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Prediction of Shear Strength of Steel Fiber Reinforced Concrete Beams without Web Reinforcement

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***Abstract*— This paper attempt to predict the shear strength of steel fiber reinforced concrete beams with different percentage of steel fiber without web reinforcement. The effect of the fiber volume fraction on the shear response of SFRC with optimum steel fiber content has been studied. Five different volume contents ranging from 0% to1.5% was used in the test specimens. Direct shear tests were conducted and finally, an equation model was developed to predict the ultimate shear strength of SFRC in terms of steel fiber content.**

Keywords*— Shear strength, steel fiber volume fraction, web reinforcement.

I. INTRODUCTION

Fibre reinforced concrete (FRC) is Portland cement concrete reinforced with more or less randomly distributed fibres. Steel fiber have been used in concrete since the early 1900 .steel fiber are widely used application in highway pavement , airport runway Because of improving propertyof concrete in all direction use of steel fiber increases.

In FRC, thousands of small fibres are dispersed and distributed randomly in the concrete during mixing and thus improve concrete properties in all directions. Steel fibers aids in converting the brittle characteristics of concrete to a ductile one. The principal role of fibers is resisting the formation and growth of cracks by providing pinching forces at crack tips fiber shear strength of concrete increased upto a optimum limit.

Vikram Vjaysinh [1] :The experimental work was carried out to evaluate the shear strength of steel fibre reinforced concrete beam without stirrups .for this18 beam cast. The beams were tested under two point loading as per IS after 28 days curing .fiber fraction is varied as 0%, 1.5%, and 3%. The shear span depth ratio (a/d ratio) for beams is kept as 0.60 for specimen-I and 0.74 specimen series II. The cube compressive strength was calculated. The experimental results were compared with theoretical results obtained from empirical operations and design codes. Also the experimental results were compared with the equation put forth by the other researchers and codes to estimate the shear strength of steel fibre reinforced concrete beam without stirrups.

Vatsal Patel [2] :The study was carried out for evaluating the influence of steel fibers on cracking, deformation and shear sterength of M20 grade reinforced concretebeams.This paper presented the results of compression test, split tensile teston beams which were casted with various percentage of steel fibre 0%,1%,3% and aspect ratio 30 and 50 with stirrups and without stirrups. Results clearly indicated that with increase in% of steel compressive strength ,tensile strength and shear strength of beam increases and also crack width reduces.

Emma Slater et.al [3] **:**This study predicts the shear strength of steel fiber reinforced concrete beams based on existing experimental results' large database containing 222 shear strength tests of SFRC beams without stirrups was divided into six different groups based on their span depth ratio (a/d>3 or a/d<3) concrete compressive strength (fc>50 or <50) and steel fiber shapes(hooked, crimped and plain) and was used to develop separate for predicting their respective shear strength. The proposed equations were obtained by performing both linear and non-linear regression analysis on each database. A statistical analysis was then performed to compare the proposed equations to those of the previously developed equations by other researchers for predicting the shear strength of SFRC beams.overall,it was observed that the linear regression equations developed from this research for SFRC database could accurately predict the shear strength compared to the other previously proposed models.

Yoon-Keun Kwak [4]:Twelve tests were conducted on Reinforced Concrete Beams Volume Fraction with Three Steel Fibre volume Fractions(0,0.5 & 0.75%) and three shear span depth ratio(2,3&4) and to concrete compressive strengths(31&65MPa).The results demonstrated that the nominal stress at shear cracking and ultimate shear strength increased with increasing fibre volume.decreasing shear span depth ratio,and increasing concrete compressive strength. As the fibre content increased the fibre mode changed from shear to flexure.

Pant Avinash S**.** [5]: The results of six bending, shear and torsion tests on steel fibre reinforced concrete beams without web reinforcement were presented and discussed the variable parameter was longitudinal steel at bottom only. The top

reinforcement,aspect ratio and volume fraction of steel fibre kept constant for all the beams.From the tests conducted,it was found that the torsional strength is independent of longitudinal reinforcement. It was shown that the experimental results compare favorably with the theoretical Prediction.

Bimal Babu Adhikary[6]: **:** This paper presented the development of artificial neural network models for predicting the ultimate shear strength of steel fibre reinforced concrete(SFRC) beams. Two models were constructed using the experimental data from the literature and the results were compared with each other and with the formula proposed by Swamy et.al. and Khuntia et.al. It was found that the neural network model, with five inputs parameters, Predicts the shear strength of beams more closely than the network with four input parameters. Moreover, the neural network models predicts the shear strength of SFRC beams more accurately than the above mentioned formulas.

II. Experimental Programs

A. .*Methodology-*

The experimental programme consist of casting ,testing of reinforced concrete beams, cubes with different percentage of steel fiber (0%-1.5%). Ten reinforced high strength concrete beams were cast .The test specimens are divided into five series. Each series consisted of different % of steel fiber from (0%-1.5%) without shear reinforcement.

B .*Details of beam specimen*

The specimens used were cubes, beam specimens .Dimensions of each test specimen are as under:
Cube: 150 mmx150 mm x150 mm,
Beam: 150 mm x 150 mm x 700 mm
Beam specimens were used to determine .,shear strength of sfrc beams .Cubes of 150 mm x 150 mm size were used to find the compressive strength.
Compressive strength of cubes are determined at 28days using compression testing machine (CTM) of capacity 2000 KN. UTM testing machine of capacity 100 tones was used to determine the shear strength of beams.

C. *Test Materials-*

1.Cement – Ordinary Portland cement whose 28 day compressive strength was 53Mpa was used.

2.Fine Aggregate - Natural River sand confirming with specific gravity is 2.65 and fineness modulus 2.33 was used.

3. Coarse Aggregate - Crushed Coarse aggregate of 20mm and 10 mm procured from local crusher grading with specific gravity is 2.63 was used.

4.Water- Portable water free from any harmful amounts of oils, alkalis, sugars, salts and organic materials was used for proportioning and curing of concrete.

5.Steel Fiber- steel fiber used having the density of 7900kg

6.propotion-cement:sand:aggregate:water (1:2.03:3.14:0.48)

III . RESULT AND DISCUSSSION

A. .*Figures and tables-*

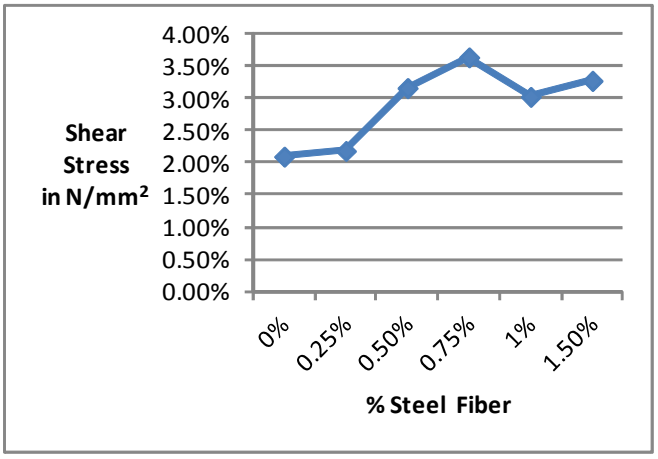
Results after casting,testing of concrete beams and cube are shown in table and figure.

Table 1

Result of Characteristics strength of concrete(fck) and shear stress ,% of steel fiber shown in table

Sr.no	Testing results		
	% vf	*fck N|Mmm^2*	*Shear stress N|mm^2*
1	***0***	***27.07***	***2.1***
2	0.5	28.65	3.165
3	0.75	***28.80***	3.90
4	1.0	27.50	3.03
5	1.5	27.4	3.28

Figure-1



Graph shows shear stress verses % of steel fiber

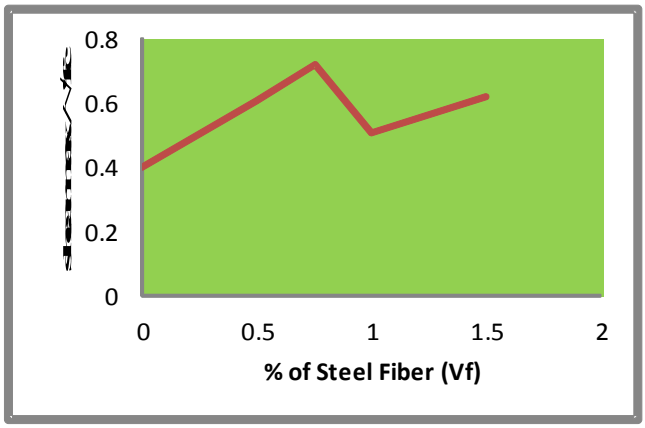
B. *Prediction of formula*

Variation of ultimate shear strength of SFRC with fiber content -

Ultimate shear strength is the main parameter in describing the shear response of concrete. Same as tensile strength, the ultimate shear strength of concrete has been correlated with its compressive strength. The ultimate shear strength of concrete is roughly proportional to the square root of the compressive strength. Following the same interrelationship between the ultimate shear and compressive strengths, the proportional coefficient is quantified here.

The area which covered upto the percentage fiber content from 0.0% to 0.75% there are many advantages all in direction for shear strength, crack resistance.

Figure-2



Variation of ultimate shear strength of SFRC with fiber content

The ratio of ultimate shear strength of the SFRC beams is the square root of average compressive strength of plain concrete and by plotted against fiber content. The normalized shear strength of plain concrete increases with an increase in fiber content. It is evident that a straight line is sufficient to qualitatively represent the dependency of the normalized shear strength to the fiber content.

The linear equation representing this straight line, which describes the interrelationship between the volumetric ratio of fibers (V_f) and the normalized ultimate shear strength $\tau_{max}/\sqrt{f_c'}$ is given as

$$\tau_{max} = \sqrt{f_c'}\,(0.4038 + 43\,V_f)$$

τ_{max} = ultimate shear strength;

f_c' = compressive strength of plain concrete;

The Equation suggests that the shear strength of plain concrete without fibers (i.e. $V_f = 0$) is

$$\tau_{max} = 0.4038\sqrt{f_c'}$$

Where, V_f = the volumetric ratio of steel fibers

C. *Mode of failure pattern of beams-*

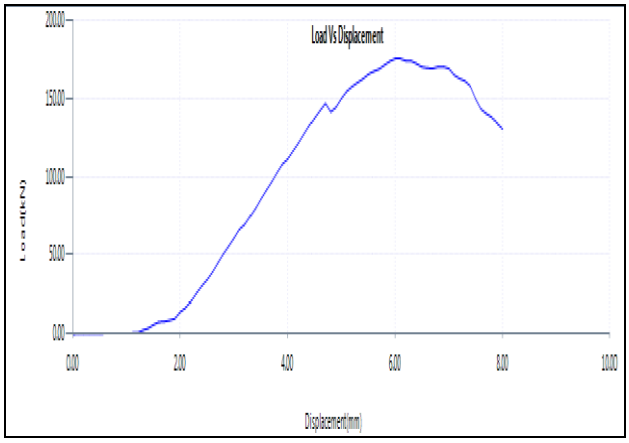
The crack pattern of all the beam specimen were same.The crack width of beam reduced when steel fiber in concrete increases.Th failure pattern is shown in figure. Failure of beam observed with inclination to the corner of beam.

Failure pattern of the beams are shown in figure.

$$\alpha + \beta = \chi. \qquad (1)$$

(1)

Mode of failure pattern of beams-
Figure-3



Graph of load verces diplacement

IV. CONCLUSION

Standard beams made of steel fiber reinforced concrete with different amount of fibers (ranging from 0.0% to 1.5.0% by volume) were tested under direct shear. The influence of fiber content on the ultimate shear strength was investigated. Based on the data obtained from the direct shear tests of these SFRC beams, an analytical constitutive model is developed to predict the ultimate shear strength of SFRC in direct shear. The following conclusions can be drawn from the outcome of this study:

(i) The ultimate shear strength of matrix increases significantly by adding fibers to the matrix.

(ii) The ultimate shear strength of SFRC tested in this project could be predicted by equation as

$$\tau_{max} = \sqrt{f_c'}\,(0.4038 + 43\,V_f)$$

(iii) The optimum content fiber for this research is 0.75% volumetric percentage.

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