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IMPROVEMENT OF CONCRETE TORSIONAL STRENGTH BY INCORPORATING RANDOMLY DISPERSED STEEL FIBRE IN TO THE CONCRETE

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Abstract: This study investigate the effect of steel fibre on compressive strength and torsion strength of beam .If external loads act far away from the vertical plane of bending, the beam is subjected to twisting about its longitudinal axis, known as torsion, in addition to the shearing force and bending moment. The current torsion design approach assumes no interaction between flexure, shear and torsion. In the present work performance of reinforced concrete beams with and without steel fibres were studied subjected to pure torsion. The experimental program consists of casting 12 reinforced concrete beams of size 150mm X150 mm and length 2m. Three of them was cast without fibres to make a comparative study with the remaining beams; The group of three beam are casted with 5% fibre ,10% fibre & 15% fibre. The longitudinal reinforcement with 4 # 8 mm diameter and 6 mm stirrups at 150 mm spacing was kept constant for all beam. The results concluded that the cracking torsional strength and ultimate torsional strength goes on increasing as the percentage of Steel fiber goes on increasing as the mentioned above.

Keywords: *Steel Fibres, Aspect ratio, Reinforced Concrete, Beam, Compressive strength, Torsional strength.*

I.INTRODUCTION:

Concrete is mostly wide construction material in the world due to its ability it can be mould and shape. However concrete has some deficiencies as like, Low tensile strength, Brittleness and low ductility, Low impact strength. These properties can be improved by the use of steel fiber in a concrete. The addition of fibers improves the crushing strength of the concrete and apparent ductility, and also provides crack resistance and crack control. This research is aimed at studying the improvement in properties of concrete like compressive strength and torsional strength. which increases with adding steel fibers with different percentages in concrete.. The study include comparison of torsional strength of the concrete beams based on the cross sectional dimensions, span and amount of Steel Fibers used with actual strength obtained based on experimental results. The research findings will help engineers to understand the overall performance of concrete for compressive strength & torsional strength . In this paper, an attempt has been made to study the strength properties of concrete with different percentages of hooked end steel fibers.The concrete mixture design is done for M30 and M 40 grade of concrete. The steel fiber reinforced concrete containing fibers of 5%, 10 % & 15% volume fraction of hooked end steel fibers of 30 aspect ratio were used. The cube size is 150mm x150mm x150 mm for testing the compressive strength of concrete. Torsional strength is checked by testing beams of size 150 mm x 150 mm x 2000 mm with central point loading. The aim of this study is to investigate the change in mechanical properties of concrete with the addition of steel fiber in high strength concrete .SFRC has been used extensively in construction of industrial floors, bridge deck overlays, airport runways, highway pavements, tunnel linings, spillways, dams, slope stabilizations, and many precast products. Steel fibers can improve the characteristics of hardened concrete, and polypropylene fibers can have significant effects on the fresh concrete. Fibers are mostly used in concrete to control cracking due to various circumstances. Some recent researches shows that using fibers in concrete Ultra-high performance fibre-reinforced concrete (UHPFRC) is a relatively new building material, which has superior durability, ductility and strength in comparison with Normal Strength Concrete (NSC) and Fibre Reinforced Concrete (FRC). The fibers can improve the shear resistance capacity under the combined action of shear and bending.

II.SCOPE AND OBJECTIVES

1. To investigate experimentally torsional moment of steel fibre reinforced concrete with varying
2. To study the effect of fiber inclusion in concrete. proportions of steel fibres 5%, 10%, 15% in concrete for M30 & M40 grade of concrete.
3. To compare results of torsional moment of steel fibre reinforced concrete with the conventional concrete.

Steel fiber

Physical Properties: Fiber length: 10-70mm

Fiber diameter: 0.25-1.00mm

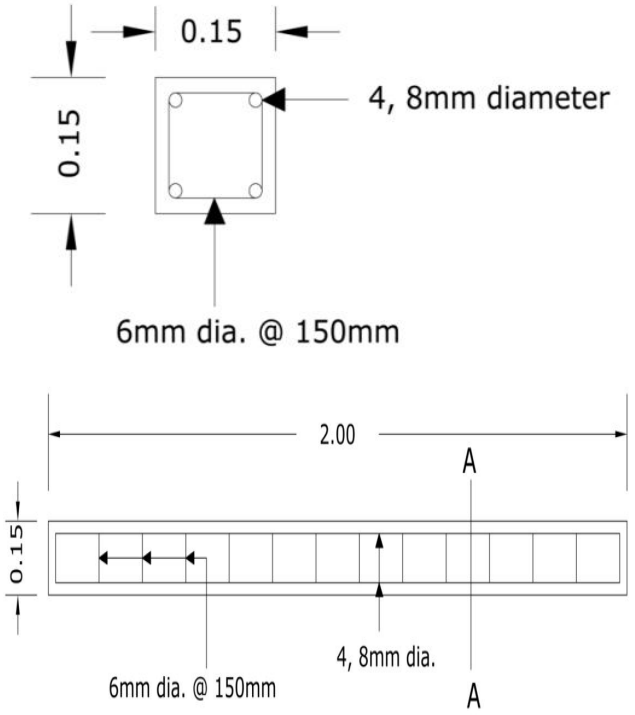
Aspect Ratio: 30-250

III.METHODOLOGY

Details of test specimens

The experimental program consists of casting 12 reinforced

concrete beams of size 150mm X150 mm and length 2m. Three of them was cast without fibres to make a comparative study with the remaining beams; The group of three beam are casted with 0.5% fibre ,1.0% fibre & 1.5% fibre. The longitudinal reinforcement with 4 # 8 mm diameter and 6 mm stirrups at 150 mm spacing was kept constant for all beam



Top view Of Torsion Beam

Reinforcement Detailing of Beams at Sec–A-A
Reinforcement Detailing of Beams

Material Properties

The M30 and M40 grade of concretes are used for the casting of SFRC beams. An Ordinary Portland Cement (OPC) of 53 MPa strength, locally available river sand as fine aggregate, crushed stone aggregate with maximum particle size of 20 mm as coarse aggregate. Steel fibre and potable water were used in this investigation. The mix proportion obtained from these materials is given table below

Final Mix for M30

Cement	**426 Kg/m^3**
Water	**231.64 Kg/m^3**
FA	**579.68 Kg/m^3**
CA	**1241.60 Kg/m^3**
Yield	**2478.92 Kg/m^3**

Final Mix for M40

Cement	**474 Kg/m^3**
Water	**224.51 Kg/m^3**
FA	**685.44 Kg/m^3**
CA	**1343.93Kg/m^3**
Yield	**2727.88 Kg/m^3**

TEST PROCEDURE

The test specimen is mounted on a suitable testing machine means Universal Testing Machine in such a manner that the beam is twisted at the end. The twisting moment of the beam can be measured. The size of beam 150×150×2000mm.

In assembling the testing apparatus the point load at the centre witch load is distributed at end point of the beam. The twisting moment can be calculated. The load can be seen the digital loading system of Universal Testing Machine.

The torsional moment is calculated as follows:

Torsional moment (MPa) = load × Distance.

TESTIN OF BEAMS ON UTM

BEAM FAILURE DUE TO TORSION

IV.RESULT AND DISCUSSION

Beam Type	Designation	Fiber Fraction (%)
Reinforced Concrete	Fiber Reinforced FR0	0%
Steel Fiber Reinforced Concrete	FR5	5%
Steel Fiber Reinforced Concrete	FR10	10%
Steel Fiber Reinforced Concrete	FR15	15%

1. Compressive Strength:

The compressive strength test is consider the most suitable method of evaluating the behaviour of steel fiber reinforced concrete for underground construction at an early age, because in many cases such as in tunnels, steel fiber reinforced concrete is mainly subjected to compression. As per IS 516-1959 in order to determine compressive strength of harden concrete at least three specimens of standard cube size should be taken. In this study in order to investigate compressive strength of hardened concrete of M30 and M40 grade specimens of each of standard cube size (15 cm x 15 cm x 15 cm) were taken.Results of Compressive strength for M30, M40 grade of concrete on cube specimen with 5%, 10%, and 15% steel fibers are shown in table 6.1, 6.2 and figure6.1 below:

Table 6.1 : Results of compressive strength of M30 mixof concrete with varying percentage of steel fibers Included.

% of Steel Fibers	Compressive Strength (Mpa)			
	Specimen 1	Specimen 2	Specimen 3	Average
0	42.56	39.25	42.87	41.56
5	43.48	40.91	44.17	42.85
10	46.55	44.31	53.66	48.17
15	52.06	55.00	55.73	54.26

Table 6.2 : Results of compressive strength of M40 mix of concrete with varying percentage of steel fibers Included.

Steel Fibers	Specimen 1	Specimen 2	Specimen 3	Average
0	43.80	42.81	43.66	43.42
5	44.04	44.20	47.17	45.14
10	52.80	52.02	46.66	50.49
15	54.73	54.71	56.46	55.3

2. Torsional Moment:

Results of Torsional strength forM30 and M40 grade of concrete on beam specimen with 0%, 5%,10% and 15% steel fibers are shown in table

Table 6.5. : Ultimate Torque induced in concrete beams of M30 grade

Beam	Load (kN)	Eccentricity	Ultimate Torque (kN-m)	Average
	9	0.525	4.725	
FR0	9.125	0.525	4.790	4.834
	9.5	0.525	4.987	
	15.46	0.525	8.116	
FR5	16.5	0.525	8.662	8.208
	14.95	0.525	7.848	
	27.5	0.525	14.437	
FR10	27.05	0.525	14.201	14.262
	26.95	0.525	14.148	
	31.25	0.525	16.406	
FR15	33.25	0.525	17.456	16.73
	31.25	0.525	16.327	

Table no.6.7. shows Ultimate Torque induced in beams of M40 grade. The 0% fiber the average cracking torque is 5.1626 kN-m,

The 5% fiber the average cracking torque is 9.4193 kN-m, The 10% fiber the average cracking torque is 14.7896 kN-m, and The 15% fiber the average cracking torque is 17.1746 kN-m. The Ultimate torsional resistance of reinforced concrete beams goes on increasing as a percentage of steel fiber included in reinforced cement concrete increases

Table 6.7. : Ultimate Torque induced in concrete beams of M40 grade

Beam	Load (kN)	Eccentricity	Ultimate Torque (kN-m)	Average
	9.55	0.525	5.014	
FR0	10.125	0.525	5.316	5.1626
	9.825	0.525	5.158	
	17.6	0.525	9.24	
FR5	18.9	0.525	9.922	9.4193
	17.325	0.525	9.096	
	28.05	0.525	14.726	
FR10	28.725	0.525	15.081	14.7896
	27.74	0.525	14.563	
	32.1	0.525	16.852	
FR15	32.85	0.525	17.346	17.1746
	33	0.525	17.325	

V.CONCLUSION

Use Of fiber in Reinforced concrete has found very beneficial to enhance the torsional strength of RC beam subjected to pure torsion. The ultimate torsional strength goes on increasing as the percentage of steel fiber goes on increasing.

Following conclusions can be obtained from the present experimental work on effects of varying percentage of steel fibers to torsional strength.

1. For M30 grade of concrete by using steel fibers about 5%,10%, 15% of weight of cement. It is found that the torsional strength of fiber reinforced concrete beams is increases by 60% - 70%, 150% - 200% , 240% - 300% respectively of conventional reinforced cement concrete beams.
2. For M40 grade of concrete by using steel fibers about 5%,10%, 15% ,of weight of cement. It is found that the torsional strength of fiber reinforced concrete beams is increases by 80% - 110%, 150% - 200%, 230% - 300% respectively of conventional reinforced cement concrete beams.

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