Effect of fly ash and GGBS on strength and durability of concrete upto 90 days

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***Abstract* - The researchers have started finding alternatives for the partial replacements for cement. This main study of this paper is on investigating the behavior of M20 concrete by partially replacing the cement by Flay Ash and ground granulated blast furnace slag (GGBS). Fly Ash and GGBS is used to make durable concrete structures in combination with ordinary Portland-cement and/or other pozzalanic materials. Cubes are tested for its compressive strength after 28,56 and 90 days of curing. The replacement percentages of cement by Fly Ash and GGBS used are 20 and 30 or 60 and 50 percentages for M20 grade.**

***keywords* - ground granulated blast furnace slag (GGBS)., compressive strength formatting**

I. INTRODUCTION

A. Importance of strength of concrete:

Strength of any structure, or part of a structure, is important, the degree of importance depending on the location of the structural element under consideration. The first floor columns in a high rise building, for example, are more important structurally than a non bearing wall. Loading is more critical, and a deficiency in strength can lead to expensive and difficult repairs or, at worst, a spectacular failure. Strength is usually the basis for acceptance or rejection of the concrete in the structure. The specifications or code. The specifications or code designate the strength (nearly always compressive) required of the concrete in the several parts of the structure. In those cases in which strength specimens fail to reach the required value, further testing of the concrete in place is usually specified. This may involve drilling cores from the structure or testing with certain non-destructive instruments that measure the hardness of the concrete.

B. FLY ASH

Now a day the world is witnessing the construction of very challenging and difficult structures, concrete being the most important and widely used structural material is called upon possess very high strength. Fly ash one of the by-products of thermal power plants is one of the most common mineral admixture used in concrete worldwide. Fly ash largely improves the durability of concrete. One of the greatest drawbacks while using fly ash as pozzolanic material in concrete is the early age performance of concrete. The early age strength development of fly ash blended binary concretes shows poor performance than the ordinary concrete. Researchers all over the world are developing Ternary blended concretes by adding a superfine mineral admixture like Micro Silica to the binary blended concretes of fly ash. Micro Silica in the ternary blend improves the early age performance of concrete and fly ash improves the properties at the later age.

C. GROUND GRANULATED BLAST FURNACE SLAG (GGBS)

Ground granulated blast furnace slag (GGBS) is the solid waste generated by industry can be used as a replacement material for cement. The utilization of supplementary cementitious materials is well accepted because of the several improvements possible in the concrete composites, and due to the overall economy. To quantify the strength of ground granulated blast furnace slag (GGBS) and high volume fly ash (HVFA) at the various replacement levels and evaluate their efficiencies in concrete. In recent years GGBS when replaced with cement has emerged as a major alternative to conventional concrete and has rapidly drawn the concrete industry attention due to its cement savings, and cost savings, environmental and socio-economic benefits. The present study reports the result of an environmental study, conducted to evaluate the strengths and strength efficiency factors of hardened concrete by partially replacing the cement by various percentages of ground granulated blast furnace slag and high volume fly ash for M20, M40 and M60 grades of concrete at different ages. The overall strength efficiency was found to be a combination of general efficiency factor, depending on the age and a percentage efficiency factor, depending upon the percentage of replacement.

Aim

To find out compressive strength of concrete upto 90 days with partial replacement of Fly ash and GGBS with cement quality

Objective

- To study the variation in compressive strength of concrete with respect to age.
- To study the comparison between plain cement concrete, fly ash cement concrete and GGBS cement concrete with respect to compressive strength.

II. METHODOLOGY

To determine the mix design for M20 grade of concrete.

Cast a no. Of cubes for following combination:

- Use of 100% cements content in mix design.
- Use of Cement (80%) + fly ash (20%) in the mix design.
- Use of Cement (70%) + fly ash (30%) in the mix design.
- Use of Cement (80%) + GGBS (20%) in the mix design.
- Use of Cement (70%) + GGBS (30%) in the mix design.

Testing of concrete cubes on 28th, 56th, 90th day. Comparison of above results.

III. EXPERIMENTAL WORK

Mix 1: Use of 100% cement concrete in mix design

A. Cement – ordinary Portland cement of 53 grade confirming to IS:12269-1987 used in the investigation.
B. Fine aggregate- Crush sand confirming to Zone-II used as fine aggregate.
C. Coarse aggregate- locally available crushed angular coarse aggregate of size 20mm and 10mm with specific gravity of 2.7 was used as Coarse aggregate.
D. GGBS- confirming to IS 12089:1981
E. HVFA- high volume fly ash
F. Water- locally available potable water confirming to IS 456-2000 is used.

Materials	For 1 cum in kg	For 6 cubes in kg
W/C	0.5	-
Cement	300	7.8
Fly Ash	-	
GGBS	-	
20mm Aggregate	563	14.64
10mm Aggregate	555	14.43
Crush Sand	918	23.87
Water	149	3.87
Admixture(1%)	3.61	0.094

Mix 2: use of cement(80%)+ fly ash(20%) in the mix design

Materials	For 1 cum in kg	For 6 cubes in kg
W/C	0.495	-
Cement	240	6.24
Fly Ash	60	1.56
GGBS	-	-
20mm Aggregate	558	14.51
10mm Aggregate	550	14.3
Crush Sand	909	23.63
Water	149	3.87
Admixture(1%)	3.61	0.094

Mix 3: Use of Cement(70%) + Fly ash(30%) in the mix design

Materials	For 1 cum in kg	For 6 cubes in kg
W/C	0.5	-
Cement	210	5.46
Fly Ash	90	2.34
GGBS	-	-
20mm Aggregate	555	14.43
10mm Aggregate	547	14.2
Crush Sand	905	23.53
Water	149	3.87
Admixture(1%)	3.61	0.094

Mix 4: Use of cement(80%) +GGBS(60%) in the mix design

Materials	For 1 cum in kg	For 6 cubes in kg
W/C	0.5	-
Cement	120	3.12
Fly Ash	-	-
GGBS	180	4.68
20mm Aggregate	558.24	14.51

10mm Aggregate	550.18	14.30
Crush Sand	909.87	23.66
Water	148.30	3.86
Admixture(1%)	3.60	0.094

Mix5: Use of Cement(70%) + GGBS (50%) in the mix design

Materials	For 1 cum in kg	For 6 cubes in kg
W/C	0.5	-
Cement	150	3.9
Fly Ash		3.9
GGBS	150	-
20mm Aggregate	559.13	14.54
10mm Aggregate	551.06	14.33
Crush Sand	911.32	23.69
Water	148.30	3.86
Admixture(1%)	3.60	0.094

IV. RESULTS

	100% cement content		Cement(80%)+fly ash(20%)		Cement(70%)+fly ash(30%)		Cement(40%)+ GGBS(60%)		Cement(50%)+ GGBS (50%)	
Days of test	Compressive Strength in Mpa	Average strength in Mpa	Compressive Strength in Mpa	Average strength in Mpa	Compressive Strength in Mpa	Average strength in Mpa	Compressive Strength in Mpa	Average strength in Mpa	Compressive Strength in Mpa	Average strength in Mpa
	38.36		34.71		23.42		25.33		31.91	
28	35.82	38.06	33.33	34.27	23.20	23.42	28.44	25.39	36.98	36.21
	40.00		34.76		23.64		22.40		39.73	
	38.71		34.89		33.64		34.40		44.89	
56	39.96	40.99	38.62	37.79	34.58	35.41	36.22	35.23	41.02	42.04
	44.31		39.87		38.00		35.07		40.22	
	52.93		51.20		40.36		39.64		50.18	
90	45.42	49.38	46.49	48.24	40.71	40.65	40.09	39.88	48.04	49.87
	49.78		47.02		40.89		39.91		51.38	

v. CONCLUSION

From the above experimental work we can say that, at initial 28 days all 5 mixes achieved 100% compressive strength. After 28,56 & 90th day compressive strength was increasing with respect to age of concrete. Hence from the above result we can say that the partial replacement of Fly Ash (20% &30%) with cement is effective and can be used actually on site in M20 grade of concrete. From the Environmental point of view it is very important to use fly ash (waste from Thermal Power Plant) and GGBS (20% &30%) (Waste from iron & steel industry) & this problem can also be solved by using these products in concrete by partial replacement.

1. Durability and service life are improved by preparing High-performance concrete
2. The use of GGBS is economical in concrete.
3. The strength of compressive strength is increases 9% to 25%.
4. It is easy to use and mix with concrete.

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VII. REFERENCES

1. Santosh Kumar Karri, G. V. Rama Rao, P. Markandeya Raju "Strength and Durability Studies on GGBS Concrete", SSRG International Journal of Civil Engineering (SSRG - IJCE), Published by: Seventh Sense Research Group.
2. Valentina D.S., Ilayaraja K., Ambica A., Spatial distribution of groundwater quality in Selaiyur village, Chennai, India, Ecology, Environment and Conservation, v-20,pp-S173-S179, 2014.
3. Aveline Darquennes, Stephanie Staquet, and Bernard Espion. (2011). "Behaviour of Slag Cement Concrete under Restraint Conditions". European Journal of Environmental and Civil Engineering, 15 (5), 787-798.
4. A. Maria Rajesh M. Adams Joe, M. Adams Joe "An Experimental Investigation on the Effect of GGBS & Steel Fibre in High Performance Concrete" International Journal of Computational Engineering Research|| Vol, 004||subject, 004|| April 2014.
5. Suchita Hirde et.al "Effect Of Addition Of Ground Granulated Blast Slag Furnace (GGBS) On Mechanical Properties Of Fiber Reinforced Concrete "International Journal Of Current Engineering And Technology E-ISSN 02277 – 04106, P-ISSN 02347 – 05161 Vol.5, No.3 (June 2015)
6. Reshma Rughooputh and Jaylina Rana (2014) "Partial Replacement of Cement by Ground Granulated Blast furnace Slag In Concrete"
7. R. D. Padhye, N. S. Deo (8 & 9 Jan 2016). "Cement replacement by fly ash in concrete"
8. Rajesh K R. Pandey, Abhishek Kumar, and Mohd. Afaque khan (Feb-2016). "Effect of ground granulated blast furnace slag as partial cement replacement on strength and durability of concrete"
9. . Dinakar, P.; Sethy, K.P.; Sahoo, U.C. Design of self-compacting concrete with ground granulated blast furnace slag. Mater. Des. 2013, 43, 161–169.
10. .Zhao, Y.; Gong, J.; Zhao, S. Experimental study on shrinkage of HPC containing fly ash and ground granulated blast-furnace slag. Constr. Build. Mater. 2017
11. .Raharjo, D.; Subakti, A.; Tavio. Mixed Concrete Optimization Using Fly Ash, Silica Fume and Iron Slag on the SCC's compressive strength. Procedia Eng. 2013,
12. Hariharan V. Vijai.k & Kumutha.R. Investigation on properties of geopolymer concrete using fly ash & ggbs"chemical science review and letters ,2014, 2(8), pp.620625