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EFFECT OF STEEL FIBRE IN THE MECHANICAL PROPERTIES OF CONCRETE

M.RAMYA[1]
PG Student,
Dhirajlal Gandhi College of Technology,
Salem

R.SUGANYA[2]
Assistant Professor,
Dhirajlal Gandhi College of Technology,
Salem

ABSTRACT

Concrete is a brittle material which has a low strength and limited ductility. These weak points of concrete can be resolved by including fibers made of different materials with high technical specifications. This special type of concrete is known as Steel Fiber Reinforced Concrete (SFRC) which exhibits superior properties in terms of ductility, fracture energy, toughness, strength and durability due to the addition of steel fibers when compared to conventional concrete. SFRC has a varied application area. In practice, steel fibers which have different lengths, diameters, and aspect ratios are used. These variable characteristics of steel fibers have highly influence on the performance of SFRC.The paper presents results of an experimental investigation carried out to study the properties of reinforced cement concrete and steel fibre reinforced concrete (SFRC) containing mixed fibres of different aspect ratio. An experimental programme was planned in which workability tests were conducted to investigate the properties of the fresh concrete mixes. Meanwhile, the properties of the hardened concrete were investigated using compressive tests, split tensile tests and flexural strength tests. And effect of fibres when it is distributed in hinged zone of structural element was also examined to achieve economy by reducing steel fibre content in concrete mix. The results indicate that the Mixed steel fibre reinforced concrete (at volume fraction of 1.5%, consisting of 75% macro fibres and 25% micro fibres) can be adjusted as the most appropriate combination to be employed in SFRC for compressive strength, split tensile strength and flexural strength. However, better workability was obtained as the percentage of shorter fibres increased in the concrete mix. And there is little amount of variation in properties of concrete between fibres in full length of the beam and fibres in hinged zone of the beam.

Keywods: Ductility,steel fiber, Steel Fiber Reinforced Concrete,aspect ratio

1 INTODUCTION

Mostly, all the structures are made of concrete which around us, but now also there is some problem to use concrete as a building material. Generally, the Concrete structures having very low tensile strength and limited ductility, because of that using steel reinforcement is a necessary one to bridge the cracks and increase the tensile capacity of concrete. The self weight of concrete structure is greater than the steel structures with the same load carrying capacity which requires large support, the transportation and handling cost will be increased. To overcome the disadvantage of concrete, the Steel fibre reinforced concrete (SFRC) can be used. Steel fibre reinforced concretes are designed in such a way that, which may satisfy all the demands during production, construction and service life of structure. The combination of both macro and micro steel fibres in a concrete mix offer more attractive engineering properties rather than single type of fibres**.** The characteristic of fibre reinforced concrete are changed by the alteration of quantities of concrete, fibre substances, geometric configuration, dispersal, direction and concentration. It is a special type of concrete in which cement based matrix is reinforced with ordered or random distribution of fibre. The addition of fibres to the conventional concrete is varying from 1% to 2% by volume depending on geometry of fibres and type of application.

1.1 Need for the present investigation

In the design of structures subjected to severe loading condition, better ductility and high strength are the important factors.Generally the concrete structures are brittle in nature with limited ductility and the micro cracks are developed in conventional reinforced concrete.Hence to increase the life of structures under the effect of severe loading condition , steel fibres are used, which enhances the ductility of concrete structures and to avoid the propagation of micro cracks in RCC, fibres are added as secondary reinforcement which improves the mechanical properties of concrete. So that study on the flexural behaviour of beams with steel fibres is to be needed. The influence of both macro and micro fibres in conventional RCC and effect of mixed fibres in hinged zone of the structural element will be studied in this project. The beams with or without fibres are to be tested under two point loadingbased on IS: 516 - 1959 to study the behavior of FRC beams in the ultimate region.

2 REVIEW OF LITERATURE

2.1 Steel Fibre Reinforced Concrete

Tantaryet al. (2011) have investigated that Steel fibre based concrete in compression. Complete compression behavior of fibre based concrete, including strength, toughness and failure modes, have been studied. Specimens were tested in displacement controlled, closed loop type, servo based hydraulic testing machine of 250 ton capacity. Addition of fibre causes reduction in workability and results in the formation of fibre balls in the mix when used in excess quantity (more than 2 %). A decrease in compressive and flexural strength was noticed at higher volume fraction of fibres, 2 % or more. Addition of fibres to concrete increased the toughness considerably.

MukeshShukla (2011) havepresented that behavior of reinforced concrete beams with steel fibres under flexural loading. Tests on conventionally RC beam specimens, containing steel fibres in different proportions, have been conducted to establish load–deflection curves. The various parameters, such as, first crack load, service load, ultimate load and stiffness characteristics of beams with and without steel fibres have been carried out and a quantitative comparison was made on significant stages of loading. The ultimate loads obtained in the experimental investigation were also compared with the theoretical loads for all types of beams. SFRC beams show better stiffness characteristics than RC beams. Fibres increase the ultimate load and first crack load.

Hamid PesaranBehbahani et al. (2012) have summarized that flexural behavior of steel fibre added RC beams with C30 and C50 classes of concrete. Different percentage of hooked-end SFs (i.e. 0%, 0.5%, 1%, 1.5%, and 2%) with the dimensions of 0.75 mm in dia and 50 mm in length are added in RC beams with two different classes of concrete have been tested. From the results of four point loading test on the SFARC beam addition of 1.0% by volume of SFs in the RC beams increases both the flexural first cracking strength and flexural toughness of the SFARC beams and leads to an appreciable increase in their ductility and stiffness and addition of SFs has more effects on the RC beams made from the concrete with higher compressive strength (C50) compared to the concrete with lower compressive strength (C30) due to better bonding between the fibres and concrete paste.

Shende et al. (2012) have examined comparative study on steel fibre reinforced cum control concrete under flexural. Different percentage of fibre 1%, 2% and 3% by volume for M- 40 grade of concrete with aspect ratio 50, 60 and 67 used. The beam is tested for flexural strength and a relationship between aspect ratio vs. flexural strength represented graphically. Flexural strength increases from 10 to 39% through addition of steel fibres. During the test it was visually observed that the SFRC specimen has greater crack control as demonstrated by reduction in crack widths and crack spacing. And steel fibre deflection of beam is very less as compare to control beam. It reveals improved ductility of SFRC due to the addition of steel fibres over control concrete.

Alberto Meda et al. (2012) have reported that flexural behavior of RC beams in fibre reinforced concrete. Number of experimental results on full-scale FRC beams tested under flexure. FRC can modify the collapse mode of beams moving the failure from concrete crushing to steel rupture. The enhancement in the bearing capacity under flexure due to the addition of fibres strongly depends on the ratio between FRC toughness and the reinforcement ratio. Overall ductility is strongly influenced by fibres. In all cases the addition of fibres determines a stiffer and in general enhanced post cracking behavior in service condition.

2.2 Summary of Literature Review

From the review of literature presented above, the points are summarized as follows,

i. Modulus of Elasticity increases by addition of steel fibre.
ii. Due to increase in fibre content, Ultimate resistance is increased, crack width and crack spacing is reduced, split tensile strength and energy absorption capacity are considerably enhanced with the addition of steel fibres.
iii. The brittle mode of failure is changed into more ductile one by the addition of steel fibres.

iv. Deflection of SFRC beam is very less as compared to control concrete beam for same applying load.

v. Addition of fibres to concrete increased the toughness considerably. 1.5% by volume of Steel fibres could be applied in the RC beams to get better flexural behaviour and it was recognized as the best fibre volume for both economical and strength aspects. The combination of two different fibres such as micro and macro fibres which also known as hybrid fibre in a concrete mix offer more attractive engineering properties rather than single fibre.

Fig. 1 Flat crimped macro steel fibres

Table 1 Specification of flat crimped macro fibres

Parameters	**Specifications**
Length of fibre	38mm
Aspect ratio	76
Diameter (d)	0.5mm
Width (w)	2 mm – 2.5 mm
Tensile Strength	400 MPa to 600 MPa
Appearance and Form	Clear, bright and undulated along the length
ASTM Specification	ASTM A820 M04 Type 1
Material Type	Low Carbon Drawn Flat Wire

Fig.2 Round crimped micro steel fibres

Table 2 Specification of round crimped micro fibres

Parameters	**Specifications**
Length of the fibre	15mm
Aspect ratio	50
Diameter	0.3mm
Tensile strength	750 MPa to 1100 MPa
Appearance and form	Clear, bright and undulated along the length
ASTM specification	ASTM A820 M04 Type I
Material type	Low Carbon Drawn Wire

Table 3 Materials required for one cubic meter of concrete

Cement (kg)	**Fine Aggregate**	**Coarse Aggregate (kg)**	**Water (kg)**	**Steel fibres (kg)**
438	631	1087	219	115

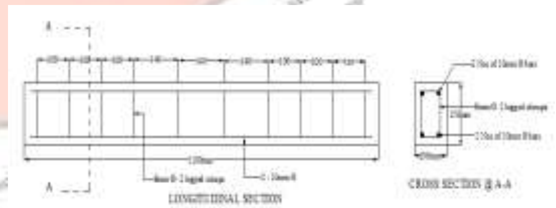

Fig.3 Reinforcement details

3 EXPERIMENTAL PROGRAMME

Table 4 Specimen identification for all the beam specimens

Specimen Identification	Proportions by weight in %		Distribution Zone
	Micro Fibres	Macro Fibres	
C	0	0	-
S1	100	0	Full length of the beam
S2	75	25	Full length of the beam
S3	50	50	Full length of the beam
S4	25	75	Full length of the beam
S5	0	100	Full length of the beam
SH	25	75	Hinged zone of the beam

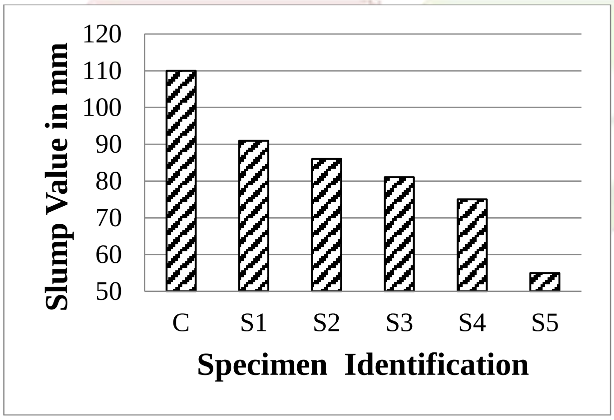

Fig.4 Results for workability test

Table 6 Compressive strength results of plain concrete and SFRC

Specimen Identification	Fibre mix proportions by weight		Compressive strength (N/mm^2)
	Micro fibres	Macro fibres	
C	0	0	31
S1	100	0	36.58
S2	75	25	37.51
S3	50	50	35.96
S4	25	75	35.03
S5	0	100	34.42

Table 7 Split tensile strength results of plain concrete and SFRC

Specimen Identification	Fibre mix proportions by weight		Split Tensile strength
	Micro fibres	Macro fibres	
C	0	0	2.3
S1	100	0	2.898
S2	75	25	3.036
S3	50	50	3.128
S4	25	75	3.335
S5	0	100	3.22

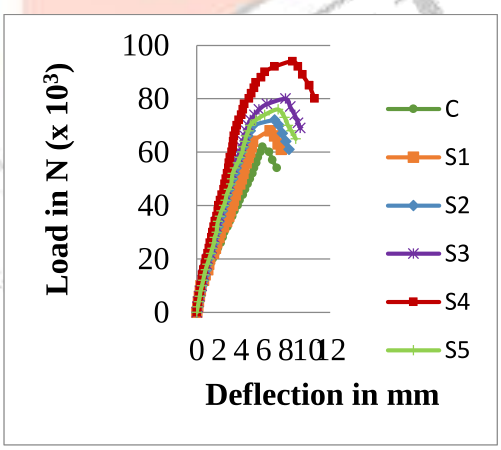

Fig.7 Load deflection behaviour for all the beams

Table 8 Experiment test results for all the beams

Specimen Identification	First crack load kN	Ultimate load kN	Ductility factor	Energy absorption Capacity Nmm ($x 10^3$)	Stiffness N/mm($x 10^3$)
C	11	62	1.55	290.14	8.33
S1	12	68	1.86	334.58	9.3
S2	13	72	1.75	424.69	10.8
S3	15	80	2.22	536.73	11.42
S4	16	94	2.38	740.32	13.79
S5	14	76	2.14	459.88	9.52

Fig.8 Failure pattern for all the beams

Fig.9 Fibres in full length of the beam

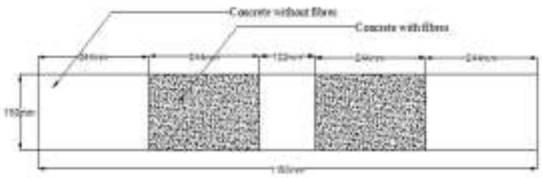

Fig.10 Fibres in hinged portion of the beam

3 RESULTS AND DISCUSSION

3.1 Load deflection curve

It can be noted that fibres in hinged zone have about the same deformational characteristics as that for fibres in full length of reinforced concrete beams. From test results of beam under two point load the various parameters for above

Table 9 Comparison of three types of beam results

Specimen Identification	First crack load kN	Ultimate load kN	Ductility factor	Energy absorption Capacity Nmm($x 10^3$)	Stiffness N/mm($x 10^3$)
C	11	62	1.55	290.14	8.33
S4	16	94	2.38	740.32	13.79
SH	16	92	2.38	678.48	12.5

4 CONCLUSIONS

4.1 SALIENT CONCLUSIONS

Based on the experimental investigation, the main conclusions that can be drawn are as follows.

- The Concrete with micro fibre has better workability and perform good in compression as compared to concrete with macro fibres.
- Fibre combination of 75% macro fibres and 25% micro fibres at 1.5% volume fraction (S4) gives the most appropriate combination as regards to the highest in the flexural and split tensile strength.
- The first crack load and ultimate load for S4 beam has been increased by the amount of 50% & 51.6% respectively as compared to control beam.
- The ductility factor and energy absorption capacity for S4 beam is greater than Control beam by the amount of 53.5% & 2.55 times respectively.
- The stiffness for S4 beam is 66.67% higher than conventional beam and it shows better stiffness characteristics as compared to all other beams.
- The variation between the S4 beam and SH beam is below 10% for all the parameter. So that fibres placed only in hinged zone is sufficient and economical by reducing the fibre content in the beam as compared to fibres in full length of the beam.

REFERENCES

1. Alberto Meda, FaustoMinelli and Giovanni A. Plizzari. (2012) "Flexuralbehavior of RC beams in fiber reinforced concrete", Construction and Building Materials, Vol.02, No.7, pp. 2930-2937.
2. Hamid PesaranBehbahani., BehzadNematollahi., Abdul RahmanMohd Sam and F. C. Lai. (2012) "Flexural behavior of steel-fiber-added-rc (sfarc) beams with c30 and c50 classes of concrete", International Journal of Sustainable Construction Engineering & Technology, Vol.3, No.1, pp. 384-394.
3. IS: 456 - 2000, "Plain and reinforced concrete – Code of practice", Bureau of Indian Standards, New Delhi.
4. IS: 1199 - 1959, "Methods of sampling and analysis of concrete", Bureau of Indian Standards, New Delhi.
5. IS: 383 – 1970, "Specification for Coarse and fine aggregate from natural sources for concrete", Bureau of Indian Standards, New Delhi.
6. IS: 516 -1959, "Methods of tests for strength of concrete", Bureau of Indian Standards, New Delhi.
7. MerveAcikgenc., KursatEsatAlyamac and ZulfuCinarUlucan. (2013) "Fresh and hardened properties of steel fibre reinforced concrete produced with fibres of different lengths and diameters", Proceedings of 2nd International Balkans Conference on Challenges of Civil Engineering, Epoka University, Tirana, Albania, pp. 658-666.