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Performance of HPC with Partial Replacement Of Cement by Ground Granulate Blast Furnace Slag and Fly Ash

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***Abstract*— The aim of project is making concrete on the cost of making ecofriendly relation and also reducing overall cost of the project and improve the workability and strength. Construction is a major economic activity. In India, it accounts for over 6 % of Gross Domestic Product (GDP). A construction project has to deal with environmental aspects. The threat of global warming is real. According to a report by Environmental Protection Agency (EPA) of the U.S.A. Greenhouse gases are accumulating in the earth's atmosphere as a result of human activities, causing global mean surface temperatures and sub-surface ocean temperatures to rise.**

With the cost of construction increasing rapidly, today the industry demands that the concrete used for building structures should not only have high strength but also have high durability. Traditionally, construction activities have relied on using normal Portland cement. Production of one tone of normal Portland cement releases approximately one tone of CO2 into the atmosphere it decreases amount of natural resources. There are many supplementary cementitious materials (SCM) used in producing concrete, like, Fly Ash, Ground Granulated Blast Furnace Slag it would help conserve natural resources. It would also save energy required for producing normal Portland cement, help the cause of environment, provide superior concrete structures and benefit the clients.

We will make different combination of cement by adding different proportion of GGBS and Fly Ash. we have to calculate optimum dry density of these different proportion for this, each proportion of cement is physical hand mix in dry start and put in Dry Loose Bulk Density Flask (DLBT). These are different combination of DLBT flask available such as 3, 15,30lit after we have to calculation the optimum dry density for each proportion. And the strength is calculated for each of the mix. Curing is done by placing specimens at room temperature. The specimen are then tested at the interval of 7, 14 and 28 days, it includes compressive strength, Water permeability test, Modulus of elasticity and Rapid chloride penetration test.

***Index Terms*— SCM (Supplementary Cementitious Materials), GDP (Gross Domestic Product), DLBT (Dry Loose Bulk Density Flask)**

I. INTRODUCTION

In the last millennium concrete has demanding requirements both in terms of technical performance and economy while greatly varying from architectural masterpiece to the simplest of utilities. Concrete is a material with which any shape can be cast and with equal strength or rather more strength than the conventional building stones. Cement concrete is one of the seemingly simple but actually complex materials. The properties of concrete mainly depend on the constituents used in concrete making. The main important material used in making concrete is cement, sand, crushed stone and water. The properties of sand, crushed stone and water, if not used as specified, cause considerable trouble in concrete. In addition to this workmanship, quality control and methods of placing also plays the leading role on the properties of concrete.

Concrete is considered as durable and strong material. Reinforced concrete is one of the most popular materials used for construction around the world. Reinforced concrete is exposed to deterioration in some regions especially in coastal regions. There for researchers around the world are directing their efforts towards developing a new material to overcome this problem. Invention of large construction plants and equipments around the world added to the increased use of material. This scenario led to the use of additive materials to improve the quality of concrete.

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II. MATERIALS

Cement

OPC (Ordinary Portland cement) 53 grade brand conforming to Indian Standard is used in the present investigation. The cement is tested its various properties as per IS code.

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Coarse Aggregate

It used were crushed angular granite metal from the local source is used as coarse aggregate (confined to Indian Standard: 383-1970). It is specific gravity is 2.77 and free from impurities such as dust, clay particles and organic matter etc. The coarse aggregate is also tested for its various properties.

Fine Aggregate

The locally available sand is used as fine aggregate in the present investigation. The sand is free from clayey matter, salt and organic impurities. The Fine Aggregate used was Crushed sand passing through 4.75 mm sieve, falling under zone II as specified in IS 383-1978 and with specific gravity of 2.74.

Admixture

Fly Ash- In this project the fly ash used belongs to class F and brought from Tata thermal power plant, Mumbai.
Ground Granulated Blast Furnace Slag: Ground granulated blast furnace slag is by-product from the blast furnaces used to make iron.
The major properties of the constituent materials were given in Table I.

Table I: Properties of the constituent materials of concrete

Material	Properties
Ordinary Portland Cement	Specific gravity
Coarse Aggregate	Size:12.5mm-20mm, Specific Gravity :2.77, Fineness Modulus : 7.14
Fine aggregate	Maximum Size: 4.74mm, Specific gravity : 2.74, Fineness Modulus : 2.78
Admixtures	Flyash, Ground Granulated Blast Furnace Slag
Water	PH=7,Density=1000kg/m3
Super plasticizer	Polycarboxylate ether(PCE)

III. NEED FOR THE STUDY

The natural resources are to be preserved. We want to decrease the cement rate for reducing the cost and environmental problem. GGBS and Flyash materials also improve the performance of the concrete .The cost of construction can be minimized.

IV. METHODOLOGY

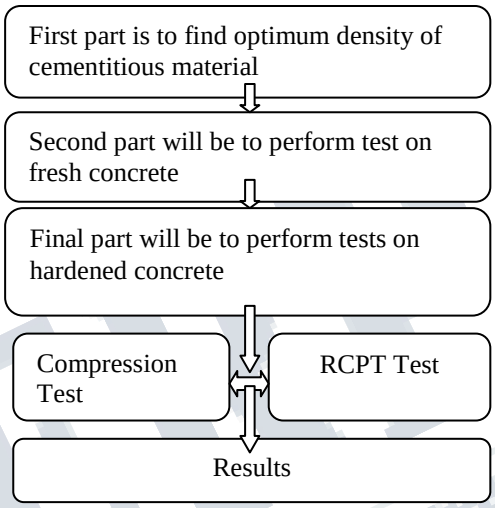

Fig I: Methodology flow chart

V. EXPERIMENT INVESTIGATION

An experimental study is conducted to find out the, workability, compressive strength and RCPT of concrete at 7days and 28days. We have taken different combinations and find adding respective proportion of OPC, GGBS and Flyash, this material mix it by mechanically, Then we find out optimum density of cementitious materials by DLBT method. After select the top combination and sum least combination this are - the partial replacement of cement by GGBS and Fly ash are varied from (10+0) %,(0+10) %,(10+10) % and (20+10) % by weight. M50 grade of concrete is designed according to IS code method. Mix proportion for control mix concrete is shown in Table II.

Table II: Mix Proportions of Concrete

Mix	Cement (Kg/m3)	Fine Aggregate (Kg/m3)	Coarse Aggregate (Kg/m3)	Water (1/m3)
Mix of M50	530	484	538	147

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Work Plan

The present experimental program includes casting and testing of specimens for workability, Compression and RCPT test. Specimens are prepared for M50 grade of concrete. Total of 40 specimens (shown in table III) with various percentages of Fly ash and Ground Granulated Blast Furnace Slag are casted

Table III: number of specimens casted for each mix

OPC	Admixture		3 Days		7 Days		28 Days	
	GGBS (%)	Fly ash (%)	No. Specimen		No. Specimen		No. Specimen	
			cube	Cylinder	cube	cylinder	cube	cylinder
100	0	0	3	-	3	-	3	1
90	10	0	3	-	3	-	3	1
80	10	10	3	-	3	-	3	1
70	20	10	3	-	3	-	3	1

Mixing

Machine mixing is adopted throughout the experimental work. First the materials cement, Fly ash, Ground Granulated Blast Furnace Slag, fine aggregate, coarse aggregate are weighed exactly. First the cement, Fly ash and Ground Granulated Blast Furnace Slag are blended with hand and then fine; coarse aggregate is added to this and thoroughly mixed. Water is weighed exactly and added to the dry mix and entire mix is thoroughly mixed till uniformity is arrived.

Casting the Specimens

For casting the cube, standard Cast iron metal moulds of size 150 x 150 x 150mm have been used. Whereas cylinders and prisms of size 150x300mm.. The moulds have been cleaned of dust particles and applied with mineral oil on all sides, before concrete is poured into the mould. Thoroughly mixed concrete is filled in to mould

Curing the Specimens

After casting, the molded specimens are stored in the laboratory free from vibration, in moist air and at room temperature for 24 hours. After this period, the specimen are removed from the moulds and immediately submerged in the clean fresh water of curing tank. The curing water is renewed after every 5 days. The specimens are cured for 7 and 28 days in present work.

VI. RESULTS

Compressive Strength Test

The cubes are tested for compression strength afterv3, 7 and 28 days. The of compression test are tabulated in table no.IV

Table IV: Compressive Strength of M60 Grade With Various Percentages of Fly ash and GGBS replacement with cement by weight.

Sr. no	Cement (%)	GGBS (%)	Fly Ash (%)	Compression Strength Of M50(N/mm ²)		
				3Days	7Days	28Days
1	10	0	0	39.94	52.38	66.46
2	90	10	0	37.28	57.42	72.39
3	80	10	10	33.20	40.90	66.21
4	70	20	10	28.48	45.55	58.42

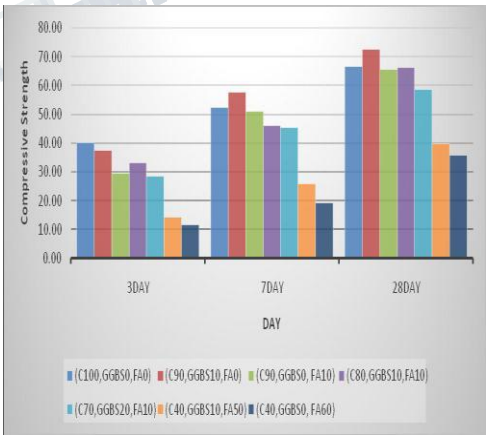

Fig II: Compressive Strength (N/mm2) Vs Percentage of FLYASH and GGBS at 3 Days,7 Days and 28 Days.

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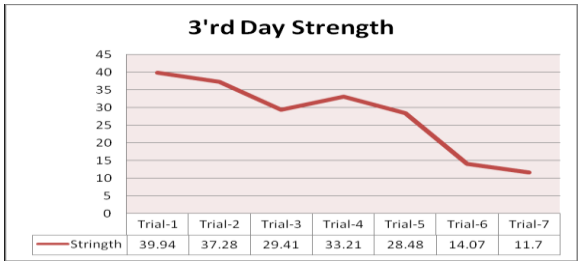

Fig III: 3'rd day Compressive Strength (N/mm2) Vs Percentage of FLYASH and GGBS at 3 Days,7 Days and 28 Days.

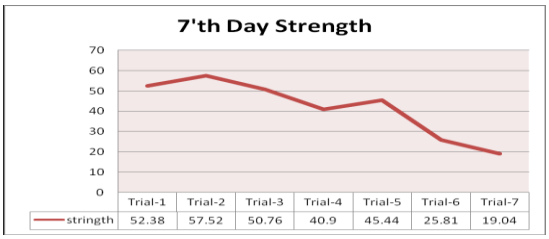

Fig IV: 7'th day Compressive Strength (N/mm2) Vs Percentage of FLYASH and GGBS at 3 Days,7 Days and 28 Days.

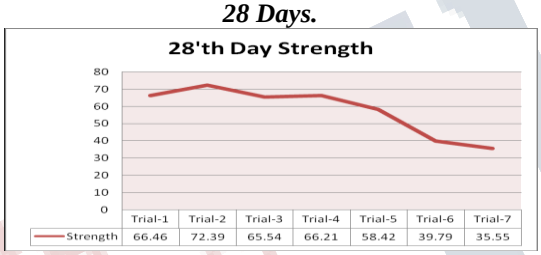

Fig IV: 28'Th day Compressive Strength (N/mm2) Vs Percentage of FLYASH and GGBS at 3 Days, 7 Days and 28 Days.

Rapid Chloride Penetration Test (RCPT).

The Cylinders are tested of100x150mm for Rapid Chloride Penetration Test, This test are tabulated in table no. V

Table V: Rapid Chloride Penetration Test of M60 Grade with Various Percentages of Fly ash and GGBS replacement with cement by weight.

Sr no	Cement (%)	GGBS (%)	Fly Ash (%)	RCPT (Coulombs)	Chloride Ion Penetration
1	10	0	0	2445	Moderate
2	90	10	0	2387	Moderate
3	80	10	10	1963	Low
4	70	20	10	1697	Low

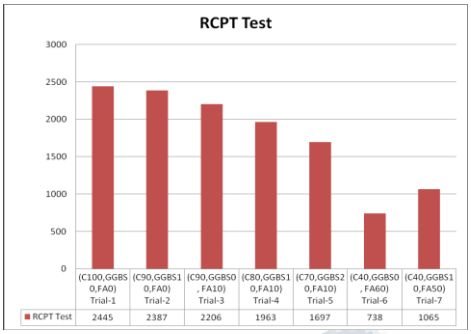

Fig V: 3'rd day Rapid Chloride Penetration Test Vs Percentage of FLYASH and GGBS at 28 Days

Property vs. cost comparison

Table VI: Property vs. cost comparison

Test	Mix	Cost(Rs)
	Compressive Strength(Mpa)	
3Day	100%OPC/ 39.94Mpa	14730
	10%GGBS/ 37.28Mpa	14535
7Day	10%GGBS/ 57.52Mpa	14535
	20%GGBS&10% FA/ 45.55Mpa	13556
28Day	10%GGBS/ 72.29Mpa	14535
	10%GGBS&10% FA/ 66.29Mpa	13654
	RCPT (Columbus)	
28Day	10%GGBS & 10% FA/1697	13556
	20%GGBS & 10% FA/1963	13654

CONCLUSION

1. The compressive strength, Rapid chloride penetration test of concrete are improve with the addition of GGBS and Flyash as partial replacement to cement.
2. The comparative standing among various mixes taking into consideration the mechanical and cost of trial (10+10 GGBS,FA) and (20+10 GGBS,FA) mix emerges as most advantageous mix displaying ideal characteristics with respect to properties as well as cost.
3. However it can be observed that trial (10+10 GGBS, FA) the Mix is a best in mechanical properties whereas ternary blend having (20+10

GGBS, FA) it ones among the blends with least cost.

4. Hence it will be appropriate to mention that the choice of optimum mix can be one among (10+10 GGBS, FA) and (20+10 GGBS, FA), which may vary depending upon the requirements of the user.

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