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Experimental investigation on high strength concrete by using GGBS and polycarboxylate ether

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***Abstract*— Concrete is a mixture of cement, fine aggregate, coarse aggregate and water. Concrete plays a vital role in the development of infrastructure Viz., buildings, industrial structures, bridges and highways etc. leading to utilization of large quantity of concrete. On the other side, cost of concrete is attributed to the cost of its ingredients which is scarce and expensive, this leading to usage of economically alternative materials in its production. This requirement is drawn the attention of investigators to explore new replacements of ingredients of concrete. The present technical report focuses on investigating characteristics of concrete with partial replacement of cement with Ground Granulated Blast furnace Slag (GGBS) and fully replacement of R-sand with M-sand. The topic deals with the usage of GGBS and advantages as well as disadvantages in using it in concrete. Here polycarboxylate ether is used to reduce the water content. Tests are carried at 7days, 14days, 28days.**

***Index Terms*— GGBS, GGBS in concrete, polycarboxylate and M-sand.**

I. INTRODUCTION

Concrete is probably the most extensively used construction material in the world with about six billion tones being produced every year. It is only next to water in terms of percapita consumption. However, environmental sustainability is at stake both in terms of damage caused by the extraction of raw material and CO_2 emission during cement manufacture. This brought pressures on researchers for the reduction of cement consumption by partial replacement of cement by supplementary materials. These materials may be naturally occurring, industrial wastes or by-products that are less energy intensive. These materials (called pozzalonas) when combined with calcium hydroxide, exhibits cementetious properties. Most commonly used pozzalonas are fly ash, silica fume, metakaolin, ground granulated blast furnace slag (GGBS). GGBS as a possible partial replacement material for cement. Amongst the various methods used to improve the durability of concrete, and to achieve high performance concrete, the use of GGBS is a relatively new approach; the chief problem is with its extreme finesse and high water requirement when mixed with Ordinary Portland cement. Here

R-sand is fully (100%) replaced with M-sand.

S.no	Material	Properties
1	Ordinary portland cement(opc-53 dalmia)	Standard consistency = 29% Initial setting time = 30mins final setting time = 10hrs specific gravity = 3.15 fineness = 0.6%
2	Fine aggregate(m-sand)	specific gravity = 2.88 silt content = 5.8% bulk density =1856Kg/m^3
3	Coarse aggregate(20mm & 12.5mm)	specific gravity = 2.9 bulk density = 1740Kg/m^3
4	GGBS	Standard consistency =35% Initial setting time=126mins Final setting time =362mins specific gravity = 2.85 fineness = 1.76%
5	Polycarboxylate ether	Water content reducing upto 40%.it gives high strength to te concrete.
6	Water	P_H = 7 Density = 1gm/c

Cement is replaced with GGBS at the percentage of 30%, 35%, 40% ,45% ,50%,55% and the chemical admixture(polycarboxylate ether) is used at the percentage of 0.4%.the tests are carried under 7days, 14days, 28days.

II.MATERIALS

1.Cement

2.fine aggregate

3.coarse aggregate

4.GGBS

5.polycarboxylate ether

6.water

III. LITERATURE REVIEW

Shariq et al.(2008) studied the effect of curing procedure on the compressive strength development of cement mortar and 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 cm^2/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 cm^2/g for grade S75 GGBS, 4000 cm2/g for grade S95 and 5000 cm^2/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.

Effect of w/cm and high-range water-reducing admixture on formwork pressure and thixotropy of self-consolidating concrete by Kamal H. Khayat and Joseph J. Assaad: An experimental program was undertaken to evaluate the effect of water- cementitious material ratio (w/cm) and type of high- range water-reducing admixture (HRWRA) on the development of formwork pressure that can be exerted when using self-consolidating concrete (SCC). Test results show that the variations in lateral pressure and thixotropy of SCC are significantly affected by the w/cm. Irrespective of the HRWRA type, mixtures proportioned with 0.46 w/cm exhibited greater initial pressure and lower thixotropy compared with mixtures made with a w/cm of 0.40 and 0.36. This is related to the higher water content and lower coarse aggregate volume in concrete proportioned with the higher w/cm, which can lead to a reduction in shear strength properties of the plastic concrete. The rate of pressure drop and increase in thixotropy with time, however, were greater in mixtures made with a higher w/cm. This is attributed to the lower HRWRA demand that can lead to sharper fluidity loss with time. For any given w/cm, the type of HRWRA appears to have a limited effect on initial lateral pressure. Compared with naphthaleneand melamine-based HRWRA, the use of polycarboxylate-based. HRWRA in SCC resulted in lower rate of pressure drop with time.

IV. CONCRETE MIX DESIGN

For the present work, concrete of M60 grade is adopted and the mix proportions of control mix concrete (without admixture) was obtained as per IS method out lined in IS 10262. Same mix proportions were also adopted for concrete with different PCE based water reducing admixture. Calculations have been carried out and finally a mix proportion that gives required 28 days compressive strength with minimum cement content and required workability of 100 mm is selected.

Cement = 446 Kg/m^3

Water = 156 litre

Fine aggregate = 856 Kg/m^3

Coarse aggregate = 1171 Kg/m^3

Chemical admixture = 1.784 Kg/m^3

Water-cement ratio = 0.35

MIX RATIO = 1:1.92:2.62:0.35

V. TEST RESULTS

Comparison of compressive strength at 7 days,14 days & 28 days

S.NO	Type of concrete	Compressive strength (N/mm^2)		
		7days	14days	28days
1	Conventional	36.98	42.25	49.91
2	GGBS (30%)	41.98	53.06	58.26
3	GGBS (35%)	42.74	55.26	61.15
4	GGBS (40%)	45.09	55.53	64.86
5	GGBS (45%)	46.04	57.73	68.92
6	GGBS (50%)	41.27	52.97	56.26
7	GGBS (55%)	40.50	51.72	54.63

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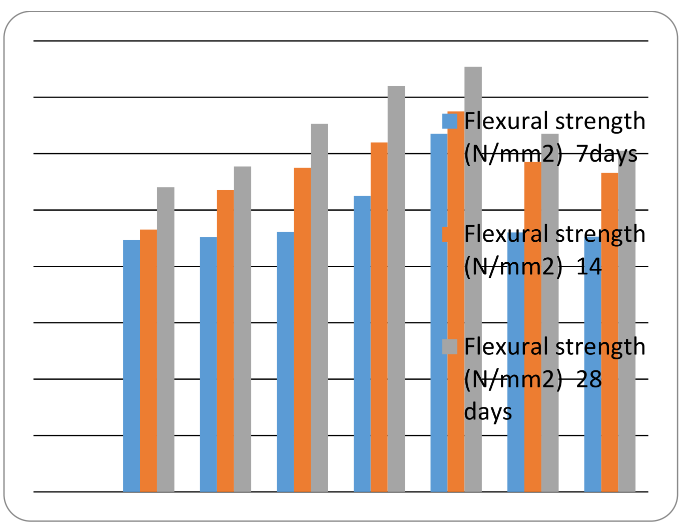
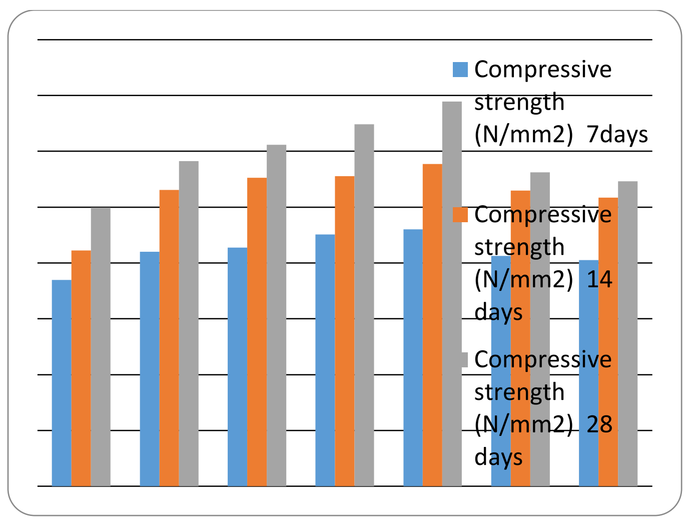
S.NO	Type of concrete	Flexural strength (N/mm^2)		
		7days	14 days	28 days
1	Conventional	8.93	9.30	10.8
2	GGBS (30%)	9.03	10.7	11.54
3	GGBS (35%)	9.23	11.5	13.05
4	GGBS (40%)	10.5	12.4	14.4
5	GGBS (45%)	12.7	13.5	15.08
6	GGBS (50%)	9.20	11.7	12.7
7	GGBS (55%)	9.05	11.32	12.1

S.NO	Type of concrete	Split tensile strength (N/mm^2)		
		7days	14 days	28 days
1	Conventional	2.16	2.93	3.3
2	GGBS (30%)	2.57	3.42	4.03
3	GGBS (35%)	2.61	3.57	4.17
4	GGBS (40%)	2.74	3.65	4.23
5	GGBS (45%)	2.83	3.79	4.51
6	GGBS (50%)	2.44	3.26	3.45
7	GGBS (55%)	2.32	3.15	3.23

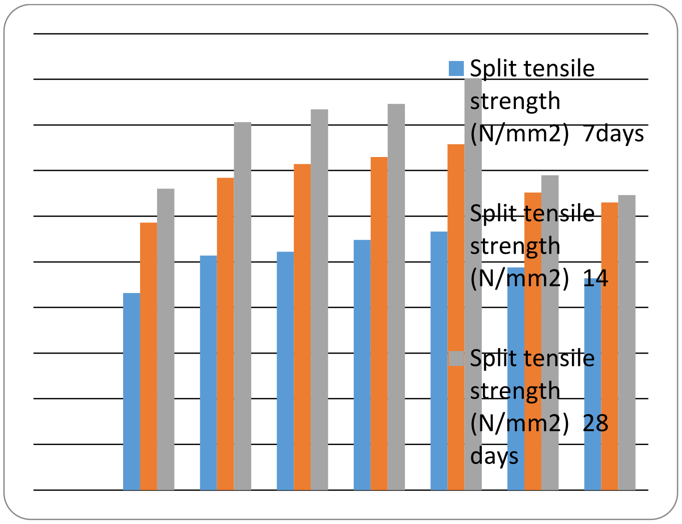
Comparison of Flexural strength at 7 days,14 days & 28 days



Comparison of Split tensile strength at 7



days,14 days & 28 days



Conclusion

1) In this project ,the mix design for concrete grade of m60 the concrete with various percentage replacement level of GGBS (30%,35%,40%,45%,50%,55%) & chemical admixture (polycarboxylate ether) used.

2) From this compressive strength ,tensile,strength, and flexural strength of concrete with replacement 45% GGBS is higher than the normal concrete.

3) The natural sand demand also reduced by introducing the m sand as it provides greater strength and being economical.

4) Concrete can be obtained by reducing water content by adding the super plasticizer.

5) The strength will be reduced after 50%.

6) This experimental investigation work can be used further experiments on the potential of replaced ground granulated blast furnace slag as cement for concrete.

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