STRENGTH PERFORMANCE STUDIES ON STEEL FIBRE REINFORCED CEMENT CONCRETE

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ABSTRACT

This project presents the performance studies of steel fibre reinforced cement concrete which is an experimental study conducted on the strength properties (compressive, flexural and split tensile strength) of modified concrete. The study is aimed at investigating how concrete behave when steel fibre is added in different percentages. A total of 135 concrete specimens (cubes, cylinder and beams) were cast and evaluated with varying percentages of steel fibre. Concrete possess a very low tensile strength and has little resistance to cracking; steel fibre is generally used to improve the strength of concrete. With reference to literature survey, the hooked end steel fibre is mixed in the concrete with various percentages (0.25, 0.5, 0.75, and 1%). M_{25} concrete mix is used in the experiment, and the strength properties of the specimen are determined after 3, 7 and 28 days of curing. Conventional and modified concrete specimens are being compared for their strength properties (compressive, split tensile and flexural) with various percentages. Evaluation is carried out by analysing the test methods with the help of graphs that were drawn based on the outcomes of various tests as mentioned above.

Keywords: Compressive strength, Flexural strength, Split Tensile strength, Conventional Concrete, Modified Concrete.

INTRODUCTION

Concrete happens to be the most used construction material averaging a total of 7 billion tons, this is due to the reason that from the ingredients of concrete such as cement, sand, aggregates, water and sometimes admixtures, it is possible to alter the properties of concrete to suit a particular condition. Despite its numerous applications and advantages, concrete is however very brittle and also weak in tension and hence susceptible to cracking and other forms of structural failures.

In order to improve the resistance of concrete to cracking and also increase its tensile strength and other strength properties, several reinforcing materials such as reinforcing steel bars, glass fibres, steel

fibres, welded wire fabric etc. are used. The individual properties of these materials compensate for the weak nature of concrete.

This work sheds light on the effects of steel fibre on cement concrete strength properties. Steel fibre reinforced concrete is defined as concrete made with hydraulic cement containing fine and coarse aggregate and discontinuous discrete fibre. For long term strength and high stress resistance, steel fibre reinforced cement concrete is increasingly being used in structures such as flooring, housing, precast, tunnelling and mining. The most suitable volume fraction values for concrete mixes are between 0.5% and 1.5% by volume of concrete. The fibres are randomly dispersed and distributed in the concrete during mixing, and thus improve concrete properties in all directions. The fibres interlock and entangle around the aggregate particles and thereby considerably reducing the workability, while the mix becomes more cohesive and less prone to segregation.

OBJECTIVES

I. To determine the optimum percentage of fibre which is sufficient enough to improve strength properties of Concrete.
II. To study the Compressive strength of concrete.
III. To study the Flexural strength and Split Tensile strength of concrete.
IV. To evaluate the Workability characteristics in terms of Slump for M_{25} grade of Concrete along with Steel Fibres (0.25 – 1%).

LITERATURE REVIEW

Dinesh Kumar. R et al (2018), conducted an experimental investigation of bending behaviour of concrete using steel fibre and polyethylene sheet and from the experimental work they concluded that as they increase the amount of steel fibre covered with polyethylene sheet, there was an increase in compressive strength by 44%, tensile strength by 74% and shear strength by 43% for optimum dosage of steel fibre (1.2%) for M_{25}. Beyond this there may be a reduction in the strength.

Aabid Hussain Bhat, et al (2018), in their work entitled experimental studies on polymer modified steel fibre reinforced concrete they concluded that the compressive strength increased at about 31.98% more than the normal concrete, a split tensile test at 3% content of fibre increased by 38.85% more than the normal concrete.

Hanumesh B.M et al(2018), conducted a study on mechanical properties of steel fibre reinforced concrete with quarry dust as a partial replacement of fine aggregate, from their study, as the quarry and steel fibre content is increased the compressive and split tensile strength is increased by 50%.

Syed Irfan Simnani, Gulzar Ahmad, (2017),conducted anexperimental study on compressive strength and split tensile strength of steel fibre reinforced concrete for M_{25} grade, according to them, there was substantial increase in strength properties on addition of 1.5% of steel fibre compared to 0%, 0.5%, and 1% of steel fibre. The compressive strength increased from 20 to 40% and split tensile strength from 18 to 26% respectively.

Athira Omanakuttan (2017), the study titled an experimental study on strength behaviour of steel fibre, glass fibre with fly ash and rice husk ash, reported that at 20% of fly ash with cement, 0.25% of glass fibre and 0.5% of steel fibre the compressive strength at 7 days was increased to 30.93 N/mm^2 and the split tensile strength was increased through 5.57 N/mm^2.

Utkarsh R. Nishane, Nitin U.Thakare (2017), conducted an experimental study on fibre reinforced concrete and concluded that for glass and steel fibre reinforced concrete strength of concrete increased with increase in the fibre dosage, up to 0.5% glass fibre when compared to aramid fibre gives 48% more compressive strength, whereas when comparing aramid and steel fibre, aramid gives 66% increased compressive strength.

Anand M et al (2017), work was based on the comparative study on high strength hybrid fibre reinforced concrete with conventional concrete, and they concluded that for hybrid fibre proportion of 0.8% to 0.2% the compressive strength is increased to 59.55N/mm^2 as compared to other proportions.

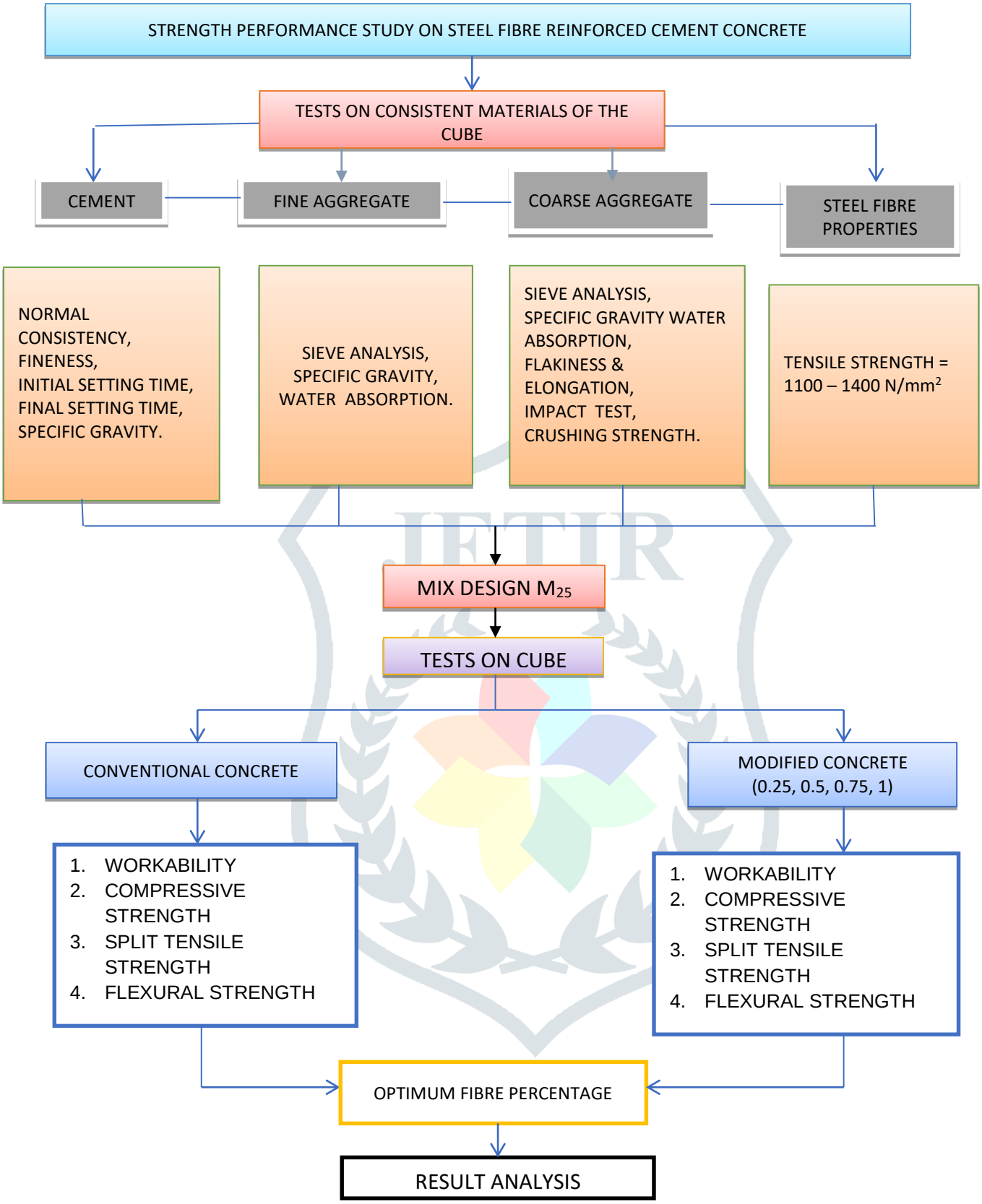
Pramod Kavade, Abhijit Warudkar (2017), studied the behaviour of steel fibre reinforced concrete, they considered only flexural strength and hence concluded that the flexural strength increased from 38.85% to 47.17%.

Avinash Joshi et al (2016), carried out an experimental work on steel fibre reinforced concrete, considering $M_{20,}$ M_{25}, M_{30} and M_{40} concrete mixes for which the specimens were cured for 3, 5, 28 days respectively. The compressive strength increased by 44%. Tensile strength also increased by 74% while shear strength increased by 43% for optimum volume of steel fibre (1.5% of steel fibre) for M_{40} grade of concrete.

Dr. Krishna Rao (2016),conducted a study on steel fibre reinforced normal compacting concrete, concluded that the compressive strength after 7, 28 and 90 days is increased by 25.96%, 24.02% and 29.9% respectively while the tensile strength after 7, 28 and 90 days are 10.82%,16.4%, and 24.14% respectively.

METHODOLOGY

Flow Chart


STRENGTH PERFORMANCE STUDY ON STEEL FIBRE REINFORCED CEMENT CONCRETE
TESTS ON CONSISTENT MATERIALS OF THE CUBE
CEMENT
FINE AGGREGATE
COARSE AGGREGATE
STEEL FIBRE PROPERTIES
NORMAL CONSISTENCY, FINENESS, INITIAL SETTING TIME, FINAL SETTING TIME, SPECIFIC GRAVITY.
SIEVE ANALYSIS, SPECIFIC GRAVITY, WATER ABSORPTION.
SIEVE ANALYSIS, SPECIFIC GRAVITY WATER ABSORPTION, FLAKINESS & ELONGATION, IMPACT TEST, CRUSHING STRENGTH.
TENSILE STRENGTH = 1100 – 1400 N/mm2
MIX DESIGN M25
TESTS ON CUBE
CONVENTIONAL CONCRETE
MODIFIED CONCRETE (0.25, 0.5, 0.75, 1)
1. WORKABILITY
2. COMPRESSIVE STRENGTH
3. SPLIT TENSILE STRENGTH
4. FLEXURAL STRENGTH
1. WORKABILITY
2. COMPRESSIVE STRENGTH
3. SPLIT TENSILE STRENGTH
4. FLEXURAL STRENGTH
OPTIMUM FIBRE PERCENTAGE
RESULT ANALYSIS

MATERIAL PROPERTIES

1. Cement

S/No	Properties	Result obtained
1	Fineness of Cement	2.5%
2	Normal consistency of Cement	34%
3	Initial setting time of Cement	30 Minutes
4	Final setting time of cement	600 Minutes
5	Specific gravity of Cement	3.16
6	Soundness of Cement	0

Table 1: Cement properties

2. Fine Aggregate

S/No	Properties	Result obtained
1	Sieve Analysis	3.78
2	Specific gravity	2.62
3	Water absorption	1.62%

Table 2: Fine Aggregate properties

3. Coarse Aggregate

S/No	Properties	Result obtained
1	Sieve Analysis of Coarse Aggregate	3.49
2	Specific gravity of Coarse Aggregate	2.64
3	Water absorption of Coarse Aggregate	0.62%
4	Flakiness Index	36.8%
5	Elongation Index	48.9%
6	Impact Test on Coarse Aggregate	18.6%
7	Crushing strength of Aggregate	17.3%

Table 3: Coarse aggregate properties

4. Steel Fibre

Product Specification

S/No	Properties	
1	Base Material	Carbon steel wire
2	Fibre Type	Corrugated, hooked end
3	Length (mm)	25 to 60 ± 10%
4	Diameter (mm)	0.05 to 1.00
5	Tensile Strength	1000 to 1400 N/mm^2± 15%

Table 4: Product specification table

Chemical Composition

% C	% Mn	% Si	% S	% P	% Ni	% Cr	% Mo	% Cu	Results
0.08	0.35	0.15	0.05	0.035	-	-	-	-	Ok

Table 5: Chemical composition of Steel Fibre

RESULTS AND DISCUSSION

Compressive Strength

Percentage of steel fibre	3 days (N/mm^2)	7 days (N/mm^2)	28 days (N/mm^2)
0	11.1	19.25	24.4
0.25	18.96	21.85	25.3
0.5	20.3	23.7	31.84
0.75	20.74	27.4	35.1
1	23.11	29.92	37.32

Table 6: Compressive Strength test result

Split Tensile Strength

Percentage of steel fibre	3 days (N/mm^2)	7 days (N/mm^2)	28 days (N/mm^2)
0	1.52	2.42	2.56
0.25	1.64	2.47	2.58
0.5	1.76	2.63	2.77
0.75	1.89	2.78	2.99
1	2.004	2.87	3.34

Table 7: Split Tensile test result

Flexural Strength

Percentage of steel fibre	3 days (N/mm^2)	7 days (N/mm^2)	28 days (N/mm^2)
0	5.62	5.64	5.7
0.25	6.48	6.5	6.7
0.5	6.925	7	7.2
0.75	7.01	7.9	8.4
1	7.14	8.39	9.6

Table 8: Flexural Strength test result

CONCLUSIONS

I. It was observed that the workability of steel fiber reinforced concrete slightly decreases due to the addition of steel fiber.

II. Compared to the conventional concrete, the steel fiber reinforced concrete (SFRC) at 1% addition shows significantly better performance at a curing period of 28 days.

III. It was observed that the compressive strength of steel fiber reinforced concrete is increased by 52.7% comparatively to the conventional concrete.

IV. The flexural strength of steel fiber reinforced concrete is increased significantly by 68.42% when compared to the conventional concrete.

V. The increment in split tensile strength of steel fiber reinforced concrete is only about 30.4% when compared to conventional concrete.

VI. The flexural strength of steel fiber reinforced concrete increased about 25.72% of its compressive strength while the conventional concrete has only 23.3% of its compressive strength.

Hence from the above conclusions, we can vehemently state that, from the percentages of steel fibre considered (0, 0.25%, 0.5%, 0.75% and 1%) 1% is the optimum fibre percentage.

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