

Strength Predictions of Saw Dust and Steel Fibres in Concrete

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ABSTRACT; The production of conventional concrete requires coarse aggregates, fine aggregates, cement, and water. This conventional concrete though has required strength but on the same time it proves to be expensive as well as environmental unfriendly. There is need for affordable building materials in providing adequate housing for the teeming populace of the world. Thus, there is the need to search for local materials as alternatives for the construction of functional but low-cost buildings in both the rural and urban areas. Therefore, this paper is an experimental investigation on saw dust by partially replacing cement in proportions of 5%, 10% and 15% respectively. Also in addition to that to increase concrete strength steel fibres in proportion of 0.5%, 0.75% and 1% is added by volume of concrete.

I.INTRODUCTION

Cement industry contributes extensively in the emission of CO₂. It also consumes high levels of energy resources in cement production. By replacing cement with a waste material, such as saw dust, the cement and cement industry together can meet the demand in construction industry and also can help in reducing the environmental pollution. Availability of consistent quality of saw dust across the country and awareness of positive effects of using saw dust in concrete are important pre requisite for changing the perception of saw dust from waste to a resourceful material. From various researches, it is found that an important property of steel fiber reinforced concrete SFRC is that it is superior in cracking resistance and resisting crack propagation. Because of this property to arrest cracks, fiber composites have increased flexibility and tensile strength, particularly under flexural loading.

II. EXPERIMENTAL PROGRAMME

2.1 Cement

Ordinary Portland 53 grade cement was used for making the concrete specimens. The specific gravity of the cement was found to be 3.15. The initial setting time and the final setting time of the cement were found to be 145 minutes and 240 minutes respectively (ASTM C 150-00).

2.2. Aggregate and saw dust

Aggregates of size ranging from 20 mm and 12.5 mm were used in this work. The specific gravity of the coarse aggregates was found to be 2.66 and fine aggregate was found to be 2.70 (ASTM C 128-01). The specific gravity of saw dust was found to be 1.37.

2.3.Fibre reinforcement

Discrete steel fibres conforming to ASTM A 820 /A 820M – 04 were used. They were Type 1 cold drawn wire grooved. The steel fibres had a length of 50 mm and a diameter of 1 mm. Hence, their aspect ratio was 50. The tensile strength of the fibre was found to be 1098 MPa using tensometer.

2.4 Mix design

Mix design was done in accordance with IS:10262:2009. Table 1 shows th mix design values.

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TABLE 1

Saw dust	Cement (kg)	Saw Dust (kg)	20mm Coarse Aggregate (kg)	12.5mm Coarse Aggregate (kg)	Fine Aggregate (kg)	Water (in l)
0% saw dust	5.42	0	5.5	5.5	8.1	2.167
5% saw dust	5.146	0.271	5.41	5.41	7.94	2.167
10% saw dust	4.875	0.54	5.22	5.22	7.62	2.367
15% saw dust	4.6	0.8126	5.18	5.18	7.38	2.467

III. TESTS PERFORMED

3.1 Compressive strength tests

Compressive strength of the concrete specimens (100mm x 100mm x 100mm) was determined according to the TS EN 12390-3. The failure load was recorded. The compressive strength of the specimen was calculated by dividing the failure load by the cross-sectional area of the specimen. Compressive strength of the cubes was determined at curing periods of 7 days and 28 days.

3.2 Split tensile strength tests

The split tensile strength of cylindrical specimens was determined as per ASTM C496. Split tensile strength was determined at curing periods of 7 days and 28 days. The cylindrical specimens were 200 mm in height and 100 mm in diameter. The split tensile strength (T) was determined from the equation

$$T = 2P/\pi ld$$

where, P is the failure load.

3.3. Flexural strength tests

Flexural strength of the concrete prisms was determined as per ASTM C293. The dimensions of the prisms were 500 mm x 100 mm x 100 mm. Flexural strength was determined for the curing periods of 7 days and 28 days.

The flexural strength of the specimen was determined from the expression,

$$f_b = pl / bd^2$$

IV. RESULTS AND DISCUSSION

4.1 Compression test

Table 2 and Table 3 shows the results of compression test for a curing period of 7 days and 28 days

TABLE 2 Compressive strength (N/mm²) (7 days)

Saw dust	0% steel fibres	0.5% steel fibres	0.75% steel fibres	1% steel fibres
0% saw dust	45.3	43.5	42.8	40.8
5% saw dust	36.95	35.75	33.7	30.95
10% saw dust	29.5	22.2	21.8	20.1
15% saw dust	19.6	14.1	12.3	11

TABLE 3 Compression test (28 days)

Saw dust	0% Steel Fibres	0.5% Steel Fibres	0.75% Steel Fibres	1% Steel Fibres
0% Saw Dust	56.8	54.3	53.4	52.3
5% Saw Dust	43.5	42.7	38.6	36.45
10% Saw Dust	35	33	31.6	30.2
15% Saw Dust	28.1	27.6	26	24.3

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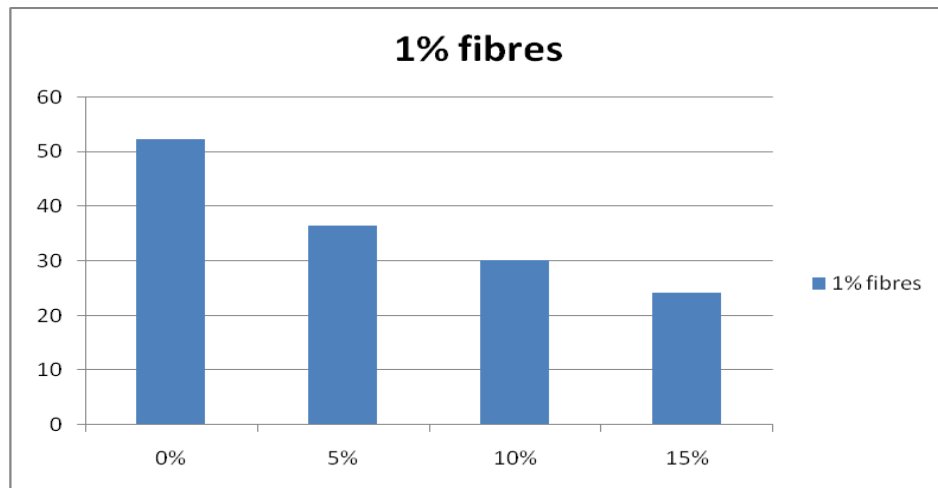


Figure 1 Compressive strength for varying saw dust with 1% fibres (28 days)

Figure 1 show the compressive strength for varying saw dust with 1% fibres at a curing period of 28 days. Saw dust contains 65% siliceous materials. But, it also contains other constituents which are high up in reactivity series. This results in delay of C-S-H gel formation reactions necessary for concrete to gain strength. Hence, early strength, i.e. 7 day strength of concrete with saw dust is low when compared with 28 days compressive strength. However, as days progress, the rate of gain of strength increases.

4.2 Split tensile strength

Table 4 and Table 5 show the test results of split tensile strength for a curing period of 7 days and 28 days. Figure 2 show the split tensile strength at 10% saw dust.

Table 4 Split tensile strength (7 days)

	0% steel fibres	0.50% steel fibres	0.75% steel fibres	1% steel fibres
0% saw dust	2.58	3.1	2.98	2.77
5% saw dust	1.94	2.72	2.63	2.31
10% saw dust	1.91	2.58	2.19	2.07
15% saw dust	1.21	2.51	1.88	1.53

Table 5 Split tensile strength (28 days)

	0% Steel Fibres	0.50% Steel Fibres	0.75% Steel Fibres	1% Steel Fibres
0% Saw Dust	3.1	3.669	3.31	3.199
5% Saw Dust	2.72	3.24	3.183	2.912
10% Saw Dust	2.228	2.812	2.324	2.292
15% Saw Dust	2.001	2.62	2.14	2.1

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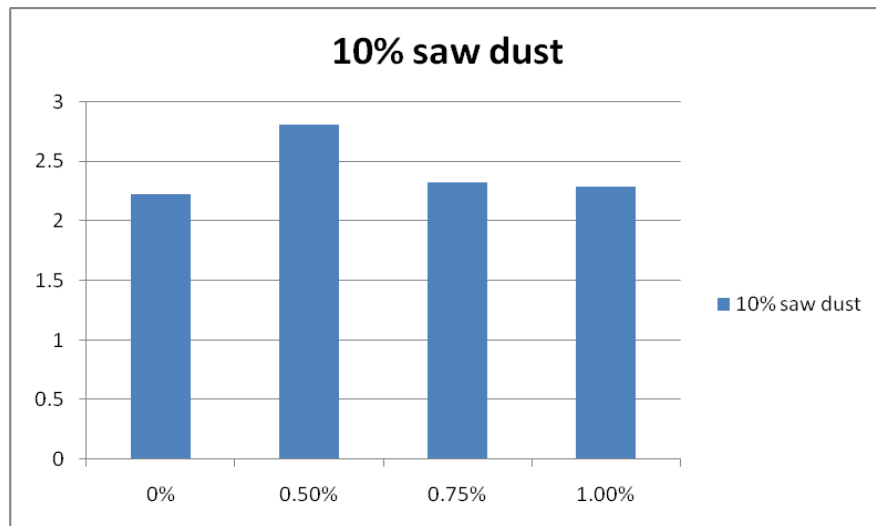


Figure 2 Split tensile strength (10% saw dust) at 28 days curing

Steel fibers show high tensile strength resistance as compared to concrete. In case of split tensile strength test, along the diameter of cylinder, compression is experienced while along the length of cylinder, tension is experienced. Hence, the dual effect leads to giving a medium value of steel fibers for optimum strength. Hence, 0.5% steel fibers is optimum in case of split tensile strength.

4.3 Flexural Strength

Table 6 show the flexural strength results for a curing period of 28 days.in flexural strength test in which effect of tensile strength is pre-dominant (in case of concrete), presence of steel fibers increases the strength as steel fibers take up most of strength.

Table 6 Flexural Strength (28 days)

	0% Steel Fibres	0.50% Steel Fibres	0.75% Steel Fibres	1% Steel Fibres
0% Saw Dust	8	8.75	9	9.25
5% Saw Dust	7.3	7.5	7.75	8
10% Saw Dust	7	7.125	7.25	7.6205
15% Saw Dust	6.125	6.5	6.625	7

V.CONCLUSIONS

- By adding saw dust, gain in compressive, flexural and split tensile strength is less for period of 7 days. But, for larger periods like 28 days, the gain in strengths are quite high in all the three cases.
- Weight reduction is observed in range of 5% to 15% compared to control mix after adding saw dust for various percentages.
- By using steel fibers, reduction in compressive strength is observed in range of 9% to 10%.
- In case of split tensile test, maximum strength values are observed for 0.5% steel fibers for different percentages of saw dust. The range of increase is 10.7% to 20.1%.
- By increasing percentage of steel fibers, flexural strength increases in range of 9.3% to 15.6% accordingly showing maximum values for 1% steel fibers for different percentages of saw dust.



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