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SHEAR AND FLEXURAL BEHAVIOUR OF FIBER REINFORCED CONCRETE T-BEAMS

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Abstract-*The use of steel fibers as shear reinforcement in reinforced concrete beams helps in enhancing the first crack tensile strength and ultimate tensile strength resulting in increase in shear strength and possible prevention of shear failure.The ultimate tensile strength is increased because additional energy is needed to pull or strip. The Fiber out of concrete, if the fibers were not broken off during initial cracking steel fibers have some advantages over vertical stirrups or bent up flexural reinforcement in resisting the shear force. Conventional stirrups reinforcement requires a high labor input for bending fixing in position. In thin web, placement of stirrups becomes completely impractical this is particularly true of prestressed concrete beams.*

Key words: *Steel Fiber, SFRC Beams, Flexure, Ductility, Cracking*

I.INTRODUCTION

Reinforced concrete floors, roofs, bridge decks consist of beams and slabs which are almost always cast monolithically. Forms are erected for beams and slabs together and concrete is poured in one operation. Stirrups and bent up bars also extended into the slab. This results in an integral connection between the slab and the beam and due to which certain portion of the slab acts together with the beam in resisting longitudinal compression in sagging (positive bending) moments regions (mid span regions) of the beams. The total resulting section is a flanged section in the span region. The slab thus performs two functions. It transfers the load to beams by spanning across the beams and also consists A the beam in transferring the load longitudinally the two actions are slab action and the beam action. Causing normal stresses in slab at right angle to each other when the slab/ and hence the flange occurs on both the sides of the beam as in the case of intermediate beam. The section looks like T-Section and the beam is known as T-beam.
A total of six beams of identical nominal dimensions bf = 250, b_w = 100, Df = 50mms were casted and tested with two concentrated loads placed in shear span of the beams. Under flexural load up to complete collapse the steel fiber reinforced concrete (SFRC) beams consists of 2-8mm 0 steel bars in tension zone. In this investigation span/depth ratio, aspect ratio of fibers (80) and volume percentage variation are 0 , 0.5% and 1.25%

II.LITERATURE REVIEW

1. (ROMULDI & BATSON) The idea that concrete can be strengthened by the inclusion of fibers was first put forward by PORTER in 1910; but little progress was made in the development of this material till 1972. When ROMULDI & BATSON has published their classical paper on this subject, they concluded that the replacement of vertical stirrups by round, flat or crimped steel fibers provided effective reinforcement against shear failure.

2. (SHARMA) in 1986 shows that steel fiber can be effectively used for increasing the shear strength of concrete.

3. (NARAYANAN and KAREEM) in 1986 studied the combined behavior of beam containing steel fiber. They concluded that fiber addition improved the flexural strength of beams both at cracking and ultimate stage.

4.(MURTHY and VENKATACHARYULU) In 1987 carried out investigation to obtain a comprehensive experimental and analytical evaluation of steel fiber as shear reinforcement.

III. MATERIALS USED AND THEIR PROPERTIES

A. Cement
Ordinary Portland cement (OPC) of 43 grade satisfying the requirements of IS: 8112-1939 is used.
The specific gravity of cement was found to be 3.15

B. Fine Aggregate:
Sand is the main component grading zone-II of IS: 383-1978 was used with specific gravity of 2.65

C. Coarse Aggregate:
Mechanically crushed stone of 20mm maximum size, satisfying to IS: 383-1978 was used. The specific gravity was found to be 2.70

D. **STEEL FIBRES:** 12mm and 8mm dia. Fe415, and 6mm dia. Fe250. The mix proportion adopted for the test beams is

Cement	Sand	Coarse Aggregate	Water Cement Ratio	Aspect Ratio
1	1.55	2.54	0.5	80

IV.EXPERIMENTAL PROGRAMM

SHEAR ANALYSIS
A.Pre Cracking Shear Resistance of RC Beam

f = MY/I and v = VAY/Ib

Principle Tension $f_1 = 0.5\,(f + \sqrt{f^2 + 4v^2})$

Principle Compression $f_2 = 0.5\,(f - \sqrt{f^2 + 4v^2})$

The inclination is given by: Tan 2θ = 2v/f

B. Post Cracking Shear Resistance of RC Beam
(Classical Approach):
Shear stress is calculated using the formula.
v = V/bd.

C. Post Cracking Shear Resistance of RC Beam
(Mechanical Approach)
V = VC + Vd + Va + VS
Vd and Va can be neglected.
VC=0.85 and for vertical stirrups
VS = 0.87 fy AV/Sb

D. Post Cracking Shear Resistance of SFRC Beam
(Mechanism Approach)
The shearing force V may be equated to:
V = Va + VC + Vd + Vf
Analysis for Ultimate Shear Strength
The ultimate shear stress is the sum of the contribution to shear by the stirrups (V_S) and fiber (V_{cf}).

$$V_u = V_{cf} + V_S$$
$$V_{cf} = Kf'_t\,(d/a)^{0.25}$$
$$V_S = A_S f_y d/s$$

V.RESULTS AND DISCUSSIONS

Table 1:Average Compressive Strength of Beams

Designation of Beams	% of Vol. of Fiber	Av. Crushing Load	Av. Compressive Strength	Grade of Concrete
B0	0%	49.6 N	22 N/mm2	M20
B1	0.5%	56 N	24.7 N/mm2	M20
B2	1.25%	65.3 N	28.9 N/mm2	M20

TABLE 2 : PROPAGATION OF CRACKS, THEIR WIDTH AND DISTANCE FROM CENTRE

Beam No.	Crack No.	Width	Distance from Centre	Height from Bot	Remarks
Beam 1 0%	1	10mm	550mm to R	186	Shear
	2	3mm	205mm to L	182	Shear
	3	2.5mm	452mm to R	152	Shear
	4	2.5mm	262mm to R	156	Shear
	5	2.6mm	457mm to L	86	Shear
	6	2.1mm	255mm to L	180	Flexure
Beam 2 0%	1	18mm	502mm to R	184	Shear
	2	12mm	457mm to R	86	Shear
	3	3mm	357mm to R	92	Shear
	4	2.5mm	554mm to L	182	Shear
	5	2mm	567mm to L	172	Shear
	6	2mm	672mm to R	181	Shear
	7	2.1mm	236mm to L	66	Flexure
Beam 1 0.5 %	1	12mm	562mm to R	189	Shear
	2	2mm	584mm to R	66	Shear
	3	2mm	288mm to L	181	Flexure
	4	1.6mm	189mm to L	92	Flexure
	5	1.72mm	583mm to R	52	Shear
Beam 2 0.5 %	1	12.5mm	84mm to C	184	Flexure
	2	13mm	87mm to C	67	Flexure
	3	2.2mm	510mm to L	98	Shear
	4	2mm	515mm to R	102	Shear
Beam 1 1.25 %	1	10mm	172mm to R	58	Flexure
	2	8mm	186mm to R	52	Flexure
	3	5mm	165mm to L	167	Flexure
	4	3mm	192mm to L	152	Flexure
	5	2mm	66mm to R	560	Shear
	6	2mm	66mm to L	869	Shear
Beam 2 1.25 %	1	8mm	182mm to L	152	Flexure
	2	6mm	192mm to L	147	Flexure
	3	5mm	202mm to L	132	Flexure
	4	3mm	89mm to R	142	Flexure
	5	2mm	101mm to C	22	Flexure
	6	1.86mm	66mm to R	562	Shear

TABLE 3 : BEAM TEST RESULTS

Sl. No.	Design of Beam	Fiber Volume	Observed Load at First Crack	Observed Load at Failure	Shear at Ultimate	
					Test	Theory
1.	B_0	0%	50 KN	70 KN	35 KN	32.6 KN
2.	B_0	0%	55 KN	75 KN	37.5 KN	32.6 KN
3.	B_1	0.5%	85 KN	106 KN	53 KN	37.4 KN
4.	B_1	0.5%	86 KN	107 KN	53.5 KN	37.4 KN
5.	B_2	1.25%	95 KN	115 KN	57.5 KN	38.0 KN
6.	B_2	1.25%	97 KN	124 KN	61 KN	38.0 KN

TABLE 4 : LOAD AND DEFECTION

Load	**B_0 0%**		**B_1 0.5%**		**B_3 1.25%**	
	S^*_C	**S^*_L**	**S_C**	**S_L**	**S_C**	**S_L**
0.2	0.45	0.4	0	0	0	0
0.4	0.55	0.6	0.30	0.25	0	0
0.6	0.68	0.75	0.32	0.3	0	0
0.8	0.87	0.90	0.38	0.32	0.2	0.25
1.0	1.05	1.5	0.55	0.45	0.4	0.3
1.2	1.25	1.55	0.75	0.65	0.6	0.35
1.4	1.40	1.60	1.20	0.85	0.85	0.42
1.6	1.60	1.65	1.27	1.25	1.25	0.55
1.8	1.75	1.70	1.65	1.45	1.30	0.62
2.0	2.00	1.80	1.7	1.6	1.4	0.75
2.2	2.18	2.0	1.78	1.70	1.55	0.8
2.4	2.35	2.10	1.85	1.85	1.60	1.0
2.6	2.45	2.4	2.0	1.40	1.75	1.1
2.2	2.6	2.7	2.15	2.4	1.80	1.25
3.0	2.8	2.8	2.35	2.80	1.90	1.35
3.2	3.4	3.25	2.47	2.70	2.20	1.4
3.4	3.64	3.40	2.82	2.95	2.4	1.54
3.6	3.80	3.65	3.40	3.0	2.65	1.65
3.8	3.92	3.7	3.42	3.1		1.7
4.0	4.0	3.8	3.5	3.2	2.8	1.6

First Crack Load = 55KN
Ultimate Load = 75KN

First Crack Load = 85KN
Ultimate Load = 107 KN

First Crack Load = 95KN
Ultimate Load = 124 KN

S_C = Deflection at Centre
S_L = Deflection at Load Point

TABLE 5 : STRAIN READING (S (10^{-4}) AT LOAD 60 KN

Compression (+Ve) Tensile (-Ve)

Depth of Beam (mm)	**B_0**		**B_1**		**B_2**	
	LOAD	**CENTRE**	**LOAD**	**CENTRE**	**LOAD**	**CENTRE**
12.5	+ 1.86	+ 1.89	+ 1.83	+ 1.84	+ 1.58	+ 1.63
0.0	+ 0.76	+ 0.83	- 0.72	+ 0.81	- 0.63	- 0.69
12.5	- 2.07	- 2.11	- 2.01	- 1.98	- 1.67	- 1.74

VI.CONCLUSIONS

1.It is observed that the non fibrous reinforced concrete beam have shown sudden failure in shear

2. As the percentage of fibrous are increased it is observed that the crack widths are reduced significantly.This is due to more uniform distribution of stresses in SFRC beams compared with CV R.C. beams.

3.It is reported that the addition of 1.25% of fibers by volume (aspect ratio of 80) increases the ultimate nominal shear strength by 74% as compared to non-fibrous beam.

4.It was noted that at ultimate cracking load the strain in the extreme fiber in compression zone is decreased with increase in the concrete section (flange, and with the increase of volume of fibers) As the percentage of fibers increased the deflections are decreased significantly.

5.The test results have indicated that with an optimum percentage of fiber 1.25% by volume of concrete has shown increase in the shear carrying capacity of the flanged (T-Section) as 60 to 70% as compared with conventional RC Beam.

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