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Experimental Study on Precast Concrete by Partial-Replacement of Cement with Ground-Granulated Blast Slag (Gabs)

Loknath Panigrahi[1], Sridhar P[2]
[1,2]Post Graduate Student, Department of Civil Engineering, VITAM College of engineering, Visakhapatnam

Abstract: ***Precast Concrete plays a vital role in development of infrastructure i.e. buildings, industrial structures with pace and good quality of construction with efficient quality control. On the other side cost of concrete is attributed to cost of its production which is direct cause of production of equal amount of carbon dioxide. This requirement is drawn the attention of investigators to explore a new replacement of ingredients of concrete. This study focuses on investigation of characteristics of precast concrete with partial replacement of cement with ground-granulated blast slag (GGBS) and attaining early strength inorder to facilitate timely demould of concrete so as to make effective use of the mould. The study involves the usage of GGBS, is advantage or disadvantage in concrete. This usage of GGBS serves as replacement to already depleting conventional building material and also as being a by-product it serves as an eco-friendly way of utilizing the product without dumping it on ground.***
Keywords: ***Precast*** *Concrete*, ***ground-granulated blast slag (GGBS), Early strength, Cost of concrete****.*

I. INTRODUCTION

A. About Precast Concrete

Concrete is a mixture of cement, coarse aggregate, fine aggregate and water. Precast concrete is a construction product produced by casting concrete in a reusable molds or forms which is then cured in a controlled environment. These are then transported to construction site and lifted into a place. Utilizing a precast concrete system offers many potential advantages over site casting of concrete, one of them the production process for precast concrete is performed on ground. There is a greater control of the quality of materials and workmanship in a precast plant rather than on a construction site. Financially, the forms used in a precast plant may be reused hundreds of times before they have to be replaced, which allow cost of formwork per unit to be lower than for site-cast production. The factors governing precast concrete. Low water-cement ratio, Medium workability, Very high water reducing admixture, Need for high early strength for early de-molding to increase productivity, Compatibility with cement replacement, Compatibility with 100% crushed sand/ manufactured sand.

B. Literature Review

Shariq et al (2008) studied the effect of curing procedure on the compressive strength development of cement mortar and concrete incorporating ground granulated blast furnace slag. The compressive strength development of cement mortar incorporating 20, 40 and 60 percent replacement of GGBFS for different types of sand and strength development of concrete with 20, 40 and 60 percent replacement of GGBFS on two grades of concrete are investigated. Tests results show that the incorporating 20% and 40% GGBFS is highly significant to increase the compressive strength of mortar after 28 days and 150 days, respectively. Peter et al. (2010) studied the BS 15167-1 which requires that the minimum specific surface area of GGBS shall be 2750 cm2/g (BS 15167-1:2006). In China, GGBS is classified into three grades; namely S75, S95 and S105. The GB/T18046 requires a minimum surface area of 3000 cm2/g for grade S75 GGBS, 4000 cm2/g for grade S95 and 5000 cm2/g for grade S105, which are higher than the BS EN's requirements (GB/T18046-2008). It was reported that slag with a specific surface area between 4000 cm2/g and 6000 cm2/g would significantly improve the performance of GGBS concretes. Mojtaba Valinejad Shoubi et al. (2013) reviewed in their research the specifications, production method and degree of effectiveness of some industrial byproducts such as GGBS, Silica Fume and PFA as cement replacement to achieve high performance and sustainable concrete which can lead not only to improving the performance of the concrete but also to the reduction of ECO2 by reducing the amount of PC showing how they affect economical, environmental and social aspects positively.

C. Objectives

1) To design concrete suitable for pre-cast construction Activities
2) To achieve adequate early strength (18 Mpa in 18 hrs for M35 grade) to serve the purpose of de-moulding for efficient use of Mould
3) To decrease the cost of concrete by replacing partially with GGBS and serving the purpose of pre-cast technology
4) To achieve the go green concept by reducing the usage of cement and thus reducing the emission of CO_2 into the atmosphere.

D. Scope

1) Minimum strength of 18 Mpa in 18hrs is required for de-mould is considered.
2) Chemical & Mineral Admixtures are used in the design of pre-cast concrete
3) Cost analysis comparison of concrete with and without GGBS is studied.
4) Compressive Tests with Standard Cube & Cylinders are studied.

II. EXPERIMENTAL PROGRAME

Initially trail mixes are done with cement, sand, coarse aggregate and with different dosages of chemical admixture to obtain a mix of desired initial strength with no segregation and bleeding.

Six controls mixes of precast concrete with partial replacement of cement aggregate with GGBS were prepared. Fifty four cube samples of precast concrete with six different weight percentages of GGBS (0%, 10%, 20%, 30%, 40% and 50%,) were cast to study the effect on compressive strength at 18 hours,7 and 28 days.

Slump flow test and compressive strength tests are conducted to study workability ant strength of concrete. The experimental investigation and the test procedure adopted to study the performance precast concrete with GGBS will now be described in detail.

A. Design Data

1) *Mix-Design Calculation:* The mix design calculations for recast concrete are carried out as per code is 10262-2009, in the laboratory.
2) *Trail Mix:* Trail mixes are done for different dosages of admixture i.e. (0.2%, 0.3% etc) to obtain a precast mix of desired strength in limited time period i.e. 18mpa in 18 hours.
3) *Mix Proportion:*

Cement Opc 53 grade	20mm (kgs)	12.5mm (kgs)	Fine agg	Water (Lit)	Admix	Workability (slump) mm			Initial compressive strength N/mm^2		
						0hr	30min	1 hr	16hr	18hr	20hr
385	732	488	717	168	0.20%	collapse	100	85	10	15	17
385	732	488	717	164	0.30%	collapse	120	100	15.2	19.1	22.2

From trail mixes it is observed that the required strength, 18mpa in 18 hrs is obtained at dosage of 0.3% of admixture. Further with increase in percentage of admixture segregation is observed. Therefore admixture of 0.3% by weight of cement is adopted to obtain precast concrete mixes of desired strength and maintained constant in all mixes for different percentages of GGBS as replacement for cement.

4) *Test Data of Material:*
a) *Cement Used:* OPC 43 Grade Conforming to IS 8112
b) *Specific Gravity of Cement*: 3.15
c) *Chemical Admixture:* Super Plasticizer(thalrakplast)
d) *Specific Gravity of Admixture:* 1.08
e) *Specific Gravity of Coarse Aggregate:* 2.68 (20mm), 1.34(12.5mm)
f) *Specific Gravity of Fine Aggregate :* 2.63
g) *Water Absorption for Coarse Aggregate :* 0.375 (20mm), 0.47(12.5mm
h) *Water Absorption for Fine Aggregate:* 2.56%

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i) Sieve Analysis: Zone II, Graded

5) Mix Design Calculation:

a) Target Mean Strength: = f_{ck} + statistical parameter X standard deviation
= f_{ck} + 1.65S
35N/mm^2 and S= 5 N/mm2
35+1.65X5 = 43.25 N/mm2
f_t= 43.25 N/mm2

b) Calculation for water content Maximum water-cement ratio for M-35 Grade concrete is taken = 0.4
Maximum size of aggregate is taken as 20mm. the calculation of water content is as per IS: 10262-2009.
As per IS :10262-2009, For every increase in 25mm slump from 50mm, increase the water content by 3% for each set of 25mm slump therefore for maximum slump 100mm.
Finally the mix proportion as per guidelines explained above is as follows:

c) Mix Proportion for 1 m^3 Concrete:

Cement (kg/m^3)	Water (lit)	Fly ash (kg/m^3)	CA (kg/m^3)	FA (kg/m^3)	Sup.plast. (kg/ m^3)
270	165.12	115	733: 488.6	734.8	0.81
1	0.61	0.42	2.71:1.8	2.7	0.003

Similar calculations have been done for other trial mixes and are presented in tabular form in table.

6) Mix Proportion M35:

Mix no	Cement	%GGBS	GGBS (kgs)	W/B ratio	CA (kgs)		FA (kgs)	Water (litr)	% Ad-mix
					20mm	12.5mm			
1	385	0	0	0.36	732	487.5	717.2	163.9	0.3
2	346	10	38.5	0.36	731	487	716.8	164.3	0.3
3	308	20	77	0.36	731	487	716.9	164.7	0.3
4	270	30	115.5	0.36	730	486.3	716	165.2	0.3
5	231	40	154	0.36	728.4	485.1	714	165.6	0.3
6	193	50	192.5	0.36	729	484.5	714	166.05	0.3

B. Results and Discussion

Fifty four cube samples and thirty six cylindrical samples of M35 grade of precast concrete have been tested in laboratory. All the specimens were cast with replacement of cement by GGBS at different percentages. Further, the water to powder ratio for all mixes were maintained at 0.36. Super plasticizer dosage for all the mixes were 0.3 % by weight of cement.
A comparative study is carried out to study the effect of GGBS on properties of precast concrete. Properties of concrete namely workability and compressive strength has been selected for study.

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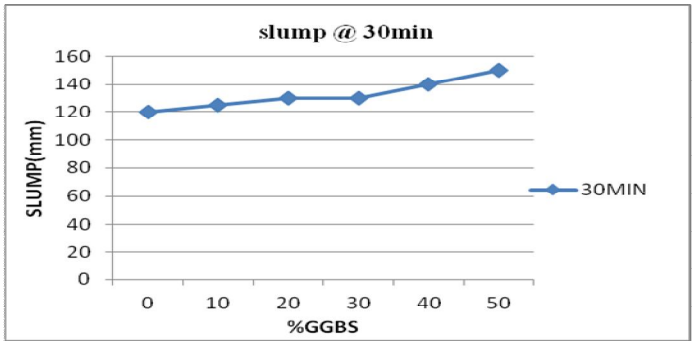
C. Slump Test Result:

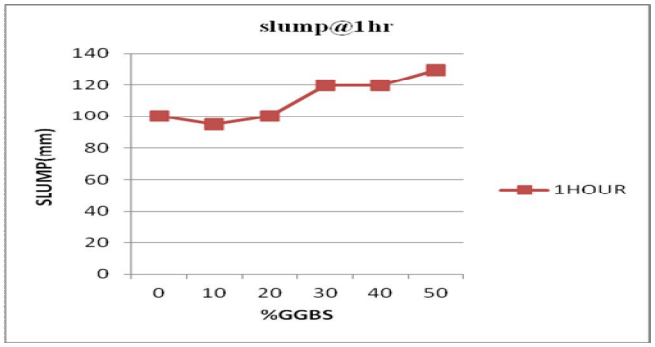
Mix no	% GGBS	SLUMP(mm)		
		0hrs	30min	1hr
1	0	collapse	120	100
2	10	collapse	125	95
3	20	collapse	130	100
4	30	collapse	130	120
5	40	collapse	140	120
6	50	collapse	150	130

D. Compressive Strength Test Result:

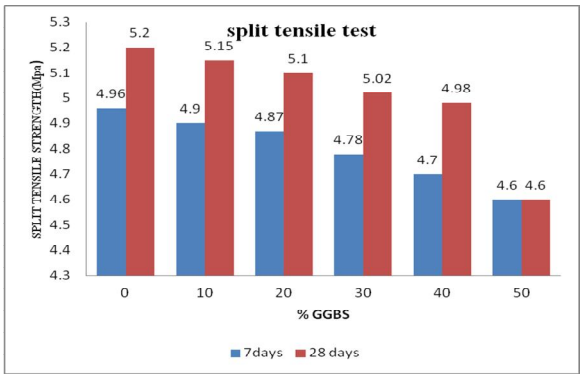
Mix no	% GGBS	Compressive strength(Mpa)		
		18hrs	7days	28days
1	0	19.06	26.45	36.68
2	10	19	24.32	36.8
3	20	18.9	22.26	38.02
4	30	18.8	20.38	35.77
5	40	18.4	19.78	35.45
6	50	18.1	18.6	35.11



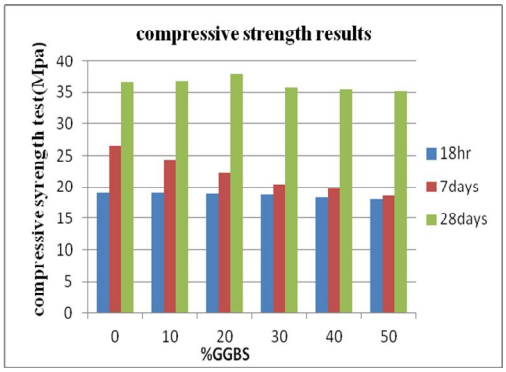
Graph representing slump test results@30min



Graph representing slump test results@1hr



%GGBS (vs.) split tensile strength



Graph representing slump test results@1hr

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E. Cost Analysis

In this project cost analysis is carried out for individual items used in concrete mix to compare the cost of the two concrete mixes i.e. normal precast concrete and GGBS induced precast concrete as shown in table

Rate Analysis For Design Mix M-35 Grade Concrete					
Providing and laying cement concrete in retaining walls, return walls (any thickness) including attached pilasters, columns, piers, abutmets, pillars, posts, struts,buttresses, plain window sills, fillets etc upto floor five level, excluding the cost of centring,string or lacing courses, parapets, coping bed blocks, anchor blocks,shuttering and finishing:					
S.NO	Descripition	Unit	Quantity	Rate	Amount
	Details of cost for 1 cum.				
	Materials:				
1	Stone aggregate 20mm	tonne	0.732	740.00	541.68
2	Stone aggregate 12.5 mm	tonne	0.488	720.00	351.36
3	Carriage of agg. 20mm &12.5 mm	tonne	1.220	106.49	129.92
4	Coarse sand	tonne	0.717	793.00	568.58
5	Carriage of coarse sand	tonne	0.717	106.49	76.35
6	Cement	tonne	0.385	5153.00	1983.91
7	Carriage of cement	tonne	0.385	94.65	36.44
8	Ad-Mixture	Lts	1.100	13.50	14.85
	Labour:				
1	Beldar	Day	0.900	500.00	450.00
2	Coolie	Day	0.780	500.00	390.00
3	Bhishti	Day	0.700	510.00	357.00
4	Mason 1st class	Day	0.060	600.00	36.00
5	Mason Ilnd class	Day	0.060	590.00	35.40
	Mixer	Day	0.070	800.00	56.00
	Vibrator	Day	0.070	350.00	24.50
	Scaffolding	L.S.	114.400	1.78	203.63
	Sundries	L.S.	14.300	1.78	25.45
	(Extra labour for lifting.material upto floor level) Coolie (0.75x2.50)	Day	1.88	329.00	616.88
	TOTAL				5897.95

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Rate Analysis For Design Mix (30% GGBS) M-35 Grade Concrete					
Providing and laying cement concrete in retaining walls, return walls (any thickness) including attached pilasters, columns, piers, abutmets, pillars, posts, struts,buttresses, plain window sills, fillets etc upto floor five level, excluding the cost of centring,string or lacing courses, parapets, coping bed blocks, anchor blocks,shuttering and finishing:					
S.NO	Descripition	Unit	Quantity	Rate	Amount
	Details of cost for 1 cum.				
	Materials:				
1	Stone aggregate 20mm	tonne	0.732	740.00	541.68
2	Stone aggregate 12.5 mm	tonne	0.488	720.00	351.36
3	Carriage of agg. 20mm &12.5 mm	tonne	1.220	106.49	129.92
4	Coarse sand	tonne	0.717	793.00	568.58
5	Carriage of coarse sand	tonne	0.717	106.49	76.35
6	Cement	tonne	0.270	5153.00	1391.31
7	Carriage of cement	tonne	0.270	94.65	25.56
8	Ad-Mixture	Lts	1.100	13.50	14.85
9	GGBS admixture	tonne	0.115	2500.00	287.50
10	Carriage of GGBS	tonne	0.115	106.49	12.25
	Labour:				
1	Beldar	Day	0.900	500.00	450.00
2	Coolie	Day	0.780	500.00	390.00
3	Bhishti	Day	0.700	510.00	357.00
4	Mason 1st class	Day	0.060	600.00	36.00
5	Mason Ilnd class	Day	0.060	590.00	35.40
	Mixer	Day	0.070	800.00	56.00
	Vibrator	Day	0.070	350.00	24.50
	Scaffolding	L.S.	114.400	1.78	203.63
	Sundries	L.S.	14.300	1.78	25.45
	(Extra labour for lifting.material upto floor level) Coolie (0.75x2.50)	Day	1.88	329.00	616.88
	TOTAL				5594.21

III. CONCLUSIONS

From the present investigation and limited observations reported, on the effect of partial replacement of cement with GGBS in precast concrete mixes, following conclusions can be drawn:

A. The Presence of GGBS as cementations material did not affect the minimum early strengths requirements (i.e. 18Mpa in 18 hours) of precast concrete.

B. The slump value is increasing with increase in GGBS content, which indicates the increase in workability of concrete.

C. It is observed that GGBS-based concretes have achieved an increase in strength for 20% replacement of cement at the age of 28 days. Increasing the GGBS content from 0% to 20 % has caused increase in compressive strength by 2% as compared to reference mix.

D. In the case of replacement of GGBS beyond 30% there will be decrease in the compressive strength values of cube.

E. Similarly in case of split tensile test it is observed that increase in % GGBS from 30-50 result in decrease in strength by 9% respectively

F. From this study, it can be concluded that, since the grain size of GGBS is less than that of ordinary Portland cement, its strength at early ages is low, but it continues to gain strength over a long period.

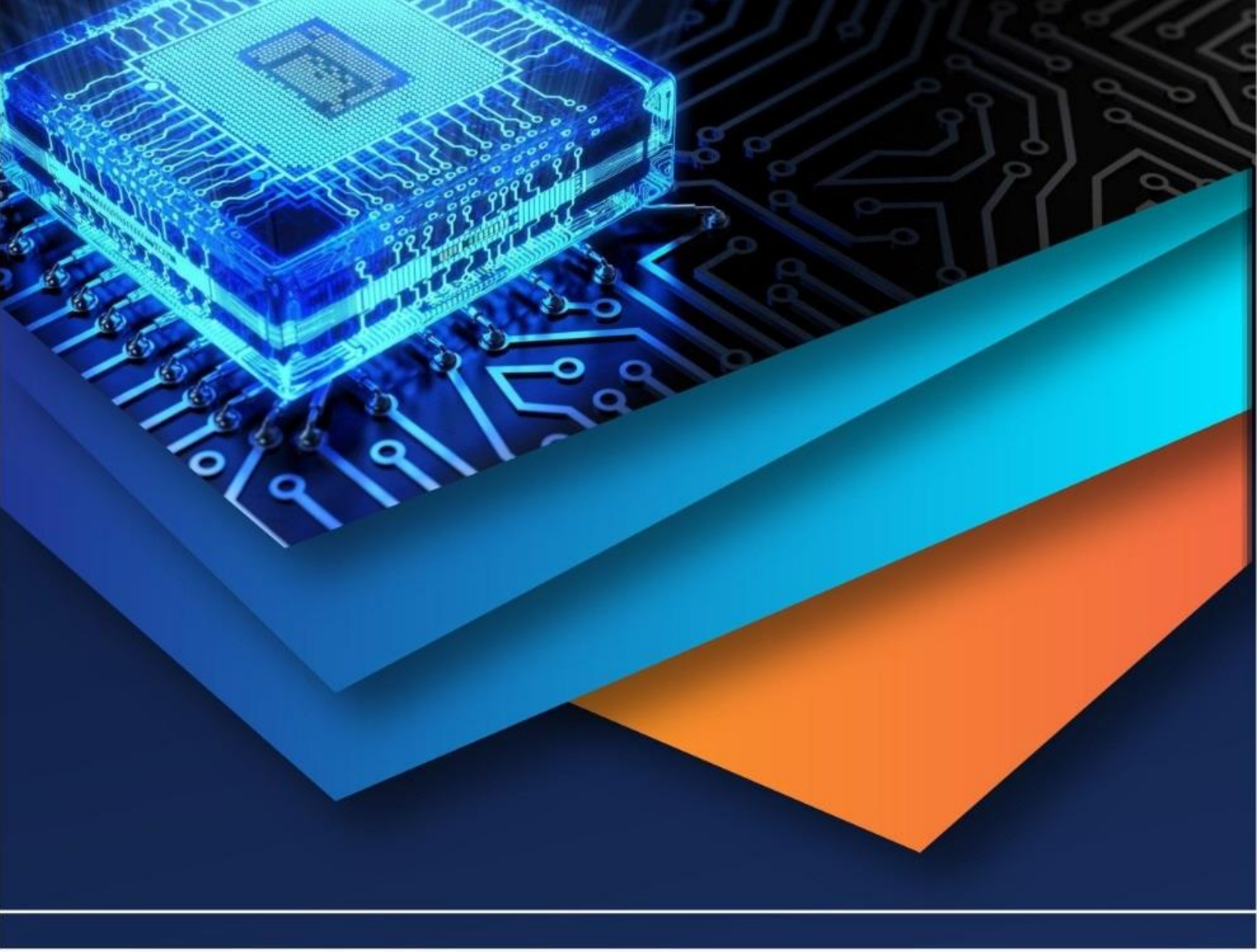
G. The optimum GGBS replacement as cementation material is characterized by high compressive strength and cost-effectiveness.

H. From the above experimental results, it is proved that GGBS can be used as an alternative material for cement, reducing cement consumption and reducing the cost of construction.

I. The partial replacement of OPC in concrete by GGBS, not only provides the economy in the construction but it also facilitates environmental friendly disposal of the waste slag which is generated in huge quantities from the steel industries.

REFERENCES

[1] Shariq et al (2008) report on properties of concrete with GGBSas partial replacement.
[2] Naidu et al. (2012) report on experimental study on concrete with partial replacement of cement with GGBS.
[3] S. Arivalagan (2014) report on Sustainable Studies on Concrete with GGBS As a Replacement Material in Cement.
[4] Yogendra O. Patil (2014) report on GGBS as Partial Replacement of OPC in Cement Concrete – An Experimental Study.
[5] D. Suresh and K. Nagaraju A review on Ground Granulated Blast Slag (GGBS) In Concrete.



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