is generating environmental deterioration; as a result, waste materials such as GGBS and Fly Ash are being utilized to substitute cement.

The main purpose of this work is to evaluate the fresh and hardened characteristics of M-25 grade control concrete and concrete prepared with partial substitution of fly ash and GGBS with varied percentages.

To evaluate hardened characteristics compressive strength testing is conducted and comparative research was done.

Green concrete with economical construction and lower CO2 emissions can be produced with these ratios.

Compressive Strength

The Compressive strength increased with addition of fly ash up and the most favorable results were visible for the sample M9 and further additions of GGBS and fly ash will tend to reduce the strength of concrete.

An increment of 34.5% percent is visible in increase of compressive strength for the sample M9 when compared the compressive strength achieved from the conventional M25 grade concrete.

Split Tensile Strength

The Split Tensile strength of Cylinders are increased with addition of fly ash up to 10% and GGBS up to 20% replace by weight of cement and further any addition of FA and GGBS the Split Tensile strength decreases.

The maximum strength is achieved for the sample M 9 and further addition of any combination of Fly Ash and GGBS to the cement will decrease its strength.

Flexural Strength

The flexural strength of prisms are increased with addition of fly ash up to 10% and GGBS up to 20% replaced by weight of cement and further any addition of FA and GGBS the flexural strength decreases.

There is an increase of 24.5% in the impressive strength of sample M9 when compared to results achieved from the conventional concrete M25.

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