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Experimental Study on Steel Fiber Reinforced Concrete for M-40 Grade

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ABSTRACT: *Critical investigation for M-40 grade of concrete having mix proportion 1:1.43:3.04 with water cement ratio 0.35 to study the compressive strength, flexural strength, Split tensile strength of steel fibre reinforced concrete (SFRC) containing fibers of 0%, 1%, 2% and 3% volume fraction of hook tain. Steel fibers of 50, 60 and 67 aspect ratio were used. A result data obtained has been analyzed and compared with a control specimen (0% fiber). A relationship between aspect ratio vs. Compressive strength, aspect ratio vs. flexural strength, aspect ratio vs. Split tensile strength represented graphically. Result data clearly shows percentage increase in 28 days Compressive strength, Flexural strength and Split Tensile strength for M-40 Grade of Concrete.*

Keywords - *Steel fibres increases Compressive, Flexural and Split Tensile Strength of Concrete*.

1. INTRODUCTION

Concrete is most widely used construction material in the world due to its ability to get cast in any form and shape. It also replaces old construction materials such as brick and stone masonry.

The strength and durability of concrete can be changed by making appropriate changes in its ingredients like cemetitious material, aggregate and water and by adding some special ingredients. Hence concrete is very well suitable for a wide range of applications. However concrete has some deficiencies as listed below:

1) Low tensile strength
2) Low post cracking capacity
3) Brittleness and low ductility
4) Limited fatigue life
5) Incapable of accommodating large deformations
6) Low impact strength

The presence of micro cracks in the mortar-aggregate interface is responsible for the inherent weakness of plain concrete. The weakness can be removed by inclusion of fibres in the mixture. Different types of fibers, such as those used in traditional composite materials can be introduced into the concrete mixture to increase its toughness, or ability to resist crack growth. The fibres help to transfer loads at the internal micro cracks. Such a concrete is called fibre-reinforced concrete (FRC).

The introduction of the paper should explain the nature of the problem, previous work, purpose, and the contribution of the paper. The contents of each section may be provided to understand easily about the paper.

2. EXPERIMENTAL PROGRAMME

1.1. Material used

The material used for this experimental work are cement, sand, water, steel fibres, and superplasticizer.
Cement: Ordinary Portland cement of 53 grade was used in this experimentation conforming to I.S. – 12269-1987.
Sand: Locally available sand zone II with specific gravity 2.65, water absorption 2% and fineness modulus 2.92, conforming to I.S. – 383-1970.
Coarse aggregate: Crushed granite stones of 10 mm size having specific gravity of 2.70, fineness modulus of 2.73, conforming to IS 383-1970
Water: Potable water was used for the experimentation.
Superplasticizer:
To impart additional workability a superplasticizer (Rheobuild 1100) 0.6 % to 0.8% by weight of cement was used. It is based on sulphonated naphthalene polymers with following properties as per I.S. – 9103-1999.

Fibers:

Steel Fibers: - In this experimentation Hook tain Steel fibres were used. The different aspect ratios adopted were 50, 60, and 67 having length 35, 30 and 30mm with diameter 0.70, 0.50 and 0.40 resp.

1.2. Experimental methodology

Compressive strength test:

For compressive strength test, cube specimens of dimensions 150 x 150 x 150 mm were cast for M40 grade of concrete. Superplasticized (0.6% to 0.8% by weight of cement) was added to this. The moulds were filled with 0%, 1% 2% and 3% fibres. Vibration was given to the moulds using table vibrator. The top surface of the specimen was levelled and finished. After 24 hours the specimens were demoulded and were transferred to curing tank where in they were allowed to cure for 28 days. After 28 days curing, these cubes were tested on digital compression testing machine as per I.S. 516-1959. The failure load was noted. In each category three cubes were tested and their average value is reported. The compressive strength was calculated as follows.

Compressive strength (MPa) = Failure load / cross sectional area.

Fig. 1 "Testing of compressive strength test specimen"

Flexural strength test:

For flexural strength test beam specimens of dimension 100x100x500 mm were cast. The specimens were demoulded after 24 hours of casting and were transferred to curing tank where in they were allowed to cure for 28 days. These flexural strength specimens were tested under two point loading as per I.S. 516-1959, over an effective span of 400 mm on Flexural testing machine. Load and corresponding deflections were noted up to failure. In each category three beams were tested and their average value is reported. The flexural strength was calculated as follows.

Flexural strength (MPa) = (P x L) / (b x d2),

Where, P = Failure load, L = Centre to centre distance between the support = 400 mm, b = width of specimen=100 mm, d = depth of specimen= 100 mm.

Fig. 2 "Testing of flexural strength test specimen"

Split Tensile strength test:

For Split tensile strength test, cylinder specimens of dimension 150 mm diameter and 300 mm length were cast. The specimens were demoulded after 24 hours of casting and were transferred to curing tank where in they were allowed to cure for 28 days. These specimens were tested under compression testing machine. In each category three cylinders were tested and their average value is reported. Split Tensile strength was calculated as follows as split tensile strength:

Split Tensile strength (MPa) = 2P / π DL, Where, P = failure load, D = diameter of cylinder, L = length of cylinder

Fig. 3 "Testing of Split tensile strength test specimen"

1.3. Experimental results

Following graphs give compressive strength, flexural strength and Split Tensile strength result for M-40 grade of concrete with 0%, 1%, 2% and 3% steel fibres for aspect ratio 50, 60 and 67

Table 1 – Compressive Strength of SFRC with 0% fibres M40 grade

Compressive strength (MPa)	**Average Compressive strength (MPa)**
48.89 42.22 44.44	45.19

TABLE 2 – COMPRESSIVE STRENGTH OF SFRC WITH 1%, 2% AND 3% FIBRES

Different aspect ratios of fibres	**For SFRC with 1% fibres**		**For SFRC with 2% fibres**		**For SFRC with 3% fibres**	
	Comp. strength (MPa)					
		Avg.		**Avg.**		**Avg.**
50	52.00 51.56 52.44	52.00	53.33 54.67 52.00	53.33	55.56 56.44 56.89	56.30
60	53.33 48.89 48.89	50.37	53.33 52.89 51.56	52.59	53.33 53.78 55.11	54.07
67	50.67 51.56 48.44	50.22	53.33 51.56 49.33	51.41	51.56 52.44 55.11	53.04

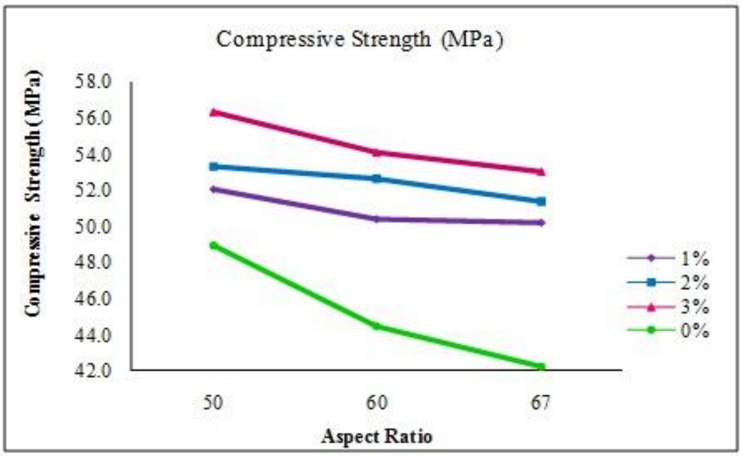

FIGURE 4: PERCENTAGE INCREASE IN 28 DAYS COMPRESSIVE STRENGTH FOR M-40 GRADE CONC

TABLE 3 – FLEXURAL STRENGTH OF SFRC WITH 0% FIBRES M40 GRADE

Flexural strength (MPa)	Average Flexural strength (MPa)
7.6 7.2 7.6	7.47

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TABLE 4 – FLEXURAL STRENGTH OF SFRC WITH 1%,2% AND 3% FIBRES

Different aspect ratios of fibres	For SFRC with 1% fibres		For SFRC with 2% fibres		For SFRC with 3% fibres	
	Flexural strength (MPa)					
		Avg.		Avg.		Avg.
50	8.8 9.2 8.4	8.8	8.8 9.6 10	9.47	10.4 10 10.8	10.40
60	8.4 8.8 8	8.40	8.8 9.2 9.6	9.20	9.6 10 10.4	10.00
67	8 8 8.8	8.27	8 9 10	9.00	8.8 10.4 10	9.73

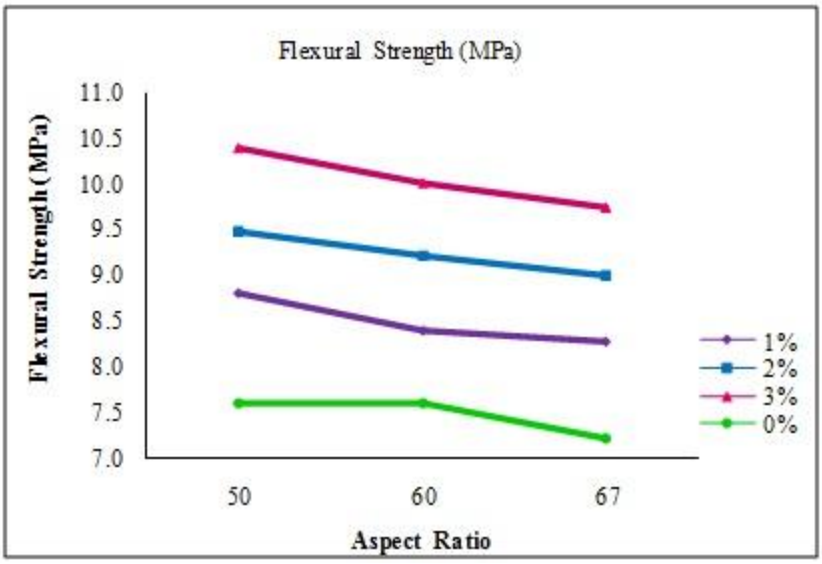

FIGURE 5: PERCENTAGE INCREASE IN 28 DAYS FLEXURAL STRENGTH FOR M-40 GRADE CONCRETE

TABLE 5 – SPLIT TENSILE STRENGTH OF SFRC WITH 0% FIBRES M40 GRADE

Split Tensile Strength (MPa)	Average Split Tensile strength (MPa)
2.83 3.11 3.26	3.07

TABLE 6 – SPLIT TENSILE STRENGTH OF SFRC WITH 1%, 2% AND 3% FIBRES

Different aspect ratios of fibres	For SFRC with 1% fibres		For SFRC with 3% fibres		For SFRC with 3% fibres	
	Tensile strength (MPa)					
		Avg.		Avg.		Avg.
50	3.11 3.54 3.26	3.30	3.82 3.82 4.10	3.92	4.39 4.25 4.39	4.34
60	2.97 3.40 3.26	3.21	3.96 3.54 3.54	3.68	4.25 4.10 4.39	4.25
67	2.83 3.26 3.40	3.16	3.54 3.96 3.40	3.63	3.82 4.25 4.53	4.20

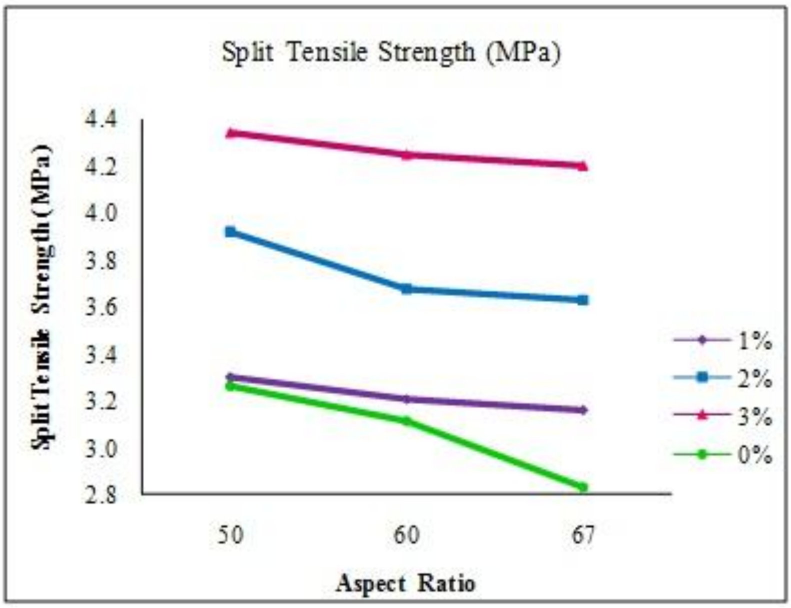

FIGURE 6: PERCENTAGE INCREASE IN 28 DAYS SPLIT TENSILE STRENGTH FOR M-40 GRADE CONCRETE

3. CONCLUSIONS

The following conclusions could be drawn from the present investigation.

1. It is observed that compressive strength, split tensile strength and flexural strength are on higher side for 3% fibres as compared to that produced from 0%, 1% and 2% fibres.
2. All the strength properties are observed to be on higher side for aspect ratio of 50 as compared to those for aspect ratio 60 and 67.
3. It is observed that compressive strength increases from 11 to 24% with addition of steel fibres.
4. It is observed that flexural strength increases from 12 to 49% with addition of steel fibres.
5. It is observed that split tensile strength increases from 3 to 41% with addition of steel fibres.
6.

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