

# **Experimental Analysis to Improve Strength and Durability of Cement Concrete with GGBS**

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**ABSTRACT:** The most of the contemporary problems are relevant to the strength of the constructions. These problems regarding strength of constructions depend on the admixture of concrete. This project certainly deals with the improvement of strength of concrete, durability by adding materials like GBBS, silica fume and fly ash. To achieve the results chemical analysis was performed on the additive concrete over a period of 20 days, showing improved strength, durability and can asses reduction in cost.

**KEYWORDS:** GBBS, Admixture, Additives, concrete, durability, fly ash, silica fume..

## **I. INTRODUCTION**

Materials like Fly Ash, Blast furnace Slag, and Silica fume etc. which are used as admixtures. One among these special concretes is the GGBS concrete which is emerging as one of the new generation construction materials in producing high strength and performance concrete for special structures. Our task is to enhance the strength, durability and reduce the cost than the conventional concrete. So that more effective constructions will be produced an may withstand natural calamities. The use of admixture is not only to increase the durability but also to obtain concrete with desired characteristics such as high compressive strength, high workability and high performance concrete. So the waste materials like GGBS, silica fume and fly ash. etc., are useful.

## **II. LITERATURE SURVEY**

**1. T. CERULLI, C. PISTOLESI, C. MALTESE, D. SALVIONI (2003)** have studied about “Durability of traditional plasters with respect to blast furnace slag- based plaster”.

The aim of his study was to provide a comparison between the physical-mechanical properties of some renders made with ordinary Portland cement, lime and slag. Furthermore an investigation was carried out to analyse mortar resistance to several aggressive conditions like acid attack, freezing and thawing cycles, abrasion, sulphate aggression, cycles in ultraviolet screening device, and salt diffusion.

The study pointed out that the use of slag for rendering purposes is highly desirable, in particular under an ecological point of view. Furthermore, long plaster durability could be obtained if the product is properly optimized in order to have low water absorption, high permeability, low content of calcium hydroxide, and absence of calcium carbonate.

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2. CHIAREA F. FERRAINS, KARTHIK H. OBLA, RUSSELL HILL (2001) studied the “influence of mineral admixtures on theology of cement paste and concrete.

3. Research by IRENE LA BARCA, RYAN FOLEV (2002) was done. Main objective is to monitor the variability of GGBFS sources. Since it is a by product its properties are not concerned. Their properties are studied. They also studied strength gain and air void development of different mixes.

### III. EXPERIMENTAL INVESTIGATION

#### 3.1 APPROXIMATE COMPOSITION LIMITS OF PORTLAND CEMENT

Oxide	Content, percent
CaO	60 - 67
SiO <sub>2</sub>	17 - 25
Al <sub>2</sub> O <sub>3</sub>	3 - 8
Fe <sub>2</sub> O <sub>3</sub>	0.5 - 0.6
MgO	0.1 - 1.4
Alkalies, K <sub>2</sub> O,Na <sub>2</sub> O	0.2 – 1.3
SO <sub>3</sub>	1 - 3

Table 3.1

#### 3.2 MAIN COMPOUNDS OF PORT LAND CEMENT ( BOUGE COMPOUNDS)

Name of the compound	Oxide composition	Abbrevia tion
Tri calcium silicate	3CaOSiO <sub>2</sub>	C <sub>3</sub> S
Di calcium silicate	2CaOSiO <sub>2</sub>	C <sub>2</sub> S
Tri calcium acuminate	3CaO,Al <sub>2</sub> O <sub>3</sub>	C <sub>3</sub> A
Tetra calcium alumina ferrite	4CaO.Al <sub>2</sub> O <sub>3</sub> .Fe <sub>2</sub> O <sub>3</sub>	C <sub>4</sub> A

Table 3.2

#### 3.1.2 COARSE AGGREGATE

##### 3.1.2.1 DETERMINATION OF SPECIFIC GRAVITY

The coarse aggregate used in the making of concrete is of 20mm size. The specific gravity of coarse aggregate is calculated as follows.

Test:

$$\text{Specific gravity} = \frac{C}{B - A}$$

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Where,

$$A = A_1 - A_2$$

= The weight in grams of saturated aggregate in water.

Here,

$A_1$  = Basket and aggregate in water after 24 hours = 3420gr.

$A_2$  = empty basket in water = 2170gr.

Therefore  $A=1250$ gr.

$B$  = aggregate after exposed to air. (not less than 10minutes in water)  
= 1970gr.

$C$  = after kept in oven for 24 hr. and then cooled.  
= 1980gr.

Therefore,

Specific gravity in calculated as 2.75

### 3.2 WORK PROGRESS IN 0<sup>th</sup> – DAY

S.NO	Vol. Of NaOH taken	Burette Readings		Vol. Of Oxalic acid consumed
		Initial	final	
1	10 ml	0	5.1	5.1 ml
2	10 ml	0	5.1	5.1 ml

Table3.3 Standardization of NaOH on 0<sup>th</sup> day

$$\begin{aligned}
 N_1 V_1 &= N_2 V_2 \\
 1.5 \times 5.1 &= N_2 \times 10 \\
 N_2 &= 0.765 \text{ N} \\
 \text{Normality of NaOH} &= 0.765 \text{ N}
 \end{aligned}$$

### 3.2.1 DETERMINATION OF CONCENTRATION OF H<sub>2</sub>SO<sub>4</sub> IN THE TRAYS

Tray. NO	Vol. Of H <sub>2</sub> SO <sub>4</sub> taken from the Tray	Burette Readings		Vol.Of Oxalic acid consumed
		Initial	final	
No.1	5 ml	0	4.95	4.95 ml
No.2	5 ml	0	4.95	4.95 ml
No.3	5 ml	0	12.4	12.40 ml
No.4	5 ml	0	12.4	12.40 ml

Table 3.4 Determination of concentration of H<sub>2</sub>SO<sub>4</sub> in the trays on 0<sup>th</sup> day

### 3.3.210<sup>TH</sup> DAY

The cubes in acid after 10 days

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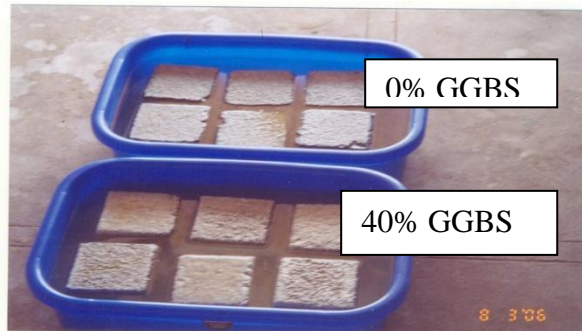


FIG 3.1 CUBES IN ACID AT 10 DAYS

2% H<sub>2</sub>SO<sub>4</sub>

The above picture reflects the view of the practically experimented work pieces immersed in acid at a rate of 10 days. First tray showing 0% GGBS, i.e. without adding any GGBS content. And the second tray showing work pieces in acid with 40% GGBS content.

### 3.2.2 DETERMINATION OF CONCENTRATION OF H<sub>2</sub>SO<sub>4</sub> IN THE TRAYS

### 3.2.3 CONCENTRATIONS AFTER 20 DAYS (C<sub>20</sub>)

Tray	Vol. Of H <sub>2</sub> SO <sub>4</sub> sample taken from the Tray	Burette Readings		Vol. Of NaOH Consumed
		Initial	final	
No. 1	5 ml	0	1.2	1.20 ml
No. 2	5 ml	1.5	3.15	1.65 ml
No. 3	5 ml	0	2.1	2.10 ml
No.4	5 ml	0	5.65	5.65 ml

Table 3.5 Determination of concentration of H<sub>2</sub>SO<sub>4</sub> in the trays after 20 days

### 3.2.6 CALCULATION OF WEIGHT LOSS

$$\text{Percentage weight loss} = \frac{(\text{Initial weight} - \text{Final weight}) \times 100}{\text{Initial weight}}$$

### 3.2.7 THE PERCENTAGE WEIGHT LOSS ON 10TH DAY

In 2% H<sub>2</sub>SO<sub>4</sub>

For cube containing 0% GGBS = 0.6%

For cube containing 40% GGBS = 0.2%

In 5% H<sub>2</sub>SO<sub>4</sub>

For cube containing 0% GGBS = 4.97%

For cube containing 40% GGBS = 3.4%

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### 3.2.8 CALCULATION OF STRENGTH LOSS

$$\text{Percentage strength loss} = \frac{(\text{Initial strength} - \text{Final strength}) \times 100}{\text{Initial strength}}$$

### 3.2.9 THE PERCENTAGE STRENGTH LOSS ON 10TH DAY

In 2% H<sub>2</sub>SO<sub>4</sub>

For cube containing 0% GGBS = 28.6%  
For cube containing 40% GGBS = 20.2%

In 5% H<sub>2</sub>SO<sub>4</sub>

For cube containing 0% GGBS = 43.49%  
For cube containing 40% GGBS = 31.51%

### 3.3 RESULTS AFTER 10<sup>TH</sup> DAY

Concentration of H <sub>2</sub> SO <sub>4</sub>	Percentage of GGBS	Acid consumption	% weight loss	% Strength loss
2%	0%	113.63 ml	0.6%	28.6%
2%	40%	100 ml	0.2%	20.2%
5%	0%	311.5 ml	4.97%	43.49%
5%	40%	204.1 ml	3.4%	31.51%

Table 3.6 Results after 10<sup>th</sup> day

This procedure have been carried out to a time period of every 10 days up to 30<sup>th</sup> day and corresponding results for 20<sup>th</sup> and 30<sup>th</sup> day were displayed below.

### 3.4 RESULTS AFTER 20<sup>TH</sup> DAY

Concentration of H <sub>2</sub> SO <sub>4</sub>	Percentage of GGBS	Acid consumption	% weight loss	% Strength loss
2%	0%	104.44 ml	4.28	49.2
2%	40%	79.45ml	0.97	40.94
5%	0%	190.20ml	12.42	60.31
5%	40%	109.53ml	9.9	51.35

Table 3.7 Results after 20<sup>th</sup> day

### 3.5 RESULTS AFTER 30<sup>TH</sup> DAY

Concentration of	Percentage of GGBS	Acid consumption	% weight loss	% Strength loss

H2SO4				
2%	0%	73.5 ml	7.25	52.3
2%	40%	42.65 ml	2.46	45.9
5%	0%	43.3ml	20.32	68.25
5%	40%	3.7ml	15.92	59.45

Table 3.8 Results after 30<sup>th</sup> day

**IV. EXPERIMENTAL RESULTS**

The results were obtained by testing the prepared cubes. Those results are as shown in the graphs. While observing the graph between Replacement percentages and variation of strength the following conclusions were drawn.

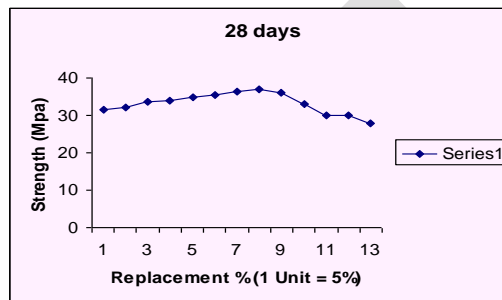


Fig 4.3 Graph between strength and % replacement for 28 days

- When the replacement percentage is increased from 0 to 65% strength is observed to increase up to optimized value
- The optimum percentage is observed at the replacement level of 40 % and the optimized value is 37 MPa



Figs 4.4(a) & (b) Cubes after 10 and 20 days immersed in acid

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Fig 4.5 Cubes after 30 days immersed in acid

The above figures representing the behaviour of the cubes with and without the addition of GGBS immersed in hydro sulphuric acid. Figs 4.4 (a) & (b) shows cubes immersed in 5% acid for about 20 days. Fig 4.5 shows cubes immersed in 2% and 5% acid for about 30 days.

### V. CONCLUSIONS

- While observing the graph between Replacement percentages and variation of strength the following conclusions were drawn:
  - When the replacement percentage is increased from 0 to 65% strength is observed to increase up to optimized value.
  - The optimum percentage is observed at the replacement level of 40 %.
- While observing the graphs between replacement levels and workability the following conclusions were made:
  - The workability increased as replacement level increases.
- While observing the graphs between no of days and acid consumption of both cement and GGBS the following conclusions were made:
  - The Cubes containing GGBS absorbed less amount of acid when compared to plain cement concrete cubes that means GGBS showed greater durability towards acid than ordinary concrete.
  - Acid consumption is reduced as the number of days of immersion increased.
- While observing graphs between number of days and weight loss following conclusions were drawn:
  - The GGBS cubes have undergone less weight loss when compared to plain cement concrete cubes in both 2% and 5% H<sub>2</sub>SO<sub>4</sub>.
  - Weight loss increased as the number of days of immersion increased.
- While observing graphs between number of days and strength loss following conclusions were made:
  - The GGBS cubes have undergone less strength loss when compared to plain cement concrete cubes in both 2% and 5% H<sub>2</sub>SO<sub>4</sub>.
  - Strength loss increased as the number of days of immersion increased.

Above results can be obtained only when quality control is good. If strict attention to details and good practices are necessary while using admixtures, perhaps more than for normal concrete.

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From these results we can conclude that if cement is replaced by GGBS concrete shows enhanced properties; better strength improved durability and workability.

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