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FIBER REINFORCED CONCRETE A BETTER MATERIAL FOR CONSTRUCTION

Roy Sasidharan[1], Vipin Chauhan[2], Sandeep Sharma[3]

[1,2,3] *Assistant Prof., Civil Department, IIMT College of Engineering Greater Noida (India)*

Fibre reinforced concrete (FRC) is Portland cement concrete reinforced with more or less randomly distributed fibres. In FRC, thousands of small fibres are dispersed and distributed randomly in the concrete during mixing, and thus improve concrete properties in all directions. FRC is cement- based composite material that has been developed in recent years. It has been successfully used in construction with its excellent flexural-tensile strength, resistance to spitting, impact resistance and excellent permeability and frost resistance. It is an effective way to increase toughness, shock resistance and resistance to plastic shrinkage cracking of the mortar. Fibre is a small piece of reinforcing material possessing certain characteristics properties. They can be circular, triangular or flat in cross-section. The fibre is often described by a convenient parameter called ―aspect ratio‖. The aspect ratio of the fibre is the ratio of its length to its diameter. The principle reason for incorporating fibres into a cement matrix is to increase the toughness and tensile strength and improve the cracking deformation characteristics of the resultant composite. For FRC to be a viable construction material, it must be able to compete economically with existing reinforcing system.

FRC composite properties, such as crack resistance, reinforcement and increase in toughness are dependent on the mechanical properties of the fibre, bonding properties of the fibre and matrix, as well as the quantity and distribution within the matrix of the fibres. Effects of Steel Fibres in Concrete: Fibres are usually used in concrete to control cracking due to both plastic shrinkage and drying shrinkage. They also reduce the permeability of concrete and thus reduce bleeding of water. Some types of fibres produced greater impact, abrasion and shatter resistance in concrete. Generally fibres do not increase the flexural strength of concrete and so cannot replace moment resisting or structural steel reinforcement. Indeed, some fibres actually reduce the strength of concrete. The amount of fibres added to the concrete mix is expressed as a percentage of total volume of the composite (concrete and fibres), termed volume fraction. Volume fraction typically ranges from 0.1 to 3%. Aspect ratio is calculated by dividing fibre length by its diameter. If the modulus of elasticity of the fibre is higher than the concrete or mortar binder), they help to carry the load by increasing the tensile strength of the material. Increase in the aspect ratio of the fibre usually segments the flexural strength and the toughness of the matrix. Some recent research indicated that using fibres in concrete has limited effect on the impact resistance of the materials.

I. LITERATURE REVIEW

Many Researchers have studied on the effect of replacement of ordinary cement by Steel fibre reinforced concrete so that the mechanical and durability properties of the concrete can be increased.

Henagar (1974) was the first to publish a paper on testing of steel fibre reinforced concrete beam-column joints [7]. Two full-scale joints were constructed. One joint was built according to ACI 318-71. The other was a joint with reduced steel congestion common in seismic resistant joints by replacing hoops with steel fibre concrete. Brass plated steel fibres with a length of 1.5-in (38-mm) and an aspect ratio of 75 were added to the concrete mix at a volume fraction of 1.67%. An earthquake loading was simulated using a quasi-static loading rate utilizing an applied double acting hydraulic Actuator. It was found that the steel fibre reinforced concrete joint had a higher ultimate moment capacity, had better ductility, was stiffer, and was more damage tolerant. Henagar concluded that hoops, in the joint, could be replaced with steel fibres. Henagar also concluded that SFRC could provide for a more cost effective joint

Shah S.P., ET al. (1986) has found the impact resistance of steel fibre reinforced concrete using modified charpy impact testing machine. The size of the specimens was 76mm x 25mm x 230mm and compressive strength was found using 76mm x 152mm cylinders. They used brass-coated steel fibres at different volume fractions of 0.5%, 1% and 1.5% were used. They observed that the impact resistance improved with fibre additions.

Soubra, Wight, and Naaman (1991) published results of testing fibre reinforced concrete for pre-cast construction [12]. Six specimens with 2 precast beam sections and one cast in place fibre joint were tested. By using fibre concrete in the cast-in-place joint, the researchers aimed to develop a

Seismic joint that is strong and ductile. Usage of pre-cast concrete beams and columns is rare in seismic areas because of its poor earthquake performance history and a lack of design recommendations for connections. Hooked steel fibres with a length of 1.2-in (30-mm) were used at volume fractions of 4%and 2.1%. Hooked steel fibres with a length of 2-in (50-mm) were also used at a volume fraction of 1%. No fibre diameter or aspect ratio was mentioned.

II. OBJECTIVE

Fibre reinforcement of concrete is one of the most effective ways for improving its resistance to impact, blast, explosion and other forms of short duration dynamic loads. While the toughening mechanism is well understood in this composite under statically applied loads, unfortunately in the case of impact and other dynamic loads, our understanding is far from adequate and continued research is clearly needed. The main cause of this is lack of a standardized test technique for conducting impact tests on fibre reinforced concrete (FRC). A wide range of impact loading tests that are mostly complicated and expensive have been used in practice. However, the results arising from them are not comparable because the test methods, specimen sizes and support conditions used in these tests are arbitrary. So the main objective of this report is to study about the impact effect of Steel Fibre Reinforce Concrete done by researchers in the past years and the development that came into the field of Fibre Reinforced Concrete.

III. IMPACT EFFECT OF STEEL FIBRE REINFORCED CONCRETE

Concrete structures are often subjected to long term static and short term dynamic loads. Due to a relatively low tensile strength and energy dissipating characteristics, the impact resistance of concrete is poor. Research work carried out so far towards the development of concrete that exhibits improved impact resistance than conventional concrete showed that the steel fibre reinforced concrete has a good potential as a viable structural material for such applications. The overall objective is to study the impact effect of steel fibre reinforced concrete. Currently there are many tests available in order to study about the impact effect of sfrc.

IV. IMPACT EFFECTS

According to S. Elavenil and G.M. Samuel Knight in their study of sfrc on the topic IMPACT RESPONSE OF SFRC PLATES UNDER DROP WEIGHT IMPACT TESTING. They conducted the experiment using drop weight test for different thickness of specimen -20, 25, 30 mm. the amount of steel fibers used for the test also varied from .5 to 1 %. They studied about the characteristic of sfrc during impact loading by recording the values obtained during the experiment. They recorded the values of displacement, velocity and acceleration attained by the specimen during the experiment. Along with they noted the effect of strength, aspect ratio and distribution of fibers. The results shows that there is a decrease in crack width for increase in steel fibre contents and the rate of decrease of crack width is higher for the aspect ratio of fibres 75 and 100. There is a 50% increase in the number of blows to failure when the steel fibre content is increased from 0.75% to 1%. Randomly distributed steel fibres in concrete offered resistance to development and propagation of cracks in the post cracking regime of concrete.

Table 1- Energy Absorbed at first crack and at failure

Sl.No .	Aspect ratio of fibre (l/d)	Fibre Content (%)	Energy First Crack (Nmm x 10^3)	Energy at Failure (Nmm x 10^3)
1	50	0.5	50	440
2		0.75	55	450
3		1.00	65	580
4	75	0.5	66	460
5		0.75	69	660
6		1.00	70	860
7	100	0.5	104	775
8		0.75	155	875
9		1.00	200	900

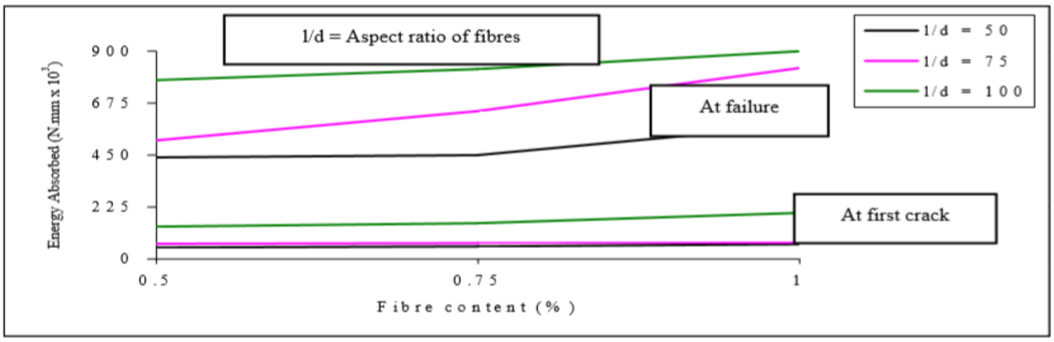

Figure 1- Energy absorbed versus Fibre Content

V. TENSILE STRENGTH

When looking into the tensile strength of sfrc, there is much difference when compared with ordinary concrete.

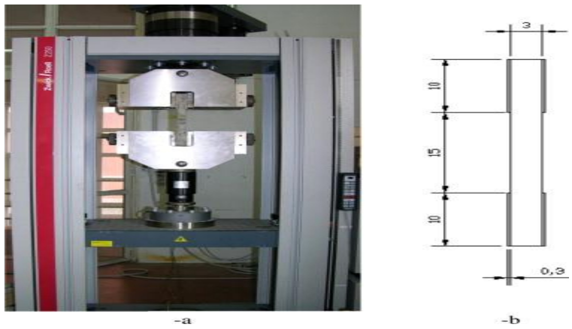

Figure 2 Direct tensile test. (a) Experimental equipment. (b) Specimen geometry.

Tensile strength measures the force required to pull something such as rope, wire, or a structural beam to the point where it breaks. The tensile strength of a material is the maximum amount of tensile stress that it can take before failure. R.S. Olivito and F.A .Zuccarello from Italy came up with the study of sfrc on the basis of tensile strength. This paper was concentrated on the mechanical static behavior of sfrc. The methods they followed in order to reach their goal were uniaxial compressive test, direct tensile test, and four point bending test. The results obtained during this experiment shown a drastic change in the strength of sfrc when the amount of fibres increased.

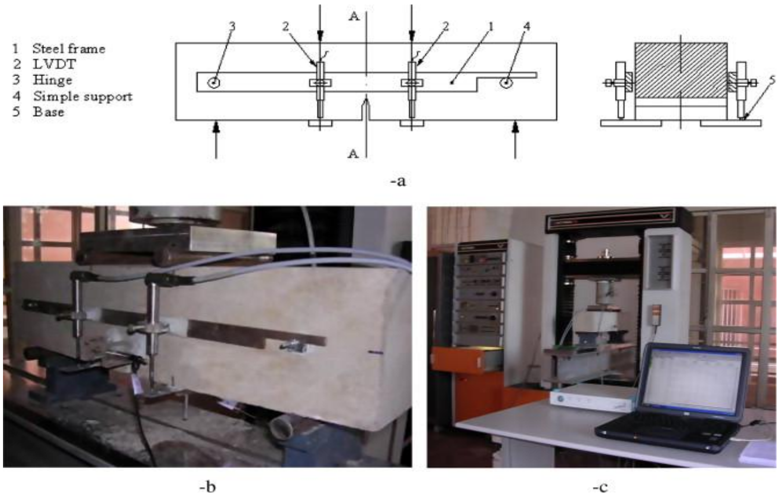

Figure 3- Four-point-bending test. (a) Transducers position scheme. (b) Specimen. (c) Experimental equipment.

Fibres are generally used as resistance of cracking and strengthening of concrete. In a project work of AmitRana, he carried out test on steel fibre reinforced concrete to check the influence of fibres on flexural strength of concrete. According to various research papers, it has been found that steel fibres give the maximum strength in comparison to glass and polypropylene fibres. Hence, in this project it was interested in finding out the optimum quantity of steel fibres required to achieve the maximum flexural strength for M25 grade concrete. It was found that with increase in steel fibre content in concrete there was a tremendous increase in Flexural strength. Even at 1 % steel fibre content flexural strength of 6.46 N/mm2 was observed and against flexural strength 5.36 N/mm2 at 0%.

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Table 2- Test results for flexural strength

Sr No (1)	%of SF (2)	Slump in mm (3)	Load in KN(4) No		AL in KN (5)	ASBD in mm (6)	FS in N/mm^2 (7)
1	0.00	30	1	29.86	30.10	248.33	5.36
			2	30.86			
			3	29.57			
2	0.75	25	1	35.55	36.03	240.00	6.46
			2	37.25			
			3	34.14			
3	1.00	25	1	32.90	33.08	258.33	5.96
			2	32.20			
			3	34.14			
4	1.25	25	1	31.29	30.26	263.00	5.45
			2	30.43			
			3	29.06			
5	1.50	25	1	35.25	37.44	271.66	6.74
			2	38.21			
			3	38.80			
6	2.00	25	1	37.51	37.10	266.67	6.68
			2	38.46			
			3	35.35			
7	2.50	25	1	35.37	37.94	278.33	6.83
			2	40.67			
			3	37.78			
8	3.00	25	1	38.06	42.82	266.67	7.62
			2	42.56			
			3	47.85			
9	4.00	25	1	44.13	48.35	250.00	8.60
			2	53.15			
			3	47.78			
10	5.00	25	1	55.34	55.14	253.33	9.82
			2	59.13			
			3	50.95			
11	6.00	25	1	73.86	71.94	263.33	12.81
			2	74.68			
			3	67.30			

VI. USE OF SFRC IN JOINTS

In a building structure joints are the most vulnerable portions during an impact loading. So using of sfrc helps in regaining its strength when compared with the normal concrete structures. Dr Sana UllahBalouch and Dr. John Paul Forth had a research on the topic STRENGTHENING OF BEAM-COLUMN JOINT WITH STEEL FIBRE REINFORCED CONCRETE DURING EARTHQUAKE LOADING. They found out the deflection produced by the joints during each cycle and plotted them on a hysteresis loop.

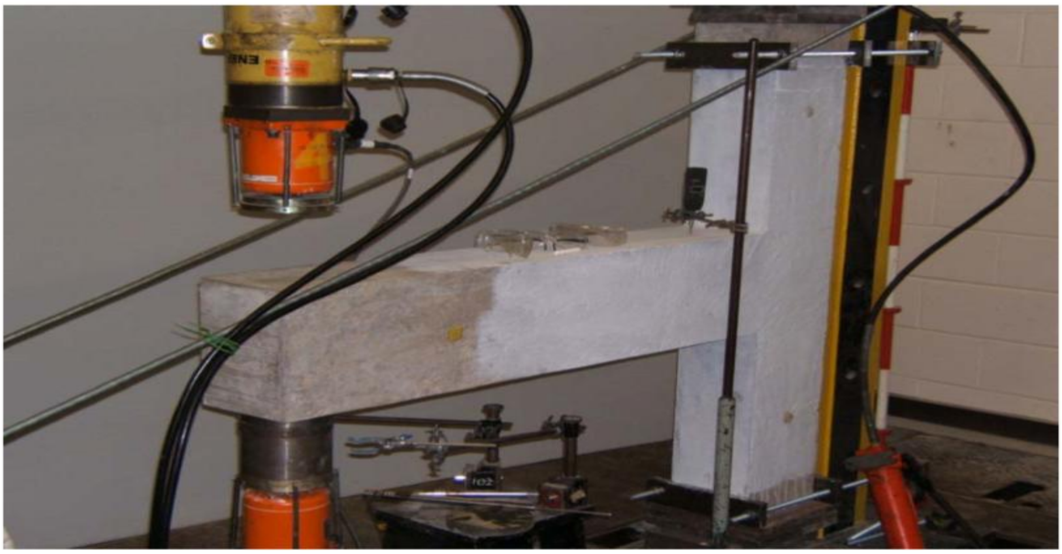

Figure9- Beam- Column joint before loading

This study showed that SFRC joints have superior performance over the seismic resistance than the plain concrete joint. This is seen by the hysteresis loops, hysteresis envelope curve and by observations made during of the testing.

These exterior SFRC joints would prevent structural collapse of a building unlike the plain concrete joint. The SFRC specimen best resisted joint cracking. When looking into the minor cracking of the joint, it began during the 1st cycle. The joint cracks became more extensive during the 3rd cycle and increased in density during the 4th cycle. A crack across the top of the joint opened during the 5th cycle and continued to open up during the 6th cycle.

Figure 11- Beam Column joints during 6th cycle (without fibres)

Specimens with SFRC took more loads that plain reinforced concrete (RC). By the fifth cycle, the conventional joints exhibited a fraction of the maximum load reached by the SFRC joints. The researchers concluded that the Beam-Column joint fibres will be able to resist the structure from collapse in earthquake hit zones.

Figure 12- beam column joints with SFRC in 6th cycle

VII. CONCLUSION

The results from this study revealed the following conclusion:

- The structures with fibres has high strength than ordinary concrete structures
- The structures with sfrc can take high peak loads
- The cracking of structures due to high impact load can be checked using fibres in concrete.
- There is no significant change in strength of the sfrc when the percentages of fibres are from .1 to 1% after the 1-2% the strength is obtained
- There is not much research regarding the applications of sfrc in joints and alternative to confining reinforcement
- The accurate results are not obtained since the scales of the original specimens are altered.

Altogether From the conclusions above we can say that structures with fibres will perform better in earthquake hit zones and even this will perform well during the real earthquake. Due to its Ductile behavior it will avoid the random collapse of the structure and this joint will be able to absorb aftershocks of earthquake.

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