Experimental Studies on Concrete by Partial Replacement of Lathe Slag and Silica Fume

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Abstract - *The project presents the results of the experimental and theoretical investigations of the concrete by partial replacement of lathe slag and silica fume This paper is about reuse the industrial wastes in concrete. The purpose of use the waste materials to reduce the environmental hazards. In addition to this, to find the properties of concrete while using replacement material Lathe scrap. An attempt of partial replacement of fine aggregate (M sand) by Lathe slag and a partial replacement of silica fume at various proportions is done to increase the strength of concrete. Various concrete tests are conducted.*

***Key Words*: Lathe slag, Silica fume,compression test,split tensile test,flexural test**

1. INTRODUCTION

Generally, concrete consist of materials like cement, coarse aggregate and fine aggregate. Their proportion in the concrete is based on grade of concrete and it determines the strength also. Now a days use of resources in the construction industry is very high.This project is to replace the material in concrete for better improvement of concrete properties and also determine the characteristic strength of replacing material. The main aim for this project is to avoid soil infertility, land filling and environmental hazards creates by industrial waste of iron and steel industries.

Adding silica fume to concrete mixes generally results in enhanced mechanical properties.The research and development of silica fume made it one of the world's most valuable and versatile admixtures for concrete and cementious products.Three percentage levels of replacement i.e. 5, 10 and 15 percent is considered for partially replacing cement with silica fume.

2. MATERIALS

GENERAL

A total number of 90 specimens are casted, in which number of cubes are 45, cylinder are 30, and prism are 15 then tested for their strength.

Cement: Ordinary Portland cement conforming to IS 269-1976 and IS 4031-1968 was adopted in this work. The cement used is 53 grade.

Coarse aggregate: The aggregate used in this project mainly of basalt rock which comes under a normal weight category. The aggregates are locally available. 50% of the aggregate used are of 10-12 mm size and other 50% are of 20mm size. The coarse aggregate was also tested for various properties like specific gravity test, fineness modulus, crushing strength test, water absorption test to check their suitability for the experiment.

Fine Aggregate: Manufactured sand (M-sand)is a substitute of river sand for concrete construction. Manufactured sand is produced from hard granite stone by crushing. The crushed sand is cubical shape with grounded edges, washed and graded to as a construction material. The size of manufactured sand (M-sand) is less then 4.75mm. Sieve analysis was done to find out fineness modulus and specific gravity for sand as per IS 383-970.

Steel Scrap: Steel Scraps of length 20 mm to 30 mm, width 1.5 to 2 mm and thickness 0.3 to 0.6 mm which is obtained from the lathe machines as waste or by product was used as reinforcing material in the concrete. So, the aspect ratio will vary from 50 to 70. The shape of its cross-section is polygonal with bright and twisted appearance. It posses high modulus of elasticity (about 200 GPa).

Silica Fume: Silica fume is the side product obtained from the manufacture of silicon metal or alloys containing silicon. It has most common application in concrete, as a replacement of cement, because of its highly pozzolanic nature. Adding silica fume to pavement concrete mixes generally results in enhanced mechanical properties.

III. TEST ON MATERIALS

1. TEST ON CEMENT

a) FINENESS TEST ON CEMENT (IS 4031-1996 part1)

- Weight of sample taken = 200g
- Fineness of cement = 100g
- Weight of residue = 2g

b) CONSISTENCY TEST ON CEMENT (IS: 4031-1988 Part4)

Standard consistency (%) = (Weight of water added / Weight of cement) × 100

= (80/250) × 100

= 32%

c) INITIAL SETTING TIME OF CEMENT (IS: 4031-1988 Part 5)

- Initial setting time = 35 minutes

d) FINAL SETTING TIME OF CEMENT (IS: 4031-1988 Part 5)

- Final setting time = 180 minutes

e) SPECIFIC GRAVITY TEST ON CEMENT (IS: 2720- Part 3)

Specific gravity = $(W_2 - W_1) / [(W_2 - W_1) - (W_3 - W_4) \times 0.79]$

= 3.15

2. TEST ON SILICA FUME

a) SPECIFIC GRAVITY TEST ON SILICA FUME

Specific Gravity = $(W_2 - W_1) / [(W_2 - W_1) - (W_3 - W_4) \times 0.79]$

= 2.23

b) SIEVE ANALYSIS (IS: 2386-1963 Part)

Table 1 .Fineness modulus of fine aggregate (M-sand)

S. No	Size of sieve	Weight retained	Cumulative weight retained	Cumulative % retained	% passing
1.	4.75mm	11	11	2.2	97.8
2.	2.36mm	35	51	9.2	90.8
3.	1.18mm	150	301	39.2	60.8
4.	300µ	248	450	88.8	11.2
5.	150µ	28	488	93.6	6.4
6.	Pan	2	500	100	0
Fineness modulus					**2.67**

Table 2. Fineness modulus of coarse aggregate (M-sand)

S. No	Size of sieve	Weight retained	Cumulative weight retained	Cumulative % retained	% passing
1.	13.2	975	975	19.5	80.5
2.	11.2	1857	2832	56.64	43.36
3.	9.5	1330	4162	83.24	16.76
4.	8	460	4622	92.44	7.56
5.	6.75	290	4912	98.24	1.76
6.	4.75	70	4982	99.64	0.36
7.	Pan	15	4997	99.94	0.06
Fineness modulus					**1.50**

c) SPECIFIC GRAVITY ON AGGREGATES (IS: 2386-1963 Part-3)

Table 3. Specific gravity of coarse aggregate and fine aggregate results

S. No.	Material	W1 (g)	W2 (g)	W3 (g)	W4 (g)	Specific Gravity
1.	Fine Aggregate	635	840	1625	1498	2.62
2.	Coarse Aggregate	635	835	1619	1498	2.53

d) WATER ABSORPTION ON AGGREGATES (IS 1124-1974)

Table 4. Water absorption of coarse aggregate and fine aggregate results

S.no	Material	W1(g)	W2(g)	Water absorption %
1.	Fine Aggregate	109.4	100	9.4
2.	Coarse Aggregate	2056	2000	2.8

IV. RESULTS

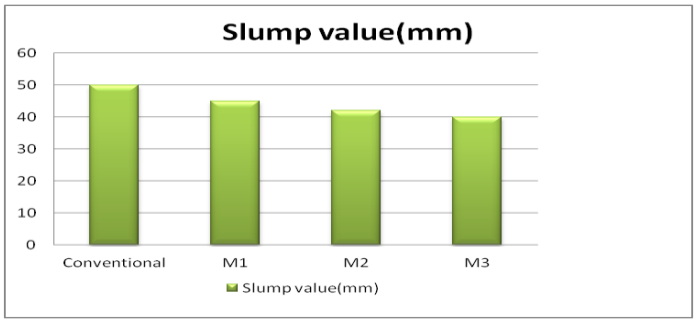
The results obtained from the experimental system were represented both in tabular form and graphical means.

1. TEST ON FRESH CONCRETE:

i. SLUMP TEST

Table 5. Slump cone test results

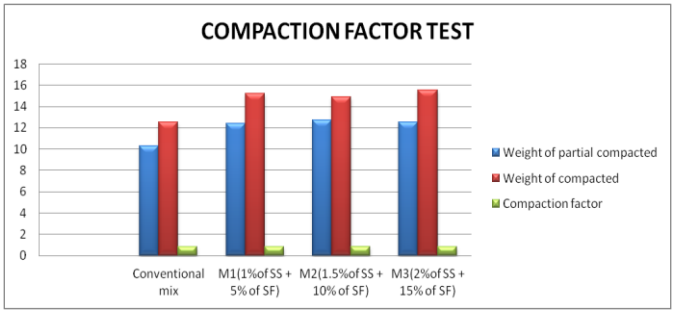
S.No	Mix Proportion	Slump value(mm)
1.	Conventional	50
2.	M1	45
3.	M2	42
4.	M3	40



ii. COMPACTION FACTOR TEST

Table 6. Compaction factor test results

S.No	Mix Proportion	Weight of partially compacted concrete	Weight of compacted concrete	Compaction factor
1.	Conventional mix	10.28	12.54	0.819
2.	M1(1%of SS + 5% of SF)	12.40	15.2	0.814
3.	M2(1.5%of SS + 10% of SF)	12.75	14.92	0.850
4.	M3(2%of SS + 15% of SF)	12.56	15.52	0.814



2. TEST ON HARDENED CONCRETE:

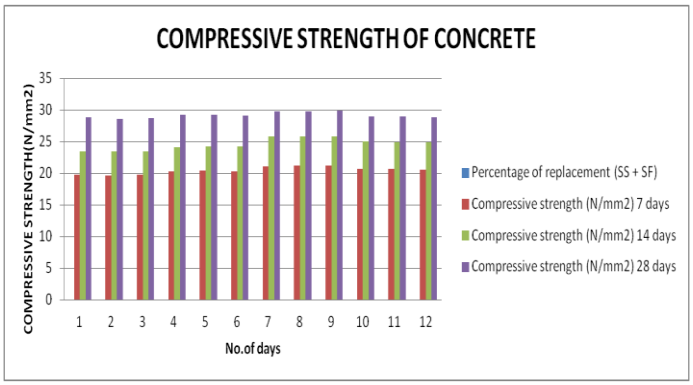
i. COMPRESSIVE STRENGTH TEST

It is one of the important characteristics. The concrete specimen of size 150 x 150 x 150 mm is casted and demoulded after 24 hours and cured and the tests are taken in the days of 7 and 28 days.

The test results are taken in values and mentioned in graphical form. The values are tabulated as follows.

S.no	NAME OF THE SPECIMEN	PERCENTAGE OF REPLACEMENT	COMPRESSIVE STRENGTH9(N/mm²)		
			7days	14Days	28 Days
1.	CUBE 1	0 % + 0 %	19.72	23.45	28.82
	CUBE 2		19.69	23.51	28.56
	CUBE 3		19.73	23.49	28.75
2.	CUBE 1	1%of SS + 5% of SF	20.35	24.13	29.22
	CUBE 2		20.37	24.21	29.30
	CUBE 3		20.34	24.19	29.13
3.	CUBE 1	1.5%of SS + 5% of SF	21.11	25.87	29.79
	CUBE 2		21.17	25.84	29.76
	CUBE 3		21.16	25.79	29.87
4.	CUBE 1	2%of SS + 15% of SF	20.69	24.99	28.98
	CUBE 2		20.65	24.96	28.95
	CUBE 3		20.58	24.86	28.82

Table 7. Compressive strength at 7 ,14 and 28 days

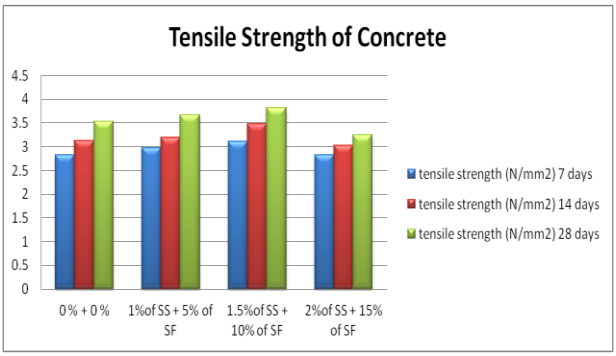


ii. SPLIT TENSILE STRENGTH TEST

Tensile strengths are based on the indirect splitting test of cylinders. The tensile strength of concrete, strength increased from the replacement of silica fume 5% ,10% and 15% with cement and lathe slag with M sand at 7 days,14 days and 28 days. The results of tensile strength for M25 grade concrete are tabulated.

Table 8. Tensile strength at 7 ,14 and 28 days

S.No.	Name of the specimen	Percentage of replacement(SS + SF)	tensile strength (N/mm²)		
			7 days	14 days	28 days
1.	Cylinder 1	0 % + 0 %	2.82	3.13	3.53
2.	Cylinder2	1%of SS + 5% of SF	2.97	3.19	3.67
3.	Cylinder3	1.5%of SS + 10% of SF	3.11	3.48	3.81
4.	Cylinder 4	2%of SS + 15% of SF	2.82	3.02	3.25

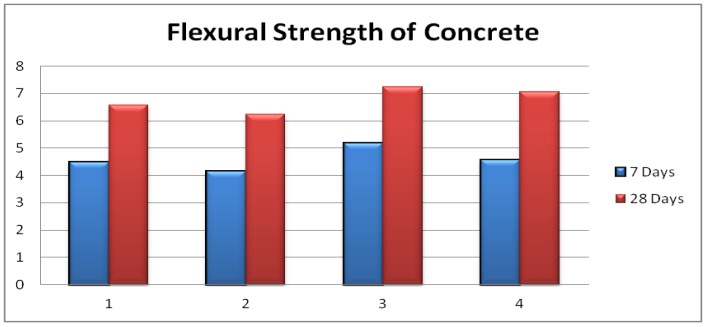


iii. FLEXRAL STRENGTH TEST

The flexural strength test was carried out on prism of cross-section 150 mm × 150 mm × 700 mm. The flexural strength of concrete, strength increased from the replacement of silica fume 5% ,10% and 15% with cement and lathe slag with M sand at 7 days and 28 days. The results of flexural strength for M25 grade concrete are tabulated.

Table 9. Flexure strength at 7 and 28 days

No. of days	Flexural Strength of conventional concrete (N/mm²)	Flexural strength of M1 (N/mm²)	Flexural strength of M2 (N/mm²)	Flexural strength of M3 (N/mm²)
7	4.48	4.14	5.18	4.56
28	6.58	6.22	7.25	7.05



V. CONCLUSION

The following conclusion could be drawn from the present work:

The present article reviewed the feasibility of using alternative materials in concrete.The mechanical properties of the concrete are increased by increasing the proportion of the lathe scrap from 0.5% up to 1.5%. From 1.5% to 2.0% it shows slight decrease in the mechanical strength. At 2.0% of lathe scrap proportion there is a considerable reduction in the mechanical strength of LSRC. The result showed that addition of lathe scrap in to OPC mixture enhanced its compressive strength while it decreased the workability of the fresh concrete containing the lathe scrap. In general from the above study it was incurred that, the performance of lathe scrap concrete proves to be better than the normal concrete.

- Lathe scrap increases the compressive strength of concrete.

Based on the finding of this study, the following conclusions were drawn: addition of steel slag increases compressive strength of concrete . Addition of steel slag in the concrete mix significantly influenced the cracking behaviour and ultimate strength.

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