Parametric Study of Concrete Using By Copper Slag and Silica Fume

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ABSTRACT

copper slag is the byproduct of smelting process of copper and silica fume .In this work we are take silica fume as 5% ,10%, 15% as constant and its replace with cement. Copper slag replace as fine aggregate with the proportion of 10%, 20%, 30% and 40%. Strength & Durability properties such as Compressive Strength, Split Tensile Strength, Flexural Strength, Acid Resistance and Sulphate Resistance were evaluated for all mixes of concrete. So in this industrial waste increase the strength and it's also make the low cost of construction.

Keyword: - *copper slag, silica fume, compressive strength, split tensile, flexural strength, durability*

1. INTRODUCTION

Development of any country depends on infrastructure facility of that country and Construction is an essential part of any country special reference to the development. Concrete's versatility, durability, sustainability, and economy have made it the world's most widely used construction material.

Copper slag is a by-product of copper extraction by smelting. During smelting, impurities become slag which floats on the molten metal. Slag that is quenched in water produces angular granules which are disposed of as waste or utilized. It is estimated that in the copper industry, for every ton of metallic copper production, approximately 2.2 tons of copper slag is generated and in the world, about 24.6 million tons of slag is produced annually. These metallurgical centers produced 2,360,000 metric tons of copper slag in the year 2002, leaving this waste deposited indefinitely as a hard floor, without current industrial utility.

2. LITERATURE REVIEW

Mr. zine kiran sambhaji , prof. pankajj B. autade Investigated the effect of copper slag as a fine aggregate on properties of concrete. In this research paper copper slag 0, 10, 20, 30, 40, 50, 60, 70, 80, 90, 100% replace with fine aggregate respectively. The conclusion of the paper is the design m25 grade concrete for 50% replace of CS show the HPC characteristic and increase the strength after that the strength are partially decrees

M.franco , H.Thiagu In this experimental study the m-30 mix design are using with water cement ratio .38 fine aggregate is replaced by copper slag and cement is replaced by fly ash from 45%to 60%.Replacement of fine aggregate by copper slag, cement by fly ash up to 50% shows good result in strength characteristics of concrete , hence replacement of copper slag up to50%is an optimum value for a normal concrete

M. V. Patil, Y.D.Patil In this research work the copper slag replace as fine aggregate in the dosage of 0% to 100% with the constant w/c 0.45. This paper conclude that the workability increase with the increase or the copper slag. addition up to 40% of c.s. as sand replacement gained 32% more that of control concrete however further addition of copper slag caused reduce in strength It was observed that up to 20% replacement of natural sand by copper slag, the split tensile strength of concrete was increased by 70% and flexural strength of concrete was increased by 50%.

3. EXPERIMENTAL STUDY

3.1 Cement:-

Cement used in the investigation was 53 Grade Ordinary Portland cement confirming to IS: 12269

3.2 Fine aggregate:-

The fine aggregate was conforming to Zone-2 according to IS: 383-1970. Locally available river sand was used as fine aggregate.

3.3 Coarse aggregate:-

Natural aggregate of maximum size 20 mm are taken in the study. The aggregate were tested as per IS: 383– 1970.

3.4 Copper slag:-

Copper Slag with sp. gravity 3.51and moisture content max 2.0% and bulk density 1.9- 2.4% as per chemical analysis of copper slag.in copper slag the silica content and iron oxide content in copper slag was found to be 26% and 60% respectively.

3.5 Silica fume:-

As per chemical analysis of silica fume, silica content and iron oxide content in silica fume was found to be 91% and 0.39% respectively

4. EXPERIMENTAL PROCEDURE:-

In the experimental program, cube, cylinder, beam casted using M20, M25, M30 grade of concrete

4.1 Compressive strength:-

The capacity of compression testing machine has 2000 KN. As per IS: 516–1959, loading rate of 2.5kN/s was applied. 150 mm x 150 mm X 150 mm size cubes were used for the testing. Compressive Strength was measured at 7 and 28 days.

4.2 Split tensile test:-

This test could be performed in accordance with IS: 5816 -1999. In split tensile strength use cylindrical mold of size 300 mm height and 150 mm diameter. This test carry out after 28 days of curing of cylinder at the day of casting.

4.3 Flexural strength:-

The flexural strength of a material. Flexural strength of concrete casting the standard size of the specimens are 10cm x 10cm x 50 cm. cured continuously 28 day from the day of casting. Testing of Beam is typical arrangement on Universal Testing Machine as equal loads are applied.

4.4 Acid resistance:-

Acid attack is determined by immersing test specimens of size150 X150 X 150 mm cubes in 5% H_2So_4. The deterioration of specimens was presented in the form of percentage reduction in compressive strength of concrete specimens at 56 days.

4.5 Sulphate resistance:-

Sulphate resistance of concrete is determined by immersing test specimens of size 150 X150 X 150 mm cubes in 5% NAOH. The deterioration of specimens was presented in the form of percentage reduction in compressive strength of concrete specimens at 56 days.

5. EXPERIMENTAL RESULT:-

5.1 Slump test:-

Table -1: Compressive strength

Sr no.	Slump test			
	Replacement	***M20(MPa)***	***M25(MPa)***	***M30(MPa)***
		28 days	***28 days***	***28 days***
1	0%SF+0%CS	63	60	59
2	5%SF+10%CS	61	63	62
3	5%SF+20%CS	65	65	63
4	5%SF+30%CS	68	68	65
5	5%SF+40%CS	70	70	65
6	10%SF+10%CS	67	67	63

Sr no.	Slump test			
	Replacement	***M20(MPa)***	***M25(MPa)***	***M30(MPa)***
		28 days	***28 days***	***28 days***
7	10%SF+20%CS	68	68	67
8	10%SF+30%CS	71	71	69
9	10%SF+40%CS	76	76	64
10	15%SF+10%CS	69	69	65
11	15%SF+20%CS	70	70	69
12	15%SF+30%CS	75	73	71
13	15%SF+40%CS	79	74	72

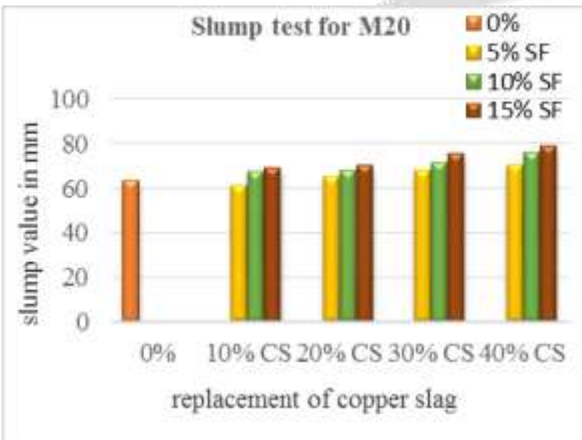

Chart:-1 Slump test for M20

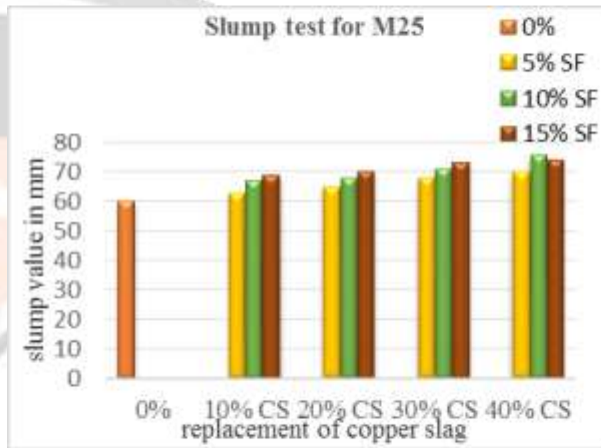

Chart:-2 Slump test for M25

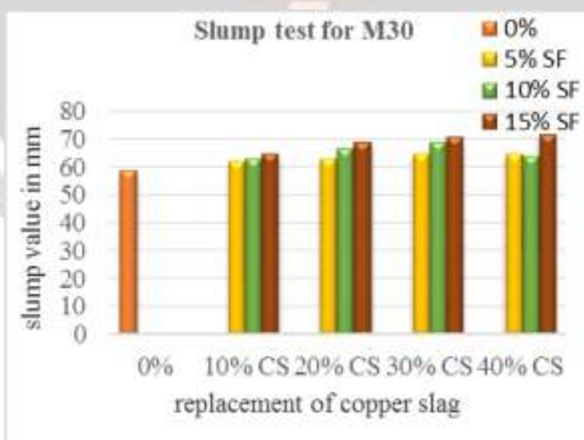

Chart: - 3 Slump test for M30

5.2 Compressive strength:-

Table -2: Compressive strength

Sr no.	Compressive strength						
	Replacement	**M20 (MPa)**		**M25 (MPa)**		**M30 (MPa)**	
		7 days	28 days	7 days	28 days	7 days	28 days
1	0%SF+0%CS	15.71	21.53	17.40	25.24	24.15	31.18
2	5%SF+10%CS	16.62	21.97	17.27	25.47	24.19	32.70
3	5%SF+20%CS	17.06	22.28	19.32	27.25	25.03	33.51
4	5%SF+30%CS	18.83	23.94	20.53	28.46	26.04	35.64
5	5%SF+40%CS	16.63	21.84	18.21	26.11	25.93	34.12
6	10%SF+10%CS	16.51	22.02	19.91	25.91	24.39	32.67
7	10%SF+20%CS	17.57	23.29	20.61	27.93	25.7	34.25
8	10%SF+30%CS	19.25	24.69	21.89	28.52	27.1	35.97
9	10%SF+40%CS	17.21	22.56	20.70	26.83	24.03	34.27
10	15%SF+10%CS	16.59	23.13	20.14	26.71	24.73	33.46
11	15%SF+20%CS	17.84	23.63	21.64	28.16	26.19	35.40
12	15%SF+30%CS	19.71	24.95	21.97	29.12	27.47	37.65
13	15%SF+40%CS	17.44	23.59	19.09	27.52	24.75	35.88

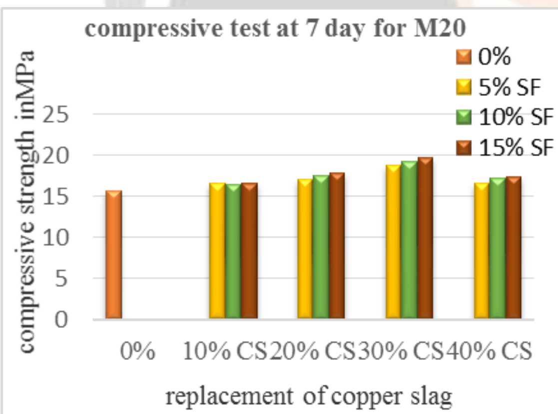

Chart:-4 compressive strength for M20 at 7days

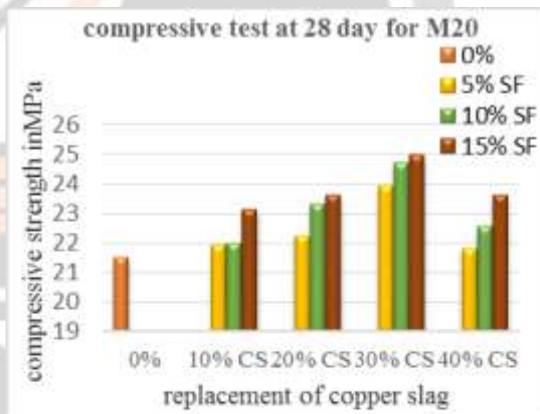

Chart:-5 compressive strength for M20 at 28days

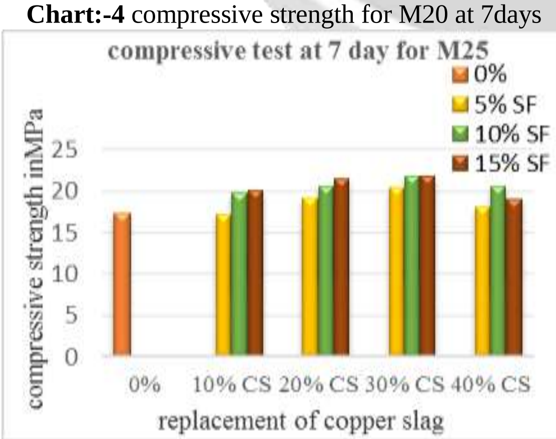

Chart:-6 compressive strength for M25 at 7days

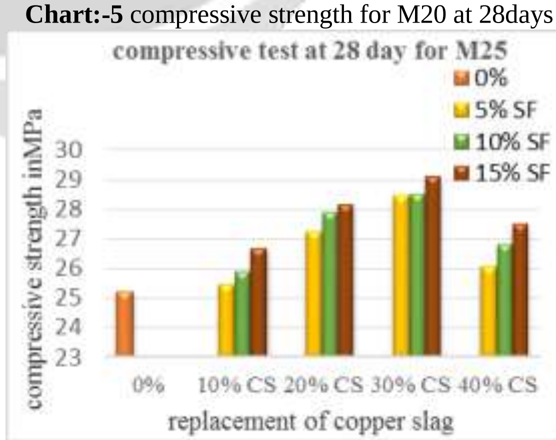

Chart:-7 compressive strength for M25 at 28day

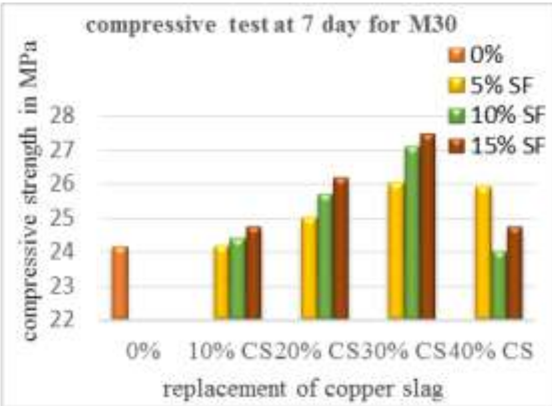

Chart:-8 compressive strength for M30 at 7days

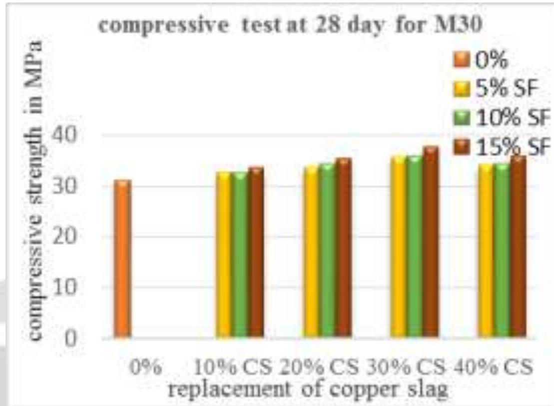

Chart:-9 compressive strength for M30 at 28days

5.3 Split tensile:-

Table -3:- Split tensile strength

Sr no.	Split tensile strength			
	Replacement	***M20(MPa) 28 days***	***M25(MPa) 28 days***	***M30(MPa) 28 days***
1	0%SF+0%CS	2.70	2.85	3.41
2	5%SF+10%CS	2.72	2.88	3.48
3	5%SF+20%CS	2.76	2.92	3.50
4	5%SF+30%CS	2.83	3.01	3.62
5	5%SF+40%CS	2.77	2.89	3.47
6	10%SF+10%CS	2.77	2.91	3.49
7	10%SF+20%CS	2.81	2.96	3.53
8	10%SF+30%CS	2.89	3.08	3.74
9	10%SF+40%CS	2.78	2.92	3.59
10	15%SF+10%CS	2.80	2.95	3.61
11	15%SF+20%CS	2.87	3.04	3.67
12	15%SF+30%CS	3.04	3.11	3.89
13	15%SF+40%CS	2.84	2.98	3.72

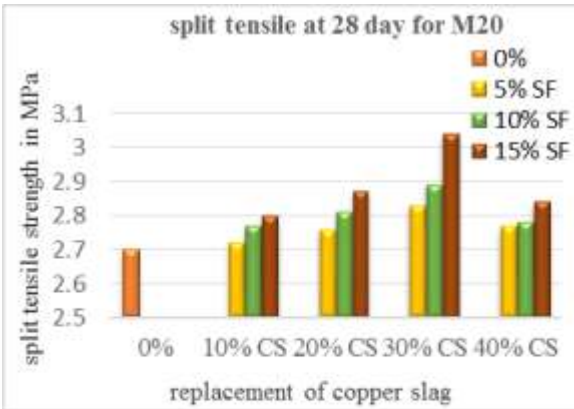

Chart:-10 split tensile for M20 at 28days

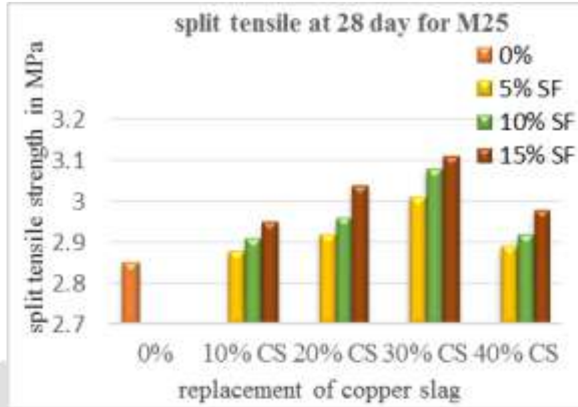

Chart:-11 split tensile for M25 at 28days

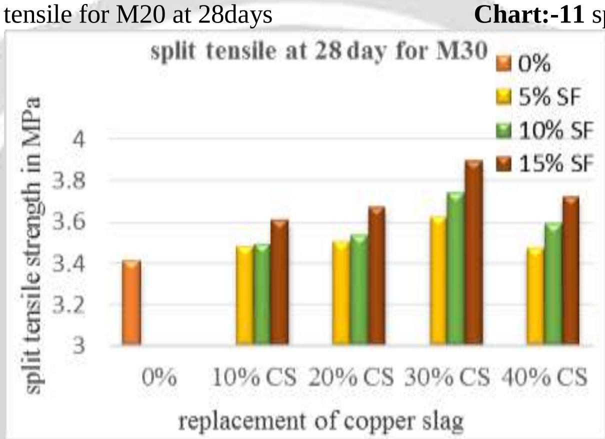

Chart:-12 split tensile for M30 at 28days

5.4 Flexural strength:-

Table -4:-Flexural strength

Sr no.	**Flexural strength**			
	Replacement	***M20(MPa) 28 days***	***M25(MPa) 28 days***	***M30(MPa) 28 days***
1	0%SF+0%CS	2.53	2.75	3.16
2	5%SF+10%CS	2.55	2.83	3.19
3	5%SF+20%CS	2.61	2.84	3.27
4	5%SF+30%CS	2.70	2.92	3.43
5	5%SF+40%CS	2.62	2.81	3.32
6	10%SF+10%CS	2.57	2.84	3.21
7	10%SF+20%CS	2.65	2.86	3.35
8	10%SF+30%CS	2.74	2.94	3.51
9	10%SF+40%CS	2.67	2.85	3.38
10	15%SF+10%CS	2.63	2.87	3.27
11	15%SF+20%CS	2.72	2.93	3.41
12	15%SF+30%CS	2.81	3.03	3.61
13	15%SF+40%CS	2.73	2.90	3.42

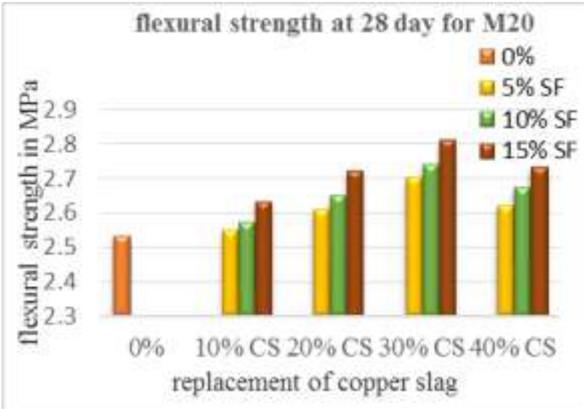

Chart:-13 flexural strength for M20 at 28days

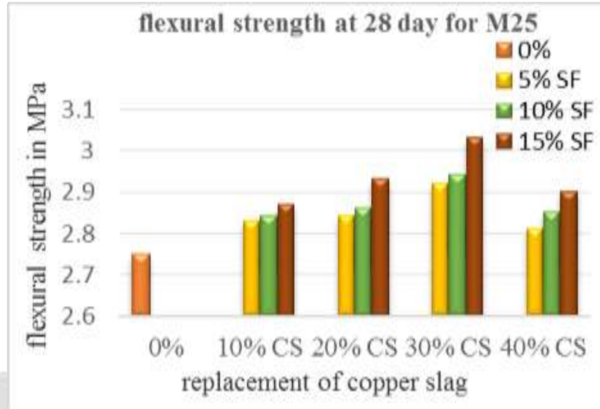

Chart:-14 flexural strength for M25 at 28days

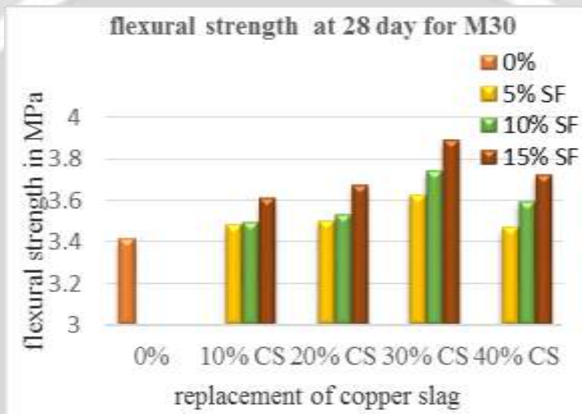

Chart:-15 flexural strength for M25 at 28days

5.5 Acid resistance:-

Table -5: Acid resistance

Sr no.	**Acid resistance**						
		M20(MPa)		***M25(MPa)***		***M30(MPa)***	
	Replacement	56 days	%variation	56 days	%variation	56 days	%variation
1	0%SF+0%CS	20.41	0	23.83	0	29.40	0
2	5%SF+10%CS	19.60	-3.96	22.70	-4.74	27.79	-5..47
3	5%SF+20%CS	19.72	-3.35	22.88	-3.97	28.48	-3.12
4	5%SF+30%CS	19.96	-2.16	23.01	-3.46	28.69	-2.41
5	5%SF+40%CS	19.79	-3.01	22.94	-3.71	28.51	-3.02
6	10%SF+10%CS	19.50	-4.43	22.92	-3.78	28.17	-4.17
7	10%SF+20%CS	19.67	-3.60	22.96	-3.64	28.62	-2.63
8	10%SF+30%CS	19.98	-2.03	23.16	-2.78	28.60	-2.72
9	10%SF+40%CS	19.76	-3.15	23.07	-3.16	28.31	-3.7

Sr no.	Acid resistance						
	Replacement	*M20(MPa)*		*M25(MPa)*		*M30(MPa)*	
10	15%SF+10%CS	19.56	-4.12	22.84	-4.13	28.28	-3.84
11	15%SF+20%CS	19.68	-3.53	23.07	-3.15	28.76	-2.16
12	15%SF+30%CS	20.01	-1.97	23.17	-2.73	28.78	-2.12
13	15%SF+40%CS	19.78	-3.06	23.05	-3.27	28.37	-3.62

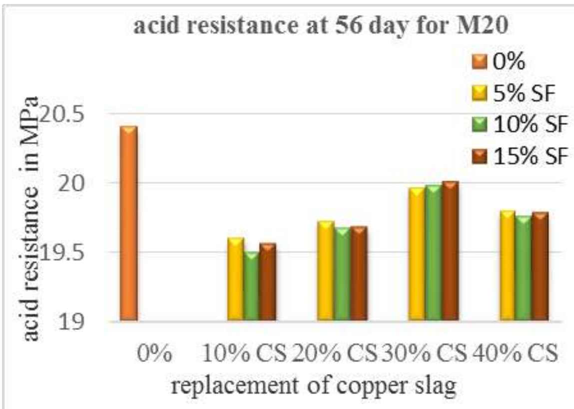

Chart:-16 acid resistance for M20 at 28days

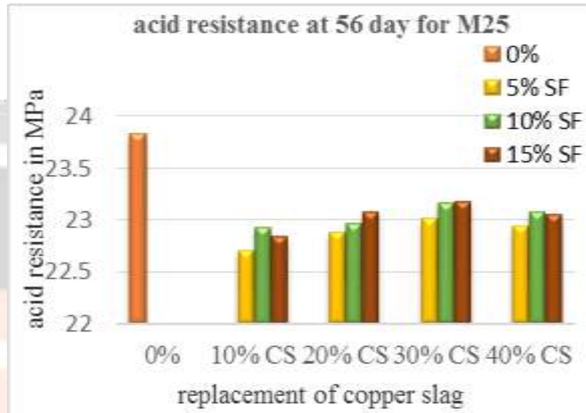

Chart:-17 acid resistance for M25 at 28days

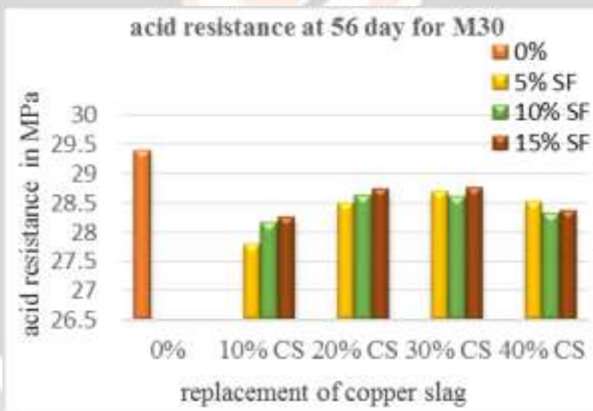

Chart:-18 acid resistance for M30 at 28days

5.6 Sulphate resistance:-

Table -6: sulphate resistance

Sr no.	Acid resistance						
		M20(MPa)		*M25(MPa)*		*M30(MPa)*	
	Replacement	56 days	%variation	56 days	%variati on	56 days	%variatio n
1	0%SF+0%CS	20.13	0	23.92	0	29.72	0
2	5%SF+10%CS	19.33	-3.94	22.98	-3.89	28.55	-3.92
3	5%SF+20%CS	19.39	-3.63	23.04	-3.67	28.60	-3.74
4	5%SF+30%CS	19.51	-3.07	23.19	-3.03	28.83	-2.98

Sr no.	Acid resistance						
	Replacement	***M20(MPa)***		***M25(MPa)***		***M30(MPa)***	
5	5%SF+40%CS	19.42	-3.48	23.07	-3.52	28.75	-3.24
6	10%SF+10%CS	19.37	-3.77	23.05	-3.63	28.63	-3.67
7	10%SF+20%CS	19.39	-3.67	23.06	-3.58	28.75	-3.24
8	10%SF+30%CS	19.54	-2.89	23.17	-3.13	28.82	-3.01
9	10%SF+40%CS	19.45	-3.34	23.11	-3.37	28.76	-3.23
10	15%SF+10%CS	19.41	-3.57	23.10	-3.41	28.58	-3.81
11	15%SF+20%CS	19.43	-3.46	23.14	-3.23	28.99	-2.43
12	15%SF+30%CS	19.64	-2.48	23.25	-2.76	28.84	-2.96
13	15%SF+40%CS	19.47	-3.27	23.17	-3.11	28.70	-3.42

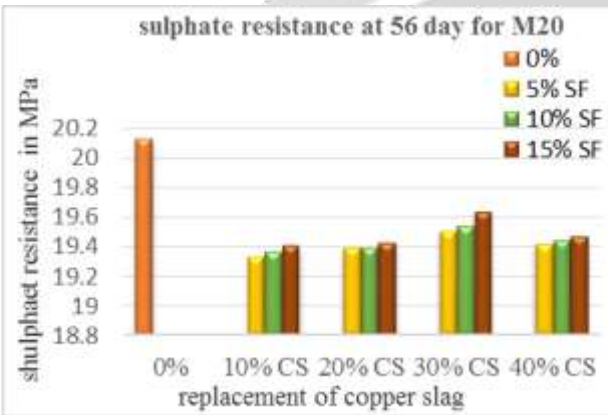

Chart:-19 sulphate resistance for M20 at 28days

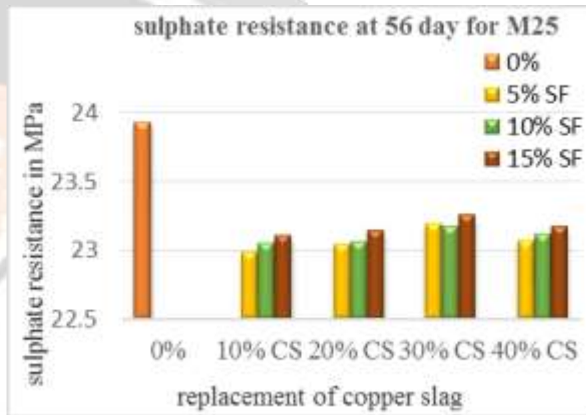

Chart:-20 sulphate resistance for M25 at 28days

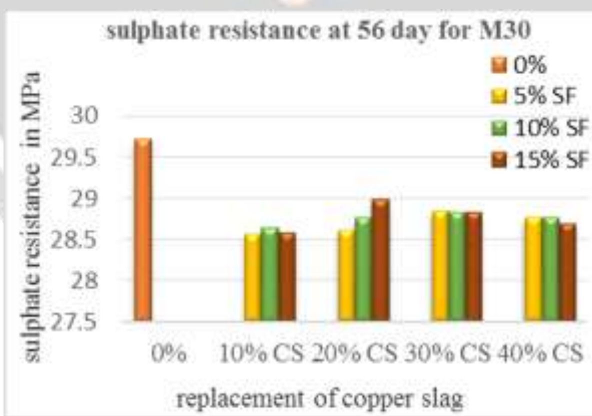

Chart:-21 sulphate resistance for M30 at 28days

6. CONCLUSION:-

- The optimum result for mechanical properties of concrete is increases at 15% silica fume and 30% copper slag with respect to normal concrete for all grade.
- The optimum result for durability properties of concrete is also increases at 15% silica fume and 30% copper slag with respect to normal concrete for all grade.

- Cost of Concrete production reduces when Copper Slag is used as a fine aggregate in concrete.
- Use of copper slag helps in waste management and dumping industrial wastes.
- Copper Slag behaves similar to River Sand as it contains Silica (SiO2) similar to sand.
- The workability improved with the addition of copper slag. This increase in the workability with the increase of copper slag quantity is due to the low water absorption characteristics of copper slag and its glassy surface.

7. REFERENCE:-

[1] M.franco , H.Thiagu ,Study On The Strength Parameter Of Concrete By Partial Replacement Of Cement Using Fly Ash And Fine Aggregate By Copper Slag, (ICEIS-2016)

[2] Binaya Patnaik,Seshadri Sekhar , Srinivasa Rao , Strength and durability properties of copper slag admixture concrete(IJRET) , VOLUME 04 SPECIAL ISSUE :01, NCRTCE-2014, FEB-2015

[3] N. Sakthieswaran , K. Ganesan , Compressive Strength of Concrete containing Fly Ash, Copper Slag, Silica Fume and Fibers – Prediction , (IJECS) , VOLUME3 ISSUE2 FEBRUARY,2014

[4] Muhsin Mohyiddeen , Effect of Silica Fume on Concrete Containing Copper Slag as Fine Aggregate , MayaT.M. ,(IJRAT) ,TASC-15 ,10-11 JUNE 2015

[5] J. ramesh kumar , k. v. ramana , use of copper slag and fly ash in high strength concrete , (ijsr) , VOLUME 4 ISSUE 10 OCT 2015

[6] Pazhani. k. jeyaraj. R. , study on durability of high performance concrete with industrial wastes , volume 2 issue 2 august 2010

[7] Er. Harpreet Singh , Er. Gurprit Singh Bath , Use of copper slag as fine aggregate– a case study(IJIERT) VOLUME 2, ISSUE 5, MAY -2015