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# Partial Replacement of Cement by GGBS in Concrete

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**ABSTRACT:** Concrete is the most widely used construction material in civil engineering industry because of its high structural strength and stability so it has become a vital part of our lives and thus the use of concrete is increasing at a very high rate. The concrete industry is constantly looking for its alternatives with the objective of reducing the solid waste disposal problem. The production of cement releases large amount of carbon dioxide gas into the atmosphere, a major contribution of greenhouse effect and the global warming. To overcome these problems there is a need of cost effective, alternative and innovative materials. In this project a comprehensive effort is made to partially replace the cement by ground granulate blast furnace slag (GGBS) as an alternative in combination with concrete admixture, for concrete ingredients which shall lead to global sustainable development and lowest possible environment impact and will also reduce cost of construction as well.

## I. INTRODUCTION

Concrete is a heterogeneous mixture of cement, aggregates and water. The global consumption of cement is too high due to its extensive use in concrete. The demand for cement is quite high in developing countries owing to rapid infrastructural growth which results in supply scarcity and produce environmental of cement. The concrete industry is constantly looking for supplementary cementitious material with the objective of reducing the solid waste disposal problem. To overcome from this crisis, partial replacement of cement with GGBS is an economic alternative. Ground granulated blast furnace slag (GGBS) is the solid wastes generated by industry. Substantial energy and cost savings can result when industrial by-products are used as partial replacements for the energy-intensive Portland Cement. This investigation attempts to study the feasibility of using locally available GGBS as partial replacements for cement and sand in concrete. In this research we prepared specimen of cubes for compressive strength test. Three samples for each set of percentage have been taken for conducting test and average of results are taken. The samples were tested at the age of 3 days, 7 days, 28 days and 56 days.

## II. LITURATURE SURVEY/BACKGROUND

In these research S.Pavia and all the authors carried out the study on durability of OPC versus GGBS concrete on exposure to silage effluent to compare the durability of OPC and GGBS mortars samples of different mix proportion were exposed to sewage effluent. This paper has evidenced that PC composites incorporating GGBS are more durable than those made with PC alone in aggressive environments under the action of acids and salts such as those produced by silage and that durability increased with increasing amount of GGBS. GGBs Mixes showed the smallest progressive rise in permeability, water absorption and capillary suction as a result of silage immersion and salt cycling, as well as the smallest mass and compressive strength loss. Therefore, a more durable concrete mix for agricultural use in silos can be specified by incorporating GGBS as a partial substitute for OPC.

Sonali K. Gadpalliwar and all the authors carried out the study on the partial Replacement of Cement by GGBS & RHA and Natural Sand by Quarry Sand In Concrete. The M40 mix proportion is designed as per guidelines, according to the Indian Standard Recommended Method IS 10262-2009. The total binder content was 400Kg/m<sup>3</sup>, fine aggregate is taken 668.9525 Kg/m<sup>3</sup>, coarse aggregate is taken 1301.122 Kg/m<sup>3</sup>. The super plasticizer content was varied to maintain a slump of 60 mm for all mixtures. This research is carried out in three phase, in first phase mix of M40 grade concrete with replacement of 0%, 15%, 30%, 45%, 60%, & 75%, 90% and 100% of quarry sand with natural sand is carried out to determine the optimum percentage of replacement at which maximum compressive strength is achieved. In second phase, cement is partially replaced with GGBS by 10%, 20% and 30%. Concrete acquires maximum increase in compressive strength at 60% quarry sand replaced by natural sand for M40 grade of concrete. This mix is named as critical mix. Good compressive strength is obtained when 22.5% GGBS + 7.5% RHA is replaced with cement and natural sand is replaced by 60% quarry sand.



Durability test carried out in the investigation through acid attack test and chloride test with 1% sulphuric acid and 3% hydrochloric revealed that 22.5% GGBS + 7.5% RHA replaced with cement and 60% sand replaced with natural sand in concrete is more durable in terms of durability factors than control mix.

K. Muthusamy and all the authors carried out a study on the durability performance of concrete containing laterite aggregates. In their study they observed that the use of 20 to 30% of laterite aggregates, as partial replacement for coarse aggregate content on the durability performance of this concrete is unknown. As such the acid resistance and water absorption of concrete consisting of various percentage of laterite aggregates, integrated as partial replacement of coarse aggregates were prepared in the form of cubes (150 x 150 x 150mm). After water curing for 28 days, the specimens were tested for the determination of compressive strength and durability against acid attack and water absorption.

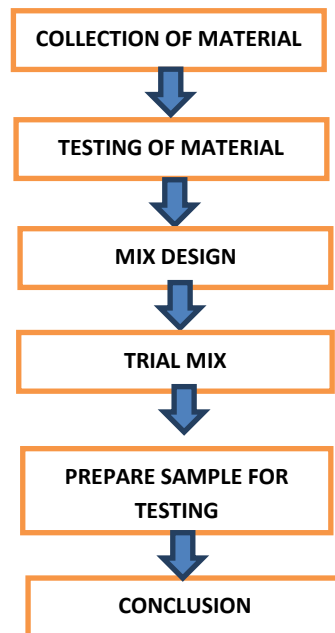
Material used in this study were ordinary Portland cement, granite aggregates, laterite aggregates, super plasticizer and tap water. A single batch of Ordinary Portland Cement (OPC0), that conforms to ASTM C150(2012), was used as a binder for producing the concrete specimens.

**Acid Resistance Test** The durability of the concrete against acid attack was investigated using a similar experimental approach to that of Awal(1998) and the durability test was carried out by immersing the cubes in 5% Hydrochloric Acid Solution (HCL) for 1800h. The pH of the solution was maintained at about 2 throughout the immersion period. Moreover, the durability performance of both the plain and laterite concrete mixes was determined by measuring the loss of mass and the reduction in compressive strength. The results show that the slump value decreases with increasing percentage of laterite. This result indicates that the concrete becomes less workable as the amount added laterite aggregates increases. Therefore, a larger amount of water is needed in order to make the mixes more workable. The workability of the laterite concrete mix is reduced probably as result of the higher rate of water absorption of these aggregates, which have higher porosity, compared to their granite counterparts.

Losses of mass and strength are clear indicators of acidic attack (Zivica and Bajza, 2001)

### III. METHODOLOGY AND DESIGN OF EXPERIMENTAL SETUP

The following flow chart shows the methodology or the process we'd be following in the project.



Collection of material and testing of materials For making concrete and project required material will be collected nearby sources. Collected material will be tested by following guidelines or codes-



• **For Cement-**

Sr. No.	Test	Test Method/ IS Code for testing
1	Consistency Of Cement	IS: 4031 (pt-4) :1988
2	Finesses	IS: 4031 (pt-2) :1988
3	Initial And Final Setting Time	IS: 4031 (pt-5) :1988
4	Destiny Of Cement	IS: 4031 (pt-11) :1988
5	Compressive strength	IS: 4031 (pt-6) :1988

• **For aggregates course and fine-**

Sr. No.	Test	Test Method/ IS Code for testing
1	Sieve Analysis	Is 2386 (pt-1): 1963
2	Specific Gravity	Is 2386 (pt-1): 1963
3	Water Absorption	Is 2386 (pt-1): 1963
4	Bulk Density	Is 2386 (pt-1): 1963
5	Flakiness Index(Course)	Is 2386 (pt-1): 1963
6	Elongation Index (Course)	Is 2386 (pt-1): 1963
7	Crushing Value (Course)	Is 2386 (pt-4): 1963
8	Impact Value	Is 2386 (pt-4): 1963
9	Material Finer Than 75 μ	Is 2386 (pt-2): 1963

GGBS-bs 6699-1992 SPECIFICATION OF ggbs USE WITH ORDINARY Portland cement

**i. Mix design**

By studying the property of materials test results conducted on in, the mix design will be prepared as per following codes-

IS 10262-2009 recommended guidelines for concrete mix designs.

Is 456-2000 code of practice for plain and reinforced cement concrete.

**ii. Trial Mix**

The purpose of concrete trial mixes is to enable you to check that the strength, workability, density and other properties of concrete. Trails mixes are often undertaken when new materials or admixture are to be used. Trials are also undertaken when setting up batch data, trial mixes can help you maximize all materials in mixes.

• **Preparing sample for test**

**i. Placing**

Concrete is placed in the molds using a trowel in three layers of approximately equal depth and is remixed in the mixing pan with a shovel to prevent segregation during the molding of specimens. The trowel is moved around the top edge of the mold as the concrete is discharged in order to ensure a symmetrical distribution of the concrete and to minimize segregation of course aggregate within the mold.

**ii. Compaction**

Compaction is the removal of air from fresh concrete. Proper Compaction results in concrete with an increased density which is stronger and more durable. Concrete is placed in the mold, in three layers of approximately equal volume. Each layer is compacted with 25 strokes with the rounded end of the rod. The strokes are distributed uniformly over the cross section of the mold and for each upper layer.

**iii. Curing**

Curing means to cover the concrete with a layer of water, so it stays moist. BY keeping concrete moist, the bond between the paste and the aggregates get stronger. Concrete doesn't harden properly if it is left to dry out. Curing is done just after finishing the concrete surface, as soon as it will not be damaged. The longer concrete is cured, the sufficiently is less likely to crack. The specimens are removed from the molds 24 hours after casting. Specimens are placed immediately in water after removal from the molds to prevent loss of moisture from specimens.



**iv. Testing**

Testing will be performed on cubes with three, seven, twenty eight and fifty six days of curing. Concrete mixes containing 50% GGBS and 100% quarry sand replacement level were cast before subjected to water curing for 3, 7, 28, 56 days compressive strength test. The results will be compiled in tabular form with each property represented on a graph to show variance as mix design changes.

For compressive strength we will use IS 516:1959.

**III. PROPOSED WORK/SYSTEM**

- GGBS replacement enhances lower heat of hydration, higher durability and higher resistance to sulphate and chloride attack when compared with normal ordinary concrete.
- Using GGBS as replacement for cement gives better compressive strength than the conventional mix; the natural hydraulic material property present in GGBS makes it an active component of the mix.
- It also contributes to environmental protection because it minimizes the use of cement during the production of concrete.
- GGBS can be used to make durable concrete structures in combination with ordinary Portland cement and/or other pozzolanic materials.
- It can be used in structures to avoid cracks due hydration process like water retaining structures which should be leakage proof.
- It can be used in areas where steel industrial waste disposal is a major problem.
- It can be also used in hot country where there is problem of rapid reduction of setting time.

**IV. EXPECTED RESULT AND DISCUSSIONS**

- **For M40 grade concrete**

Grade	% Replacement	Compressive strength (N/mm <sup>2</sup> )	
		7 Days	28 Days
M40	0	38.36	46.07
M40	30	39.11	52.58
M40	40	35.99	51.55
M40	50	35.33	48.74

- **For M20 grade concrete**

Grade	% Replacement	Compressive strength (N/mm <sup>2</sup> )	
		7 Days	28 Days
M20	0	18.81	28.43
M20	30	17.62	28.76
M20	40	16.29	27.54
M20	50	15.14	26.48

**V. CONCLUSION**

As per the test expected test results, it can be seen that up to 30% replacement there is an increase in strength but with an increase in percentage of GGBS that is for 40% & 50% there is a decline in compressive strength. Therefore, it is observed that maximum strength is achieved for 30% replacement of cement by GGBS thus making it an optimum value.

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