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Experimental Studies on Replacement of Cement by GGBS

Prof.Bedrekar A.Y[1], Prof.Dhumal M.S[2], Mr.Pinjari P.V.[3], Mr.Gaikwad Y.P.[4], Mr.Inamdar M.L.[5], Mr.Waghmare A.S.[6]
Institute Karmayogi Institute of Technology (Poly) Shelve Pandharpur

Abstract: ***The product of cement causes environmental pollution due to high CO_2 emigrations. To reduce this problem, partial relief of cement with artificial by- products like Ground Granulated Blast Furnace Sediment(GGBS) is an effective result. This study investigates the effect of partial relief of cement by GGBS on the strength parcels of concrete. Different probabilities of GGBS(10, 20, 30 etc.) were used and compressive strength tests were conducted at 7, 14 and 28 days. The results show that GGBS improves long- term strength and continuity of concrete while reducing environmental impact.***

I. INTRODUCTION

Concrete is a admixture of cement, fine total, coarse total and water. Cement is the main list material in concrete. Still, cement manufacturing releases a large quantum of carbon dioxide which affects the terrain.

Ground Granulated Blast Furnace Sediment (GGBS) is a by- product attained from the iron manufacturing assiduity. It's produced during the manufacture of iron in blast furnaces and is fleetly cooled to form a glassy grainy material. GGBS has cementitious parcels and can be used as a partial relief for cement.

The use of GGBS in concrete helps in

- Reducing heat of hydration
- adding continuity
- Improving long- term strength
- Reducing environmental pollution

II. LITERATURE SURVEY

1) Suthar Sunil B. and B.K. Shah (2013)

In their study on high-strength concrete containing Alcofine and fly ash, the authors observed a marked improvement in strength development during both early and later curing stages. The enhancement was attributed to the ultra-fine nature of Alcofine, which improves particle packing, and the pozzolanic activity of fly ash, which produces additional calcium silicate hydrate (C–S–H) gel, leading to denser microstructures and reduced porosity.

2) Sourav and Ashok Kumar Gupta (2014)

The authors examined the relationship between cube and cylinder strength in concrete containing Alcofine. They found that mixes with 13% Alcofine achieved the highest strengths, with cube specimens consistently outperforming cylinder specimens. This strength gain was linked to the high fineness and reactivity of Alcofine, which accelerates hydration and increases packing density.

3) Patil Yogendra O., P.N. Patil, and D. Arun Kumar (2013)

This study on the partial replacement of cement with GGBS concluded that replacing 20% of OPC with GGBS optimizes compressive strength. The improvement was attributed to the latent hydraulic activity of GGBS, which reacts with calcium hydroxide to form additional C–S–H gel. However, increasing GGBS content beyond 20% was found to slow early hydration, leading to reduced early strength.

III. OBJECTIVES OF THE STUDY

The main objectives of this study are:

1) To study the properties of concrete with partial replacement of cement by GGBS.
2) To determine compressive strength at 7, 14 and 28 days.
3) To find the optimum percentage of GGBS replacement.
4) To reduce environmental impact by minimizing cement usage.

IV. MIX DESIGN

Concrete mix design was carried out for M20 grade concrete as per relevant standards.
Materials used:

- Cement (OPC)
- Fine aggregate (sand)
- Coarse aggregate
- Water
- GGBS (10%, 20%, 30% replacement of cement)

Replacement Levels:

- 0% (Control mix)
- 10% GGBS
- 20% GGBS
- 30% GGBS

The water-cement ratio was kept constant for all mixes.
Foronecubeof0.15*0.15*0.15M

1) Cementcontent=425.11*(0.15*0.15*0.15M)=1.434kg.
2) Watercontent=185*(0.15*0.15*0.15M)=0.624litter.
3) Coarseaggregate=1157.58*(0.15*0.15*0.15M)=3.906kg.
4) Fineaggregate=651.14*(0.15*0.15*0.15M)=2.197kg.
5) Replacing10%ofCementwithGGBS=1.434*(10/100) =0.143kg.
6) Replacing20%ofCement withGGBS =1.434*(20/100) =0.286kg.
7) Replacing30%ofCement withGGBS =1.434*(30/100) =0.429kg.

Cube volume = 1.1*(0.15)3 = 0.0037125 m^3

MIX (%)	CEMENT (kg)	FA (kg)	CA (kg)	GGBS (kg)	WATER (lit)
0%	1.43	2.19	3.90	0	0.711
10%	1.28			0.143	
20%	1.14			0.286	
30%	1.0			0.429	

V. EVALUATING PROGRAMME

1) Casting of Specimens
2) Concrete cubes of standard size (150mm × 150mm × 150mm) were cast for each mix.
3) Curing
4) Specimens were cured in water for 7, 14 and 28 days.
5) Compressive Strength Test
6) Compressive strength test was conducted using Compression Testing Machine (CTM). The results were recorded and compared.

VI. CURING

In the experimental study on replacement of cement by **GGBS (Ground Granulated Blast Furnace Slag)**, curing plays a very important role in achieving proper strength and durability of concrete. After casting the concrete specimens such as cubes or cylinders, they are kept undisturbed for 24 hours at room temperature. After 24 hours, the specimens are carefully removed from the moulds and immediately immersed in clean water for curing. The curing is carried out in a water tank at a temperature of about 27 ± 2°C. The specimens are kept in water for different curing periods such as 7 days, 14 days, and 28 days. Proper curing ensures continuous hydration of cement and GGBS, improves strength development, reduces shrinkage cracks, and enhances durability.

Since GGBS reacts more slowly than ordinary cement, adequate curing time is essential to achieve better long-term strength and performance of concrete.

A. Slump conetest:

SR.NO	Replacing percentage of Cement with GGBS	rkability
1	10%	130mm
2	20%	115 mm
3	30%	135 mm

Table6.1.1.1ValuesofworkabilitybySlumpconetest

Compressive Strength of Concrete

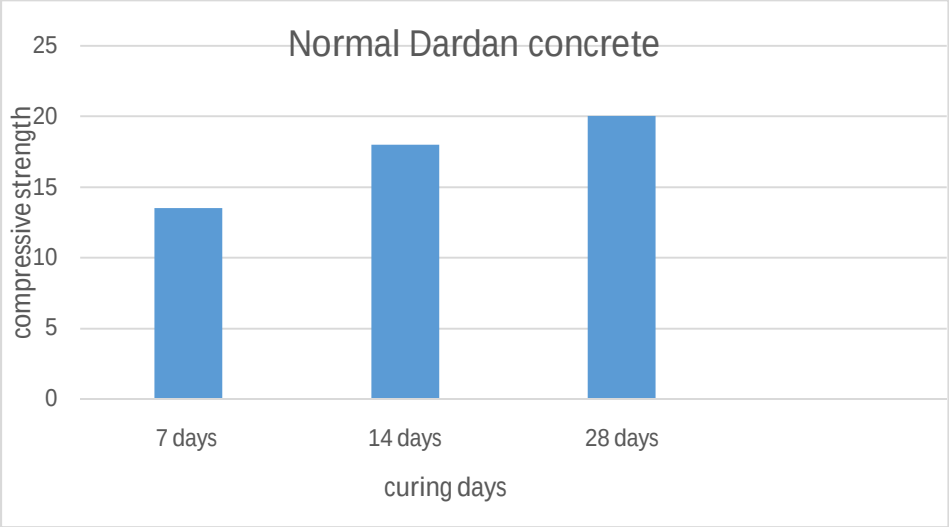
Experimental Studies on relief of Cement By GGBS The contraction test process for experimental studies on relief of cement by GGBS(Ground Granulated Blast Furnace Sediment) is carried out to determine the compressive strength of concrete.In this study, cement is incompletely replaced by GGBS in different probabilities similar as 10, 20, 30, etc., and concrete cells are prepared.First, the accoutrements like cement, GGBS, fine total, coarse total, and water are counted according to the blend design.The dry accoutrements are mixed duly, also water is added and mixed until invariant concrete is attained.The fresh concrete is poured into standard cell moulds of size 150 mm × 150 mm × 150 mmAfter casting, the moulds are kept unperturbed for 24 hours at room temperature.also the samples are removed from the moulds and placed in a curing tank filled with clean water for curing ages of 7 days, 14 days, and 28 days.After the needed curing period, the cells are taken out and wiped to remove face water.Each cell is placed precisely in a Compression Testing Machine(CTM).The cargo is applied gradationally and slightly until the instance fails.The maximum cargo at failure is noted, and the compressive strength is calculated by dividing the failure cargo by thecross-sectional area of the cell.The results are compared with normal concrete to study the effect of GGBS relief on strength.

B. TestsonHardenconcrete:

Compressivestrengthofnormalconcretecube:

Curing	Compressive Strength (N/mm^2)
7days	13.5
14days	18
28days	20

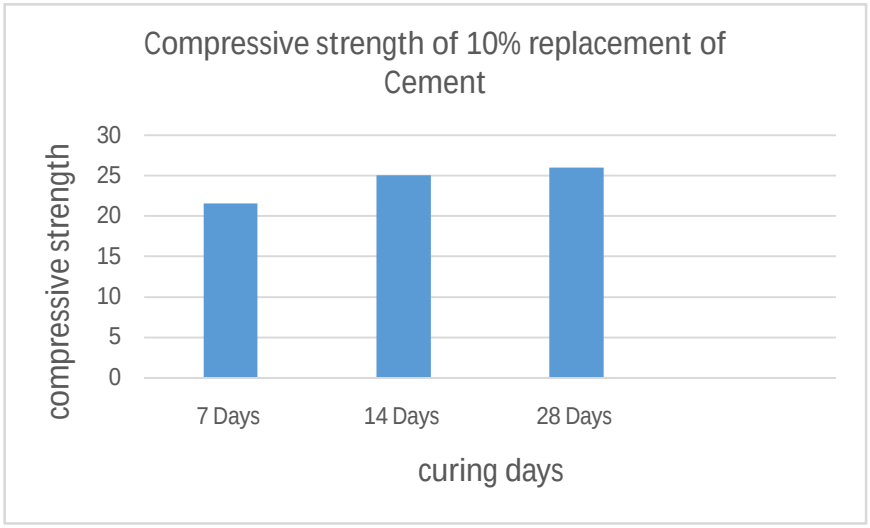
Table6.1.2.1Comp.strengthvaluesfornormalconcrete



Compressivestrengthof10%replacementofCement

Curing	Compressive Strength (N/mm2)
7days	21.5
14days	25
28days	26

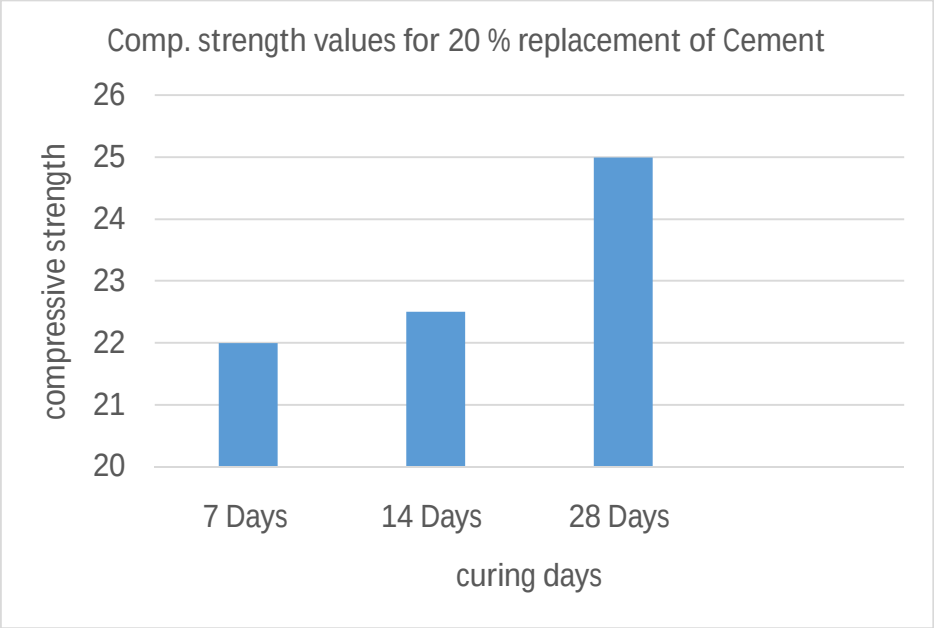
Comp.strengthvaluesfor10 %replacement of Cement



Compressivestrengthof20 %replacementofCement

Curing	Compressive Strength (N/mm^2)
7days	22
14days	22.5
28days	25

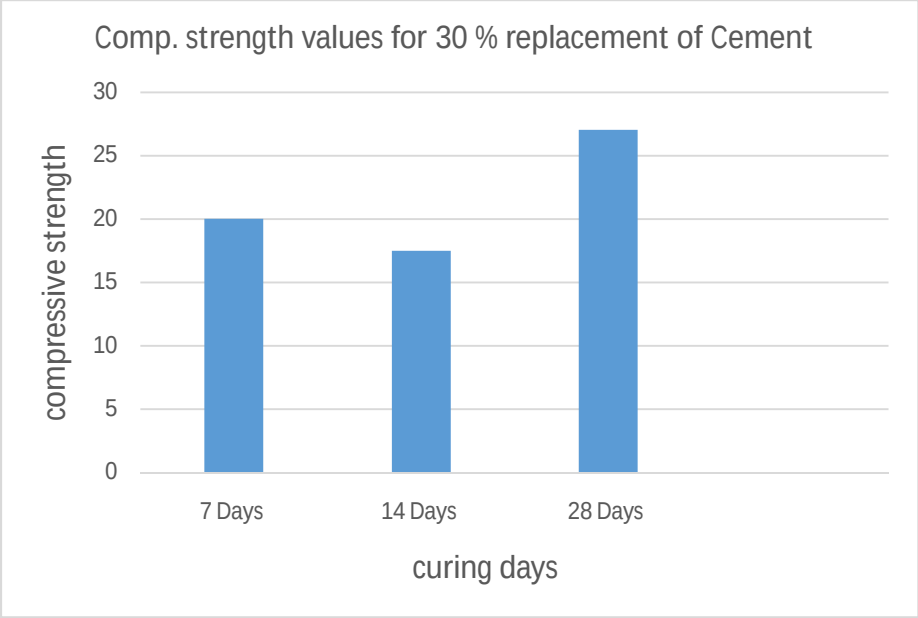
Comp.strengthvaluesfor20%replacement of Cement



Compressivestrengthof30 %replacementofCement

Curing	essive Strength (N/mm^2)
7days	20
14days	17.5
28days	27

Comp.strengthvaluesfor30 %replacement of Cement



VII. COSTESTIMATION AND HARDWARE

Sr. no	NameofParticularitem	Quantity	Costofitem
1	GGBS	10kg	100/-
2	Cement(OPC)	50kg	360/-
3	Sand	50kg	550/-
4	Aggregate	50kg	650/-
	Total=		1660

VIII. RESULTS AND DISCUSSION

- 7-day strength slightly decreased with higher GGBS percentage.
- 28-day strength increased for 20%–30% replacement.
- 20% replacement showed optimum strength results.
- Workability improved with increase in GGBS content. CONCLUSION
- GGBS can be effectively used as partial replacement of cement.
- Optimum replacement level is around 20%. • GGBS improves long-term strength and durability.
- Use of GGBS makes concrete more eco-friendly and economical.

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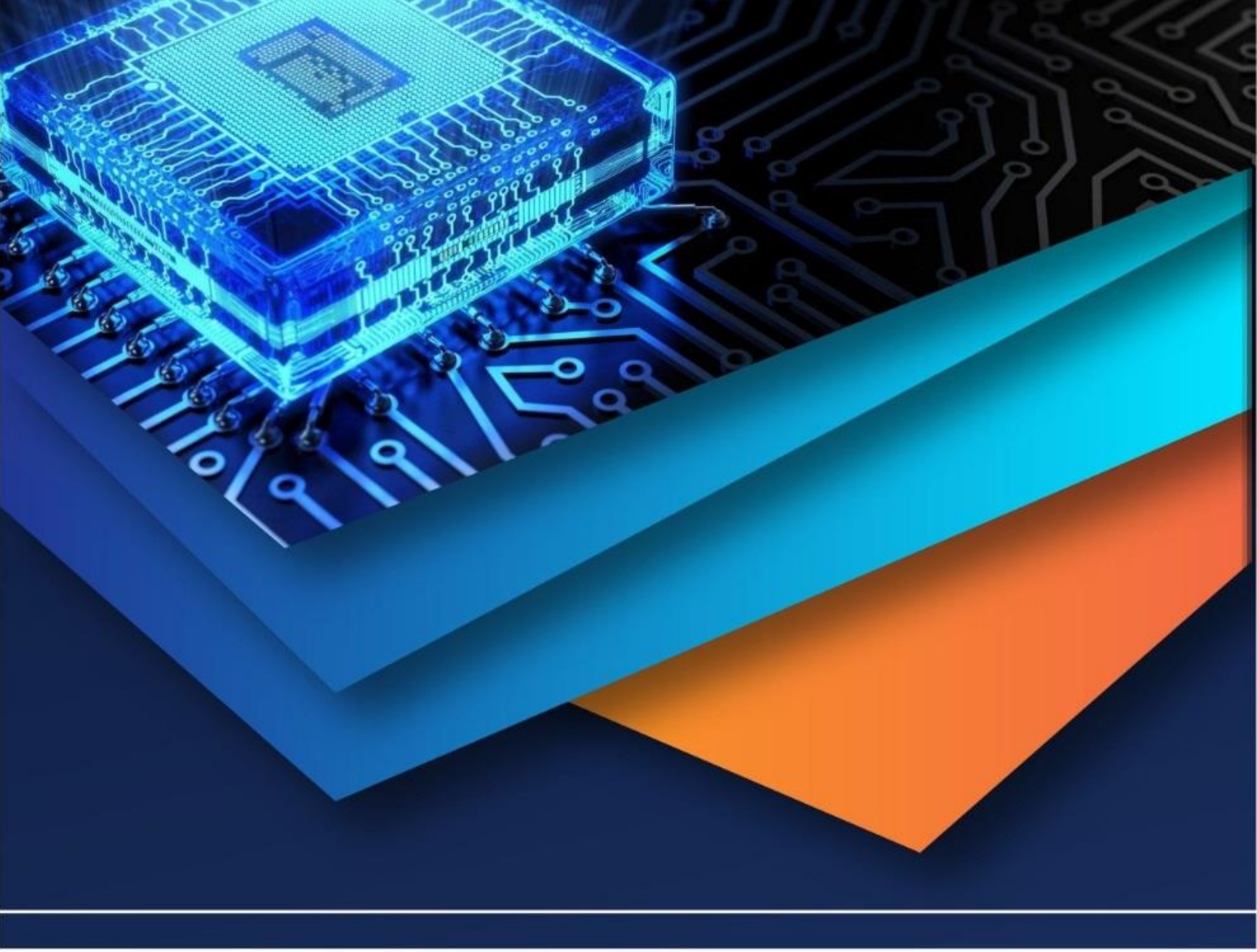

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