Experimental Study on Strength Properties of High Strength Concrete Using Mineral Admixtures

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Abstract- *Concrete is a versatile material. It is usually a strong and durable material. High strength concrete the compressive strength is greater than 55Mpa at the 28days strength. Durability increased in high strength by adding pozzolanic materials (fly ash silica fume GGBS). High-strength concrete is used low water to cement ratio which is obtained by adding water reducing plasticizer or high range water reducing plasticizer. The objective of this work is to study the strength properties of concrete. Here M70 grade concrete used and concrete containing copper slag as partial replacement of fine aggregate and mineral admixture(silica fume and GGBS) as partial replacement of cement in the concrete mix design. Copper slag content has been 40% as a replacement of fine aggregate and silica fume 5%,10%,15% & 20% and GGBS 5%,10%,15% & 20% as a replacement of cement respectively .This research paper study on mechanical properties of HSC. The test results shows 40% replacement of fine aggregate as copper slag gives the more strength. And Silica fume & GGBS as partial replacement of cement (up to 10%). From the results, it was observed that the use of copper slag and mineral admixture in concrete has shown Increase in strength of HSC.*

Keywords- High Strength Concrete, Copper Slag, Silica Fume, GGBS.

I. INTRODUCTION

Concrete is the second most consumed material in the world that is considered as durable and strong material, and has relatively high compressive strength and significantly low tensile strength Silica fume also referred to as micro silica or condensed silica fume and it‘s a byproduct material that is used as a pozzolanic. Silica fume is used as partial replacement of cement in concrete to improve its properties like compressive strength, bond strength & abrasion resistance. Silica fume also reduce the chloride ions in concrete, hence protects corrosion of steel bars. GGBS is a pozzolanic material it's have high pozzolanic properties. GGBS has used in as partial replacement of cement in concrete that increase the durability, and also increase the lifespan of buildings. Copper slag is a obtained from copper industries. During the copper smelting process 600,000 MT/Annum of granulated slag with rich iron and moderate silica content is generated which is termed as copper slag. A copper slag property is similar as the river sand properties.

II. LITERATURE REVIEW

Singh,h.(2015)he Conducted an Experimental Investigation on Properties of Concrete by Replacement Copper Slag for Fine Aggregate. The fine aggregates were replaced with percentages 0% to 60% of Copper Slag by weight. The fresh concrete and Hardened Concrete test are conducted. Compressive strength was determined at 7,14 and 28 days. The Properties of concrete is increase with the use of copper slag in concrete. The optimum percentage identified by 40% of copper slag as replacement of fine aggregate .he observed as 25.58 N/mm^{2}at 28 days for M_{20} concrete.[1]

Hanumesh, Varun and Harish Watches the Mechanical Properties of Concrete Consolidating Silica Fume as Partial Replacement of Cement. The basic role of this examination is to analyze the mechanical properties of M20 grade control concrete and silica smolder concrete with various rates (5, 10, 15 and 20%) of silica smolder as an incomplete substitution of concrete. The result indicated that the compressive quality of cement is expanded by the utilization of silica smolder up to 10% substitution of concrete. From 10% there is a decrease in compressive quality and the split rigidity of cement is expanded by the utilization of silica seethe up to 10% substitution of concrete. From 10% there is a lessening in split elasticity. The ideal level of substitution of concrete by silica seethe is 10% for M20 evaluation of cement. [2]

Perumal & Sundararajanhe study the Effect of partial replacement of cement with silica fume on strength features of high performance concrete. Strength and durability properties for M60, M70 and M 110 grades of HPC trial mixes and to arrive at the maximum levels of replacement of cement with

Silica Fume (SF), investigations were taken. The strength and durability characteristics of these mixes are compared with the mixes without SF. Compressive strengths of 60 MPa, 70 MPa and 110 MPa at 28days were obtained by using the 10 percent replacement of cement with SF. The results also indicate that the SF concretes possess superior strength properties.[3]

Akshatha K. B (2018) This paper generalizes the results of study on silica fume based high-strength concrete. - Increase in the consumption of materials required in the production of concrete has led to depletion of materials. In this thesis used M45 grade. The various proportion of slica fume used as 0 to 12.5%. The steel fiber used various percentages as 0.5%, 0.75% and 1% by volume fraction. The optimum. Proportion identified as 7.5% SF and 0.75% hooked fiber.

Saini has undergone research work based on High Performance Concrete of grade of M60 w here SF was added @15% by weight of cement to ensure durability of structure. They found 28 days compressive strength of HPC varied b/w 78.6 to 81.3 Mpa indicating good control of quality of concrete.

III. OBJECTIVES

- Study the physical and chemical properties of silica fume, GGBS and Copper Slag.
- Evaluate the utility of silica fume, GGBS and Copper Slag as a partial replacement material of cement and fine aggregate respectively.
- Study the fresh& hardened concrete properties of the concrete
- Find out the optimized level of replacement of silica fume, GGBS and Copper Slag in the concrete.
- To propose an observational connection between mechanical properties of cement.

IV. MATERIAL PROPERTIES

4.1 Cement

Ordinary Portland Cement (OPC) of 53 Grade used.

Table 1 Physical properties of cement

S.No	Properties	Result
1	Specific gravity	3.14
2	Consistency	33%
3	Initial setting time	34 miu
4	Fineness	2%

4.2 Fine Aggregate

Table 2 Physical properties of M sand

S.No	Properties	Result
1	Bulk density	1726kg/m³
2	Finesse Modulus	3.96
3	Specific gravity	2.80
4	Water absorption	0.5%

4.3 Coarse aggregate

20 mm size crushed course aggregate were used

Table 3 Physical properties of Coarse aggregate

S.No	Properties	Result
1	Specific gravity	2.80
2	Water absorption	0.52%
3	Impact value	35%

4.4 Copper slag

Table 4 Physical properties of Copper slag

S.No	Properties	Result
1	Appearance	Black glassy granules
4	Specific gravity	3.6
5	Bulk density	2.00-2.33 g/cc
6	Fineness modulus	2.89
7	Water absorption	0.40

Table 5 Chemical properties of Copper slag

Sr. No.	Component	% of chemical component
1.	Sio2	26.50
2.	Fe2O3	67.59
3.	Al2O3	0.29
4.	CaO	0.15
5.	Na2O	0.58
6.	K2O	0.23

4.5 Silica Fume

Table 6 Physical properties of Copper slag

S.No	Properties	Result
1	Physical state	Micronized powder
5	Density	0.77gm/cc
6	Specific gravity	2.64
7	Moisture	0.055%

Table 7 Chemical properties of silica fume

Sr. No.	Component	% of chemical component
1	(Sio_2)	99.9
2	(Al_2O_3)	0.031
3	(Fe_2O_3)	0.012
4	(CaO)	0.0
5	(MgO)	0.0
6	(SO_2)	0.0
9	(LOI)	0.001

4.6 Ground granulated blast furnace slag

Table 8 Chemical properties of GGBS

Element	App Conc.	Intensity Corrn.	Weight%	Weight% Sigma	Atomic%
O K	33.39	0.5588	50.64	0.65	67.19
Mg K	3.29	0.7255	3.84	0.18	3.36
Al K	7.91	0.7924	8.46	0.24	6.65
Si K	13.60	0.7963	14.48	0.30	10.94
Ca K	25.44	0.9861	21.86	0.37	11.58
Mn K	0.68	0.7943	0.72	0.16	0.28
Totals			100.00		

4.7 Water

Portable water is used and pH value is 6-7.

4.8 Super plastizers

Poly carboxylate ether based super plastizers are used in this project.

V. EXPERIMENTAL WORK

In this research work, M70 grade of concrete is tested and mix proportions of M70 concrete is 1:1.94:3.8 with water cement ratio of 0.26.

5.1 Mix Proportion of Concrete Grade

As per IS 10262: 2019, mix design for M70 grade concrete is given in table 9

Table 9 Mix proportion by weight

S.no	Material name	Quantity in kg/m^3
1	Cement	320
2	Silica fume	107.7
3	GGBS	107.7
4	Water	141.3
5	Fine aggregate	621.2
6	Coarse aggregate	1245
7	Chemical admixture	2.67

5.1.1 Mix Identification

Table 10 Mix proportion identification

S. No	Description	Mix Identification
1	Conventional	M_0
2	5%of silica fume &5%GGBS&40%of copper slag	M_1
3	10%of silica fume &10%GGBS&40%of copper slag	M_2
4	15%of silica fume &15%GGBS&40%of copper slag	M_3
5	5%of silica fume &5%GGBS&40%of copper slag	M_4

VI. RESULT AND DISCUSSIONS

6.1 Fresh Concrete

6.1.1 Workability Test

Slump test was prepared by as per IS: 1199-1959. Table 5.1 shows results of workability of various mix of concrete.

Table 11 Workability of concrete mix

S.No	Mix Identify	Slump (mm)
1	M_0	90
2	M_1	85
3	M_2	80
4	M_3	75
5	M_4	87

6.2 HARDENED CONCRETE

6.2.1 Compressive Strength Test

Table 12 gives the compressive strength at 7,14 and 28 days result of % replacement of mineral admixtures and copper slag in mortar for 7,14 and 28 days curing. For testing 150×150×150 mm cube mould were casted.

Table 12 compressive strength value

S.No	Mix proportion	Compressive strength in N/mm^2		
		7day	14 day	28 day
1	M_0	47.7	67.5	76.8
2	M_1	51.1	77.12	83.12
3	M_2	52	75.6	81.87
4	M_3	51.3	74.3	80.56
5	M_4	49.7	70.2	79.1

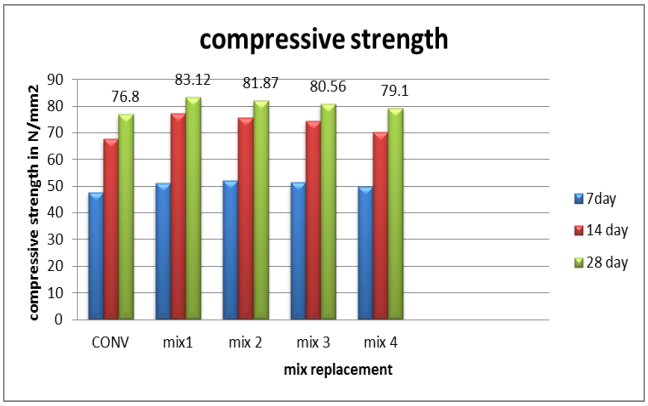

Fig 1show compressive strength of concrete

7.2.2 Split Tensile Strength Test

For testing 150mm X 300 mm cylinder mould casted and 7,14 and 28 days value found

Table 13 split tensile strength value

S.No	Mix proportion	Compressive strength in N/mm²		
		7day	14 day	28 day
1	M_0	2.75	3.53	5.58
2	M_1	4.22	5.81	6.14
3	M_2	3.67	5.10	5.37
4	M_3	3.66	4.59	5.25
5	M_4	3.88	4.80	4.9

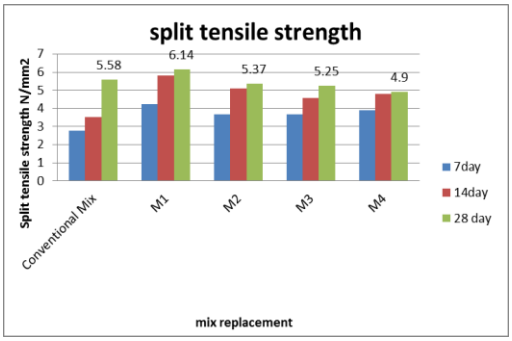

Fig 2 split tensile strength of concrete

6.2.3Flexural Strength Test

For flexural quality, solid light emission 500 × 100 × 100 mm, were casted with various level of mineral admixtures extend from 0 to 20% &copper slag 40%. At that point the shafts are continued restoring for 28 days. Three examples were tried at each restoring age.

Table 14 flexural strength value

S.No	Mix proportion	Compressive strength in N/mm²
		28 day
1	M_0	6.75
2	M_1	8.55
3	M_2	8.1
4	M_3	7.65
5	M_4	7.2

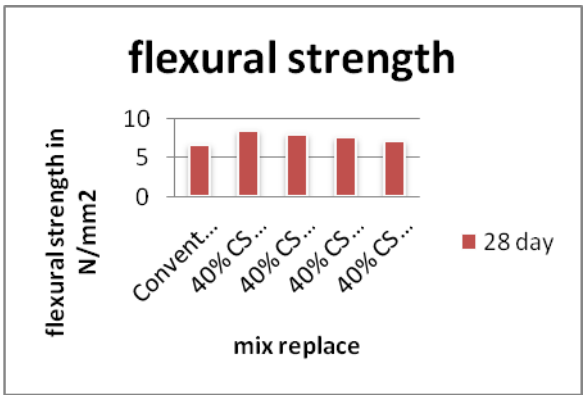

Fig 3 show split tensile strength of concrete

VII. CONCLUSION

Based on the investigations carried out on the use of silica fume and GGBS in concrete as a mineral admixture for cement and copper slag as a fine aggregate replacement, the following results are concluded

- The physical and chemical properties of the materials are determined.
- Mix design is arrived based on the material property& As per IS method (10269-2019) to follow the mix design procedure.
- Using of mineral admixture as silica fume and GGBS it improves the compressive strength, bond strength, abrasion resistance, reduces permeability of concrete to chloride ions and also protects reinforcement from corrosion.
- Slump values decrease with increasing the amount of silica fume and GGBS.
- The mix having 5% silica fume replacement and 5% of GGBS and 40% of copper slag showed an increase in strength of the reference mix at the age of 28
- The mix having 5% silica fume replacement and 5% of GGBS and 40% of copper slag shows highest value for compressive strength, split tensile strength and flexural strength.

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