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EFFECT OF STEEL FIBERS ON CONCRETE IN ACIDIC ENVIRONMENT

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Abstract- ***In this study effect of steel fibers on the strength and weight of concrete for M 40 grade will be studied by varying the percentage of fibers in concrete and types of fibers. Loss of Compressive strength & loss of weight will be compared and tabulated. Fibers addition results in more closely spaced cracks reducing the crack width and improved resistance to the cracks. Due to presence of Steel fibers in Ordinary Portland cement Concrete (OPCC) has achieved significant improvement in its mechanical properties. There is a significant increase in Compressive Strength of concrete with addition of Crimped Steel Fiber when compared to Straight and Hooked Steel Fiber. The percentage loss in Compressive Strengths of Straight Steel Fiber (2%), Hooked Steel Fiber (2%) and Crimped Steel Fiber (2%) are 5.98%, 6.1% & 5.86% respectively. Similar trend is followed for loss of weight.***

Index Terms: Crimped Steel Fiber, Straight, Hooked Steel Fiber, loss in Compressive strength, loss in weight.

I. INTRODUCTION

Generally plain concrete shows very low tensile strength, limited ductility and little resistance to cracking, but are we don't have any alternative material for concrete for that forced to use plain concrete due to the exigency. Hence there is an urgent need to reinforce the conventional concrete to cope up with tensile loads and strains suited to our needs. The presence of micro cracks at the mortar-aggregate interface is the inherent weakness of plain concrete. The application of load leads to propagation of cracks and brittle fractures in conventional concrete due to its poor tensile strength. Normally micro cracks appear in concrete during hardening stage. When load is applied, micro cracks start developing along the planes. Further application of load leads to uncontrolled formation of the micro cracks. Concrete mix that contains short, discrete fibers are uniformly distributed and randomly oriented is called fiber reinforced concrete. The fibers used are steel fibers, synthetic fibers, glass fibers and natural fibers. The fibers in members resist the opening of the cracks due to micro cracking and increase the ability of the members to withstand loads.

II. LITERATURE REVIEW

Peter H.Bischoff (2003) studied the post cracking behavior of beam made with both plain and steel fibre - reinforced concrete. He concluded that samples which contain steel fibers shows increased tension stiffening and smaller crack spacing, which leads to a reduction in crack widths. Also it is observed that fatigue loading did not show any significant effect on either tension stiffening (or) crack width control for the specimens tested.

Kaushik S.K., et al. (2003) carried out experimental investigation on the mechanical properties of reinforced concrete by adding 1.0% volume fraction of crimped type flat steel fibers. It was noticed that short fibers act as a crack resisters and enhances the strength, where as long fibers contributed to overall ductility. They concluded that best performance was observed with mixed aspect ratio of fibers

Schnutitgen (1975) has shown that the increase in ultimate tensile strength is not as large as the corresponding increase in flexural strength. Tests on fiber reinforced concrete in uniaxial compression have indicated only marginal increase in compression strength due to the introduction of fibers. However, significant enhancement in the post-cracking ductility of concrete is observed.

III. MATERIALS AND METHODS

3.1 Properties of Materials

3.1.1 Cement

In this project, Zuari Cement of 53 grade Ordinary Portland Cement conforming to IS: 12269–1987 was used for the entire work. The cement was purchased from single source and was used for casting of all specimens. The physical properties are shown in Table 1.

Table 1 Physical Properties of cement

S. No	Property	Test results	Limits as per IS 12269 – 1987
1	Fineness (retained on 90-µm sieve)	5%	<10%
2	Normal Consistency	33%	--
3	Initial setting time of cement	63 min's	30 minutes (minimum)
4	Final setting time of cement	450 min's	600 minutes (maximum)
5	Expansion in Le-chatelier's method	2 mm	10 mm (maximum)
6	Relative density	3.15	3.10 – 3.25

3.1.2 Fine Aggregate

Locally available river sand confirming to IS specifications was used as the fine aggregate in the concrete preparation. The Physical properties are shown in Table.2.

Table 2 Physical Properties of Fine Aggregate

S. No	Test conducted	Results obtained		Permissible Limits as per IS 383 – 1970
1	Relative Density	2.67		2.5 to 3.0
2	Fineness modulus	2.77		--
3	Bulk density	**Loose State**	1450 kg/m^3	1400 to 1750 kg/m^3
		Compacted State	1520 kg/m^3	
4	Water absorption (%)	1.09		Max 3%
5	Sieve Analysis	Zone – II		--

3.1.3 Coarse Aggregate

Crushed granite metal size 20 mm and 10 mm obtained from the local available quarry and confirming to IS specifications were used. The Physical properties of coarse aggregate are shown in Table.3. The coarse aggregate used for concrete mix is a combination of 20 mm and 10 mm size aggregates in ratio 1.5: 1.0.

Table3 Properties of Coarse Aggregate

S. No	Test conducted	Results obtained	Permissible Limits as per IS 383 – 1970
1	Relative Density	2.78	2.5 to 3.0
2	Fineness modulus	7.1	--
4	Water absorption (%)	1.20	Max 3%
5	Sieve Analysis	Zone – II	--

3.1.4 Steel fibers

Table4 Properties of Steel fibers

S. No	Properties	Straight Fiber	Crimped Fiber	Hooked Fiber
1	Length of Fiber	45 mm	36 mm	35 mm
2	Diameter of fiber	0.45 mm	0.45 mm	0.55 mm
3	Aspect ratio of Fiber	100	100	64
5	Density	7850Kg/m^3	7850Kg/m^3	7850Kg/m^3

3.1.5 Water

Water used for casting and curing of concrete test specimens is free from impurities which when present can adversely influence the various properties of concrete.

3.2 Concrete Mix Proportion

In the present experimental investigation, the influence of combined application of various types of steel fibres on M40 grade concrete is studied.

M40 grade of concrete were designed as per the Indian Standard code of practice. The various ingredients for one cubic meter of M40 grade concrete are shown in Table 5.

Table 5 Quantities of Ingredients per cum of M40 Grade Concrete

S. No	Mix Identification	Cement (kg's)	Fine Aggregate		Water (lit)	Steel Fibers (kg's)
			Sand (kg's)	Coarse Aggregate (kg's)		
1	C.C	360	704	1302	164	0
2	1% SF (Straight)	360	704	1302	164	78.50
3	2% SF (Straight)	360	704	1302	164	157
4	3% SF (Straight)	360	704	1302	164	235.5
5	1% SF (Hooked)	360	704	1302	164	78.50
6	2% SF (Hooked)	360	704	1302	164	157
7	3% SF (Hooked)	360	704	1302	164	235.5
8	1% SF (Crimped)	360	704	1302	164	78.50
9	2% SF (Crimped)	360	704	1302	164	157
10	3% SF (Crimped)	360	704	1302	164	235.5

3.3 Test Specimens

Concrete test specimens consist of 15 cm × 15 cm × 15 cm cubes, Concrete cube specimens were tested at 28 days of curing with diluted magnesium sulphate(Acid) to obtain the loss of compressive strength and loss of weight. The rate of loading is as per the Indian Standard code specifications.

IV. RESULTS AND DISCUSSIONS

4.1 Sulphate resistance

From the Fig.1 & 2, The Loss of Weight (%) is minimum for Concrete with 2% Crimped Steel Fibre when compared to other proportions and Control Concrete. It can also be observed that concrete with 2% Crimped Steel Fibre has lesser percentage Loss of Compressive Strength

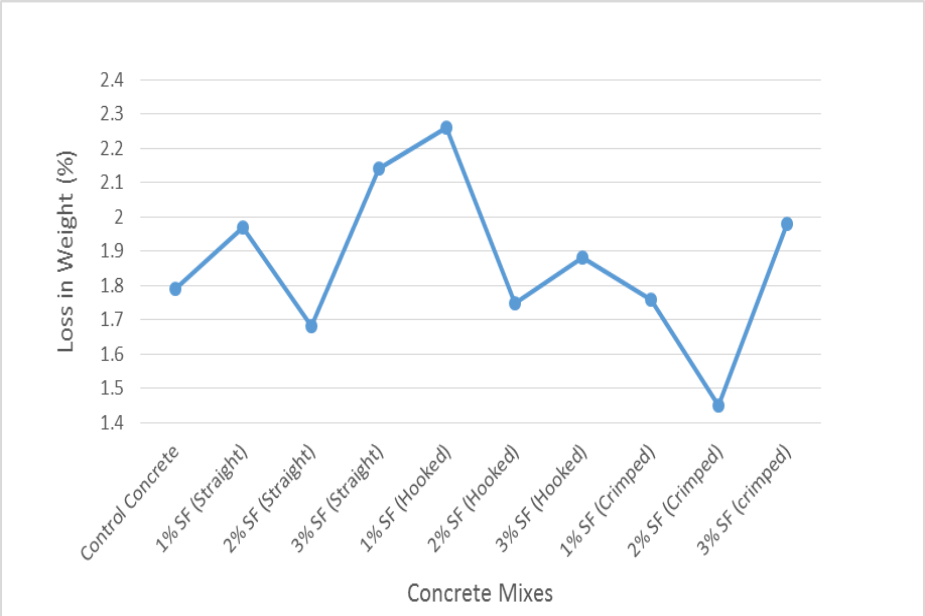

Fig.1 Comparison of Loss of Weight with various percentages of (1%, 2% & 3%) of Straight Steel Fibers, (1%, 2% & 3%) of Hooked Steel Fibers and (1%, 2% & 3%) of Crimped Steel Fibers

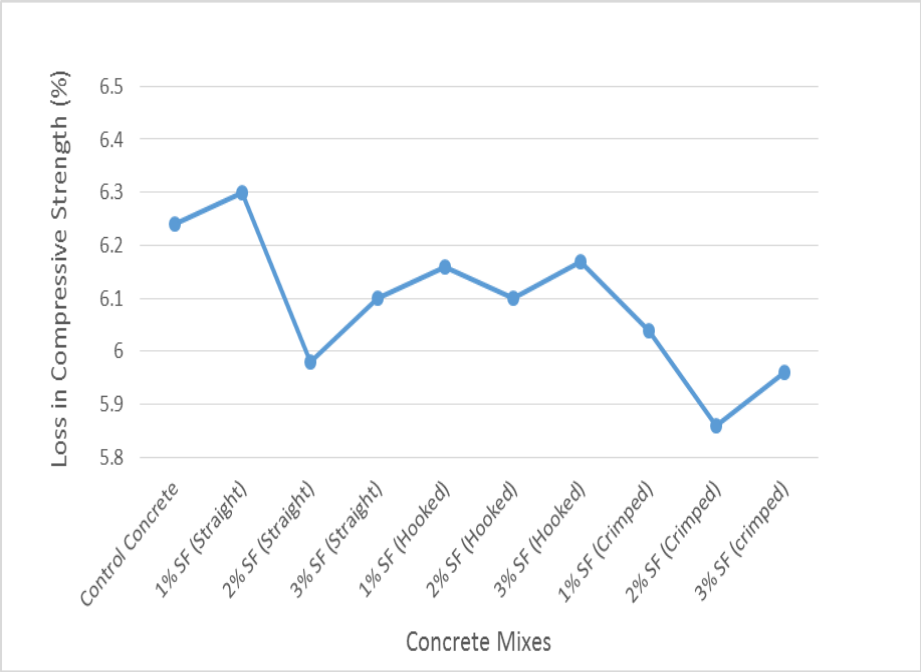

Fig.2 Comparison of Loss of Compressive Strength of Control Concrete with various percentages of (1%, 2% & 3%) of Straight Steel Fibers, (1%, 2% & 3%) of Hooked Steel Fibers and (1%, 2% & 3%) of Crimped Steel Fibers

V. CONCLUSIONS

- The percentage loss in compressive strength of SFRC mixes is decreasing with age of exposure to acid due to the presence of steel fibres.

- The percentage Loss of Weight with the usage of 2% Crimped Steel Fiber is less when compared with other proportions. It can also be observed that concrete with 2% Crimped Steel Fiber has lesser % Loss of Compressive Strength.

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