Comparative Study of Oriented and Non Oriented Fiber Reinforced Concrete

Sabir Khan, Shiv Kumar

Abstract: Concrete is a common construction material used in world because it can take our desired shape with minimum efforts. We know concrete is strong in compression and weak in tension and concept of adding fibers to improve strength of concrete is common in world. So for improving concrete property we add spring(helical) shaped fibers of spring length 25mm and diameter 8mm and aspect ratio 3.125 and length of plane(linear) wire 100mm and diameter 1mm so aspect ratio of plane(linear) wire is 100. Now concrete was reinforced by above mentioned spring fibers in following percentage 0%, 0.5%, 1% and 1.5% by weight of cement. A total 15 cubes of standard size 150mm×150mm×150mm and 15 cylinders of 150mm diameter, 300mm height and 15 beams of 100mm×10mm×500mm were casted and tested after 28 days by compression and split tensile and two point load method respectively for checking strength of concrete in compression, tension and flexure.

Index Terms: Compressive strength, Flexural Strength, Helical Shaped Fiber, Oriented Fiber Reinforced Concrete, , Split Tensile Strength.

I. INTRODUCTION

Reinforced cement concrete:

Reinforced concrete is a mixture of many basic compounds (cement, coarse aggregate, fine aggregate, admixture, water with reinforcement) in a fixed ratio to get desired strength. Those are used in the construction of various structures now days for removal of the old type of construction using timber, rocks etc. Due to their unavailability and cost and very laborious these materials have been replaced by concrete, the strength of which could be altered by altering the quantity of basic composition of the concrete and also adding certain additives which contribute to the strength, durability and workability of it. As the time elapses the growth of the country increases exponentially and to meet the growth of the country certain structure are to be made to sustain it for example, the construction of metro that helps in growth of a country need to be made using material that are highly durable and safe. Due to this the need of making such a concrete whose strength is very high arises but after a certain limit by changing the quantity the strength doesn't change considerably thus the idea of mixing fibers in concrete was introduced and that helped very much in increasing the strength. In past we use stones, cow dung, mud in construction but we cannot predict the actual strength of that member. After a long period of struggle, Romans made cement – called Pozzolana – before Christ by mixing slaked lime with a volcanic ash from Mount Vesuvius and used it to make concrete for building, the art was lost during the Dark Ages 5th century -15th century A.D. and was not revived until eighteenth and nineteenth centuries (A. D.). Marcus Vitruvius Pollio, Vitruvius, an Architect/Engineer during the golden age of Caesar Augustus (around 25 BC). In his writings around 25 BC in Ten Books on Architecture distinguished types of aggregate appropriate for the preparations of lime mortars. For the use of structural members, he recommended pozzolana, which were volcanic sand from the sandlike beds of Puteoli, brownish-yellow-gray in color near Naples and reddish brown at Rome. He specifies 1 part lime to 3 parts pozzolana for cements use in buildings.

II. OBJECTIVE

The objectives of analysis are:

➢ To gain a better understanding of the structural behavior under the action of the applied loading.

➢ To obtain sets of applied actions which are in equilibrium with reactions and which can be used for the design of individual structural elements.

➢ To check compressive, tensile, flexure strength of concrete under the influence of randomly arranged spring fiber at different percentage with respect to weight of cement.

➢ To check the compressive strength of cubes, split tensile strength of cylinder and flexural strength of beams.

Fig.1 Orientation of Fibers in Cube Mould during Casting

I. Estimation of mix ingredients

Volume of concrete	$1\ m^3$
Taking 2% for air entrapped	$1-0.02\ = 0.98\ m^3$
Volume of cement	Mass of cement / Specific gravity of cement)×(1/100) $= (372/3.15) \times (1/1000) = 0.1180\ m^3$
Volume of water	(Mass of water / Specific gravity of water) × (1/1000) $= (186/1) \times (1/1000) = 0.186\ m^3$
Volume of total aggregates	$0.98 – (0.118 + 0.186)$ $= 0.694\ m^3$
Mass of coarse aggregates	(volume of total aggregate)x(volume of coarse aggregate) × (Specific gravity of coarse aggregate) ×1000 $=0.694 \times 0.67 \times 2.74 \times 1000$ $= 1274.04$ kg
Mass of fine aggregates	(volume of total aggregate)x(volume of fine aggregate) × (Specific gravity of fine aggregate) ×1000 $= 0.694 \times 0.33 \times 2.74 \times 1000$ $= 618.354$ kg

III. TEST PERFORMED

A. Compression test

A compression test can be performed on CTM (Compression Testing Machine) by keeping the test-piece on base block and moving down the central grip to apply load. It can also be performed on a compression testing machine.

A Compression testing machine shown in Fig.2. It has two compression plates/heads. The upper head moveable while the lower head is stationary. Uniform distribution of load over the test- piece ends. A load gauge is fitted for recording the applied load.

Fig.3 CUBE SPECIMEN AFTER 28 DAYS

B. Split tensile test:

A Split Tensile test can be performed on CTM (Compression Testing Machine) by keeping the test-piece on base block and moving down the central grip to apply load. It can also be performed on a compression testing machine.

A Compression testing machine shown in figure. It has two compression plates/heads. The upper head moveable while the lower head is stationary. Uniform distribution of load over the test- piece ends. A load gauge is fitted for recording the applied load.

Fig.2 COMPRESSION TESTING MACHINE

Fig.4 SPLIT TENSILE STRENGTH TEST IN CTM

SPECIMEN:-15 Cylinder specimen of dimension: diameter (15cm), height (30cm).

Fig.5 CYLINDER SPECIMENS AFTER 28 DAYS

C.   Two Point Flexure test:

Flexural test evaluates the tensile strength of concrete indirectly. It tests the ability of unreinforced or reinforced concrete beam or slab to withstand failure in bending. The results of flexural test on concrete expressed as a modulus of rupture which denotes as (MR) in MPa. The flexural test on concrete can be conducted using two point load test. The configuration of the test is shown in Figure.

Fig.6 TWO POINT LOAD TEST

SPECIMEN:-15 Beam specimen of dimension (50 x 10 x 10 cm^3)

Fig.7 BEAM SPECIMEN AFTER 28 DAYS

IV.   RESULT AND DISCUSSION

A TESTING OF ORIENTED FIBER REINFORCED CONCRETE SPECIMEN

1.   Cube

II Compressive Strength at 0%, 0.5%, 1%, 1.5% fiber

Sr. no.	% of fiber	Load (KN)	Average Load (KN)	Average Compressive Strength (N/mm^2)
1)	0%	584 590 581	585	26

2)	0.5%	668 610 627	635	28.22
3)	1.0%	705 730 755	730	32.44
4)	1.5%	632 600 613	615	27.33

Average compressive strength of cube at 0% fiber is 26N/mm^2.

In 0.5% fiber increase of 8.53% compressive strength as compare to 0% oriented fibers.

In 1% fiber 24.76% increase in compressive strength as compare to 0% and 14.95% increase in strength as compare to 0.5% oriented fibers.

In 1.5% fiber increase of 5.11% compressive strength as compare to 0% fiber and decrease of 3.15% compressive strength as compare to 0.5% and decrease of 15.75% compressive strength as compare to 1% oriented fibers.
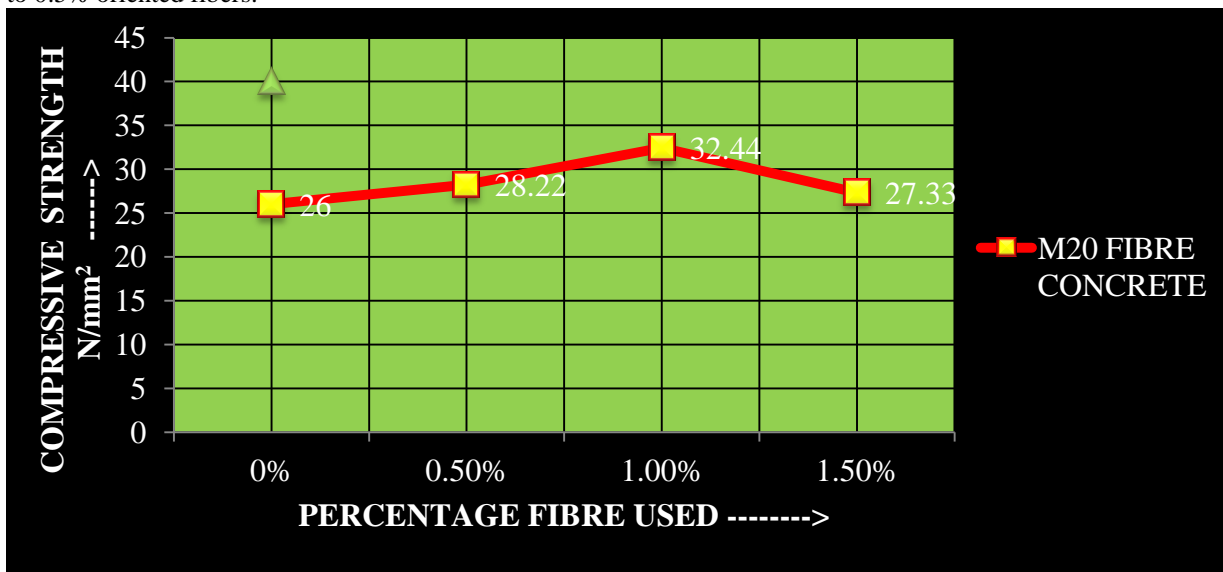

Fig.8 GRAPH FOR COMPRESSIVE STRENGTH WITH ORIENTED FIBERS

2. Cylinder

III Tensile Strength at 0%, 0.5%.1%, 1.5% fibe

Sr. no.	% of fiber	Load (KN)	Average Load (KN)	Average Tensile Strength (N/mm^2)
1)	0%	165 140 145	150	2.12
2)	0.5%	180 170 190	180	2.54
3)	1.0%	140 170 170	160	2.26
4)	1.5%	160 165 170	165	2.33

Average split tensile strength of cylinder at 0% fiber is 2.12 N/mm^2.

In 0.5% fiber 19.81% increase of tensile strength as compare to 0% .

In 1% fiber 6.6% increase of tensile strength as compare to 0% and decrease of 11.02% tensile strength as compare to 0.5% oriented fibers.

In 1.5% fiber increase of 9.9% tensile strength as compare to 0% and decrease of 8.26% tensile strength as compare to 0.5% and increase of 3.09% tensile strength as compare to 1% oriented fibers.
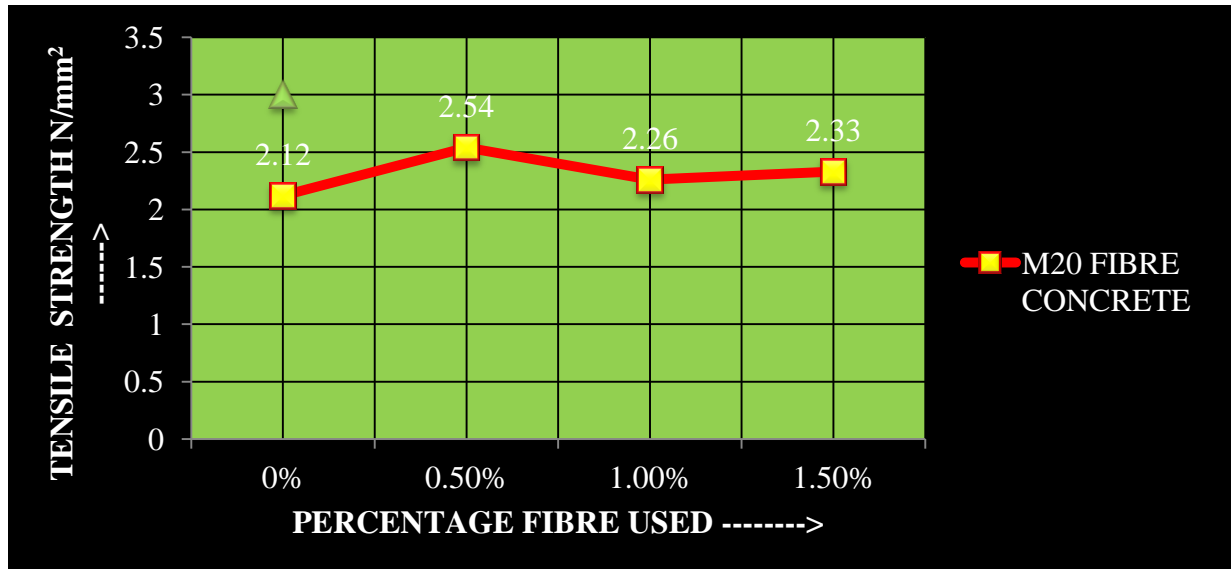

Fig.9 GRAPH FOR TENSILE STRENGTH WITH ORIENTED FIBERS

3. Beam

IV Flexural Strength at 0%, 0.5%.1%, 1.5% fiber

Sr. no.	% of fiber	Load (KN)	Average Load (KN)	Average Flexural Strength (N/mm^2)
1)	0%	45 49 47	47	4.60
2)	0.5%	60 58 62	60	5.88
3)	1.0%	52 46 52	50	4.90
4)	1.5%	44 50 50	48	4.70

Average split flexural strength of cylinder at 0% fiber is 4.6 N/mm^2.

In 0.5% fiber 27.82% increase of flexural strength as compare to 0%.

In 1% fiber 6.52% increase of flexural strength as compare to 0% and decrease of 16.66% flexural strength as compare to 0.5% oriented fibers.

In 1.5% fiber increase of 2.17% flexural strength as compare to 0% and decrease of 20.06% flexural strength as compare to 0.5% and increase of 4.08% flexural strength as compare to 1% oriented fibers.
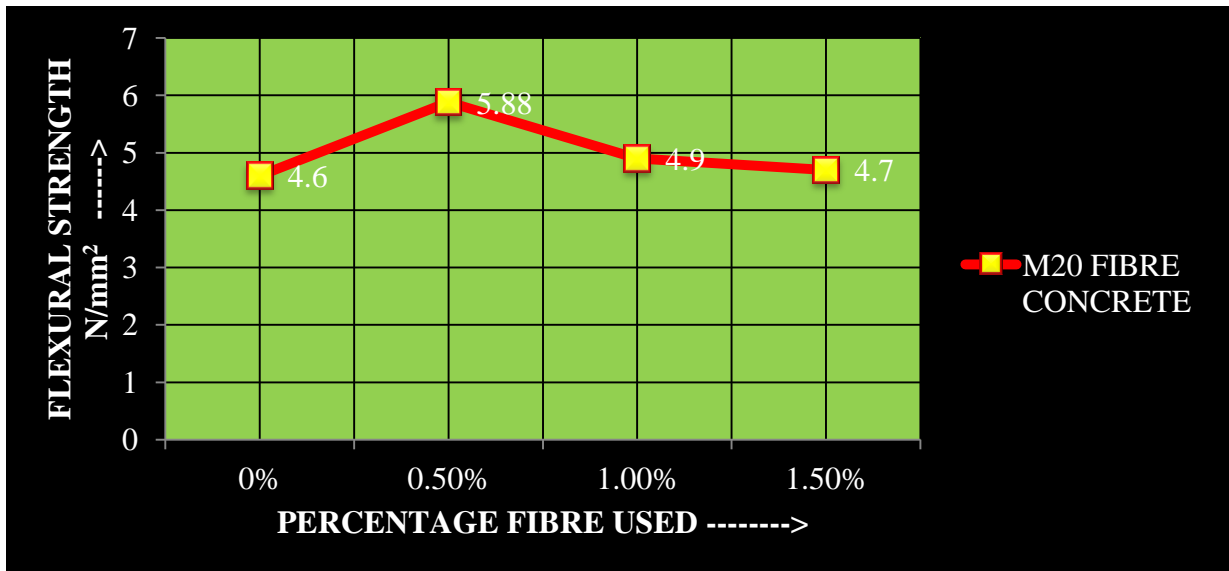
Fig.10 GRAPH FOR FLEXURAL STRENGTH WITH ORIENTED FIBERS

a.   ***Random fiber concrete***

1.   *Cube*

Table V Compressive Strength at 0%, 0.5%, 1%, 1.5% fiber

Sr. no.	% of fiber	Load (KN)	Average Load (KN)	Average Compressive Strength (N/mm^2)
1)	0%	617 623 620	620	27.55
2)	0.5%	665 662 653	660	29.33
3)	1.0%	758 751 756	755	33.55
4)	1.5%	635 624 631	630	28

Average compressive strength of cube at 0% fiber is 26N/mm^2.

In 0.5% fiber increase of 6.46% compressive strength as compare to 0% oriented fibers.

In 1% fiber 21.77% increase in compressive strength as compare to 0% and 14.38% increase in strength as compare to 0.5% oriented fibers.

In 1.5% fiber increase of 1.63% compressive strength as compare to 0% fiber and decrease of 4.53% compressive strength as compare to 0.5% and decrease of 16.54% compressive strength as compare to 1% oriented fibers.

Fig.11 GRAPH FOR COMPRESSIVE STRENGTH WITHOUT ORIENTED FIBER

i.   *Cylinder*

Table VI Tensile Strength at 0%, 0.5%.1%, 1.5% fiber

Sr. no.	% of fiber	Load (KN)	Average Load (KN)	Average Tensile Strength (N/mm^2)
1)	0%	124 128 138	130	1.84
2)	0.5%	140 148 138	153	2.16
3)	1.0%	145 155 150	150	2.12
4)	1.5%	168 155 157	152	2.15

Average split tensile strength of cylinder at 0% fiber is 2.12 N/mm^2.

In 0.5% fiber 17.39% increase of tensile strength as compare to 0% .

In 1% fiber 15.21% increase of tensile strength as compare to 0% and decrease of 1.85% tensile strength as compare to 0.5% oriented fibers.

In 1.5% fiber increase of 16.84% tensile strength as compare to 0% and decrease of 0.46% tensile strength as compare to 0.5% and increase of 1.41% tensile strength as compare to 1% oriented fibers.

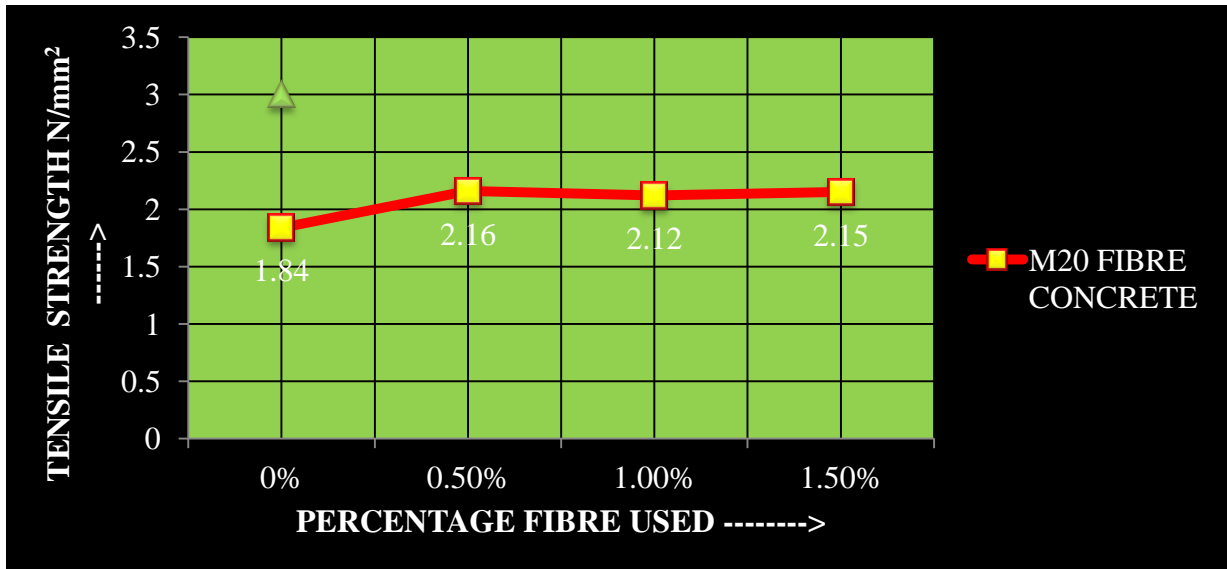## Comparative Study of Oriented and Non Oriented Fiber Reinforced Concrete

Fig.12 GRAPH FOR TENSILE STRENGTH WITHOUT ORIENTED FIBERS

ii. *Beam*

Table VII Flexural Strength at 0%, 0.5%.1%, 1.5% fiber

Sr. no.	% of fiber	Load (KN)	Average Load (KN)	Average Flexural Strength (N/mm^2)
1)	0%	31.7 35.4 36.7	45.6	4.47
2)	0.5%	51.8 63.3 57.91	51.67	5.06
3)	1.0%	53.43 45.6 43.98	47.67	4.67
4)	1.5%	46.4 50.3 51.29	49.33	4.83

Average split flexural strength of cylinder at 0% fiber is 4.47 N/mm^2.

In 0.5% fiber 13.19% increase of flexural strength as compare to 0%.

In 1% fiber 4.47% increase of flexural strength as compare to 0% and decrease of 7.7% flexural strength as compare to 0.5% oriented fibers.

In 1.5% fiber increase of 8.05% flexural strength as compare to 0% and decrease of 4.54% flexural strength as compare to 0.5% and increase of 3.42% flexural strength as compare to 1% oriented fibers.
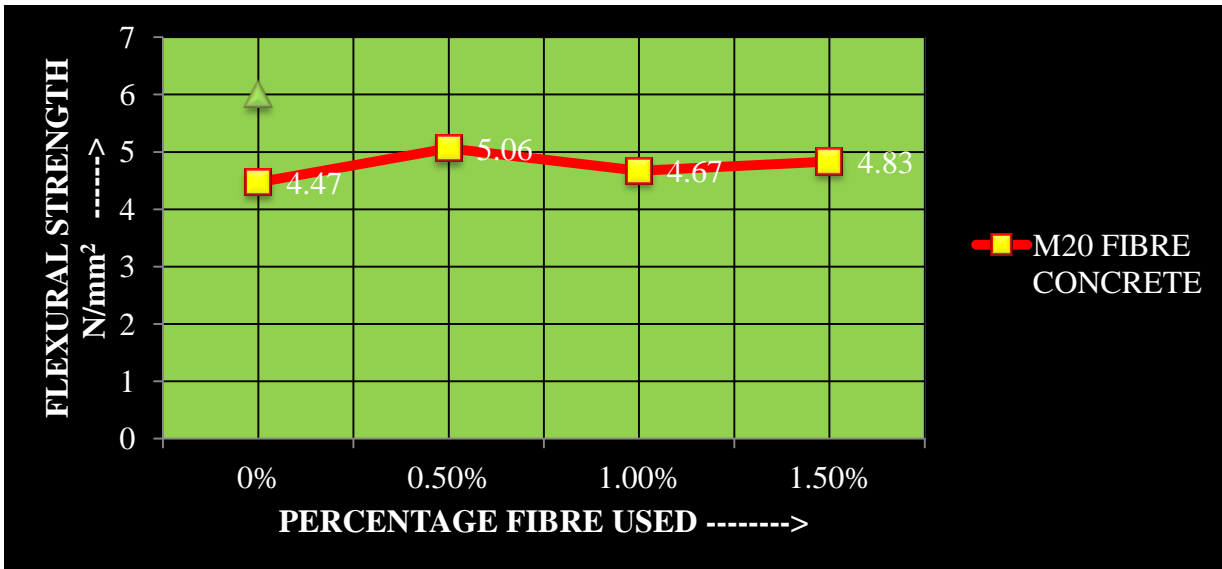
Fig.13 GRAPH FOR FLEXURAL STRENGTH WITHOUT ORIENTED FIBERS

   b.   Comparison between oriented and random fibers
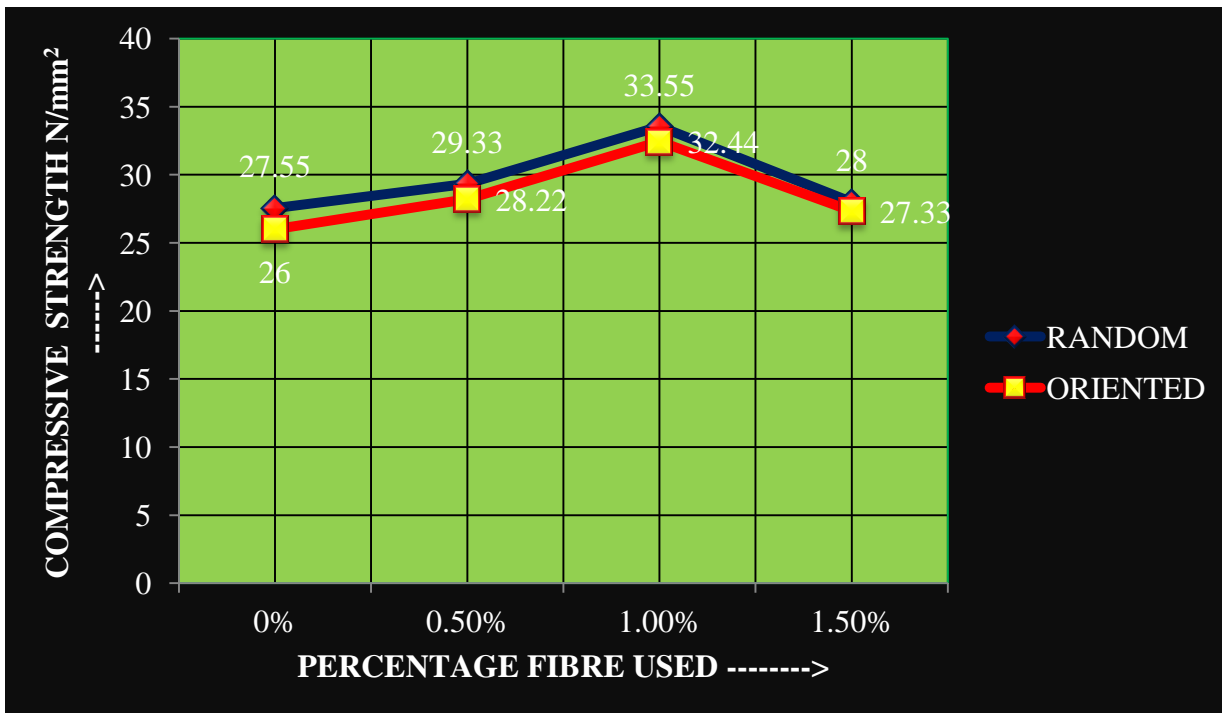
   i.   Graph for Compressive Strength

Fig.14 GRAPH FOR COMPRESSIVE STRENGTH

Maximum Compression Strength of Oriented Fiber
Concrete is 32.44 N/mm^2 at 1.5% Fiber.
Maximum Compression Strength of Non Oriented Fiber
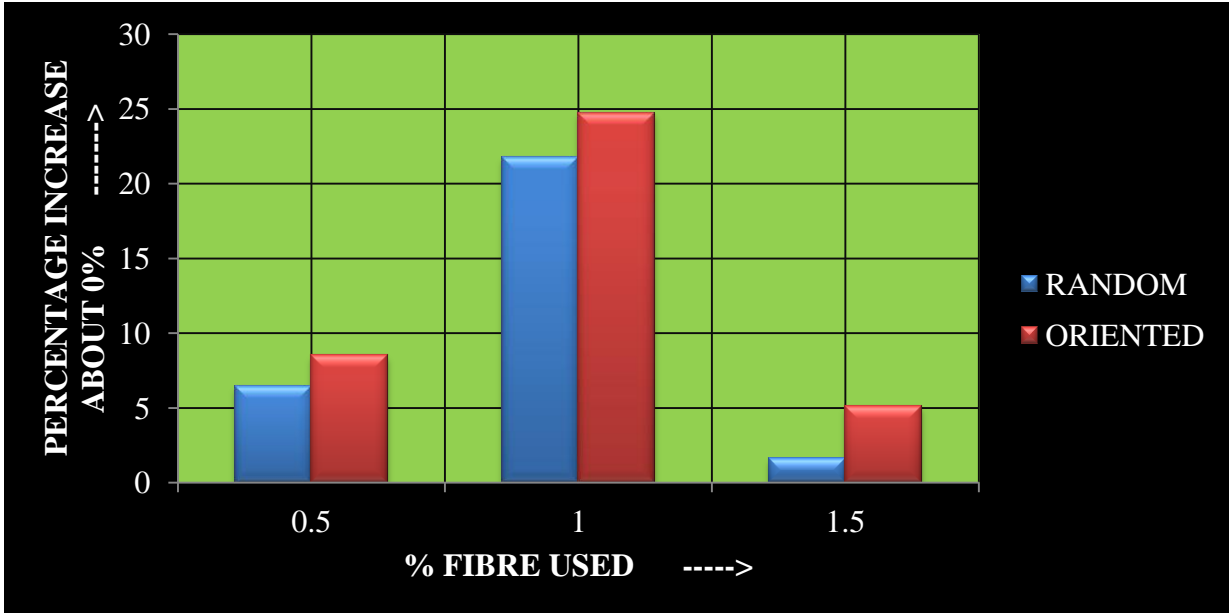Concrete is 33.55 N/mm^2 at 1.5% Fiber.

Comparative Study of Oriented and Non Oriented Fiber Reinforced Concrete

Fig.15 GRAPH FOR PERCENTAGE CHANGE IN COMPRESSIVE STRENGTH
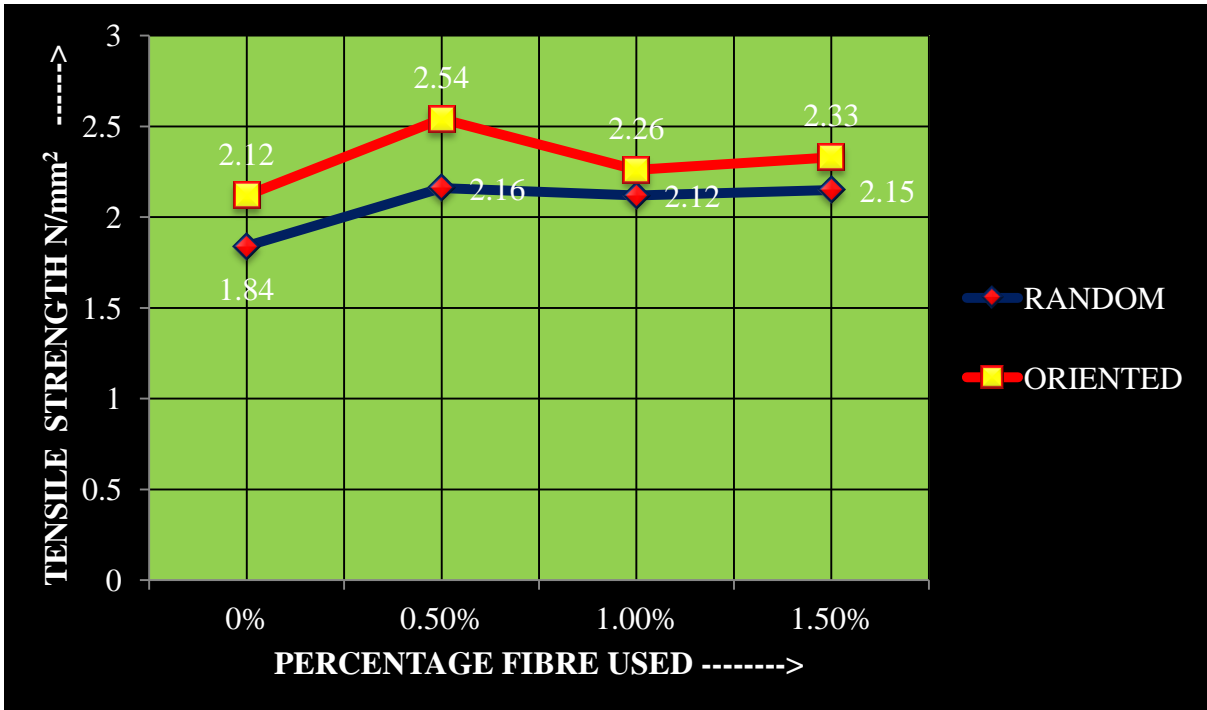
ii. Graph for Tensile Strength

Fig.16 GRAPH FOR TENSILE STRENGTH

Maximum Tensile Strength of Oriented Fiber Concrete is 2.54 N/mm^2 at 0.5% Fiber.

Maximum Tensile Strength of Non Oriented Fiber Concrete is 2.16 N/mm^2 at 0.5% Fiber.
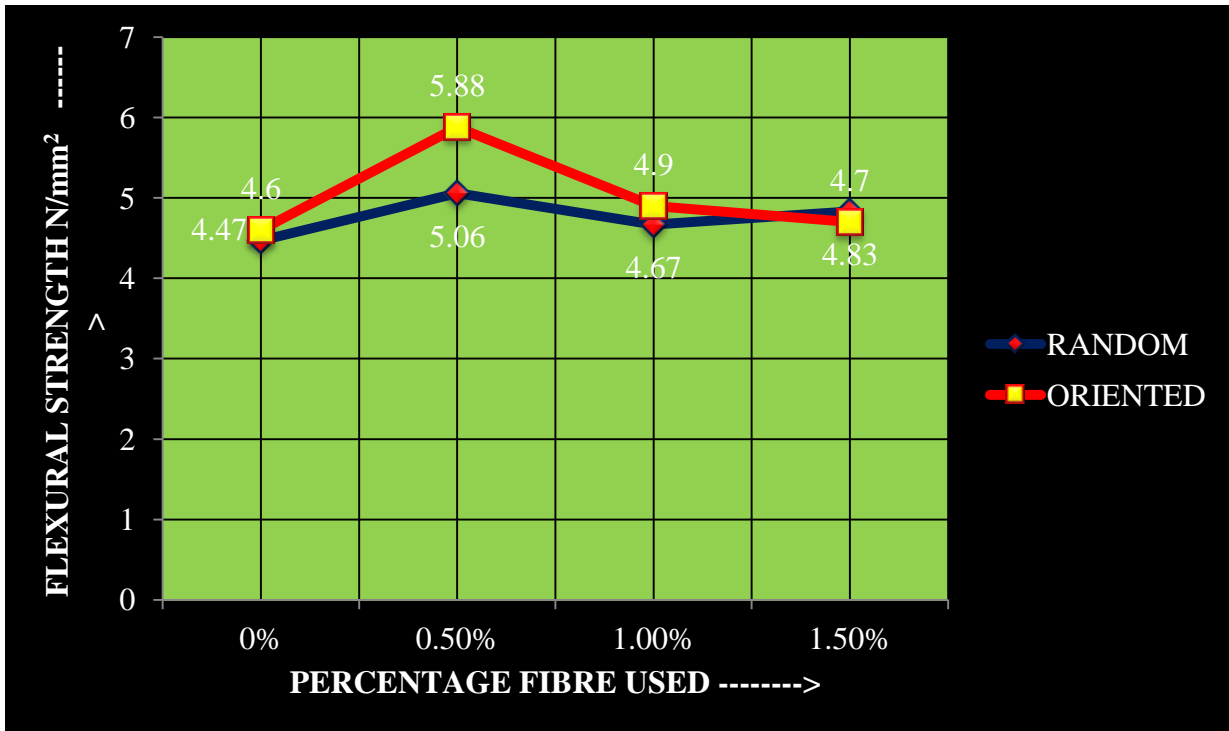
iii. Graph for Flexural Strength

Fig.17 GRAPH FOR FLEXURAL STRENGTH

Maximum Flexural Strength of Oriented Fiber Concrete is 5.88 N/mm^2 at 0.5% Fiber.

Maximum Flexural Strength of Non Oriented Fiber Concrete is 5.06 N/mm^2 at 0.5% Fiber.

V. CONCLUSION

Compressive Strength Increase As We Increase The Percentage Of Fiber Up To 1 Percent Than It Will Decrease. Split Tensile Strength Increase As We Increase The Percentage Of Fiber Up To 1 Percent Than It Will Decrease. Flexural Strength Increase As We Increase The Percentage Of Fiber Up To 1 Percent Than It Will Decrease. At Same Percentage Of Fiber Compressive Strength, Splittensile Strength And Flexural Strength Of Concrete Also Increases In Oriented Fiber As Compared To Non Oriented Fiber. We Got Maximum Strength Of (32.44 N/Mm2) In M20 Concrete So We Can Use This Concrete Where We Require M25 And Save Money And Earn Profit Of 40.8% Approximately.

REFERENCES

1. GrijaSelvamani, ShanthiniDuraisamy,AbinayaSekar ,"A Review on Fiber Reinforced Concrete",International Journal of Civil Engineering and Technology (IJCIET) Volume 7, Issue 6, November-December 2016, pp. 386–392.
2. Shrikant M. Harle,"Review on the Performance of Glass Fiber Reinforced Concrete",International Journal of Civil Engineering Research. ISSN 2278-3652 Volume 5, Number 3 (2014), pp. 281-284.
3. Job Thomas and AnandRamaswamy, "Mechanical Properties of Steel Fiber Reinforced Concrete", Journal of Materials in Civil Engineering, Vol.19, No.5, pp. 385-392, 2007.
4. Premalatha, J. and SundaraRajan, R. "Strength Properties of High Strength Fibrous Concrete", The Indian Concrete Journal, pp.37-41, 2007.
5. Wu Yao, Jie Li and Keru Wu, "Mechanical Properties of Hybrid Fiber-Reinforced Concrete at Low Volume Fraction", Cement and Concrete Research, Vol.33, pp.27-30, 2003
6. Rami Haddad, H. and AhnedAsteyate, M. "Role of Synthetic Fibers in Delaying Steel Corrosion Cracks and Improving Bond with Concrete", Canadian Journal of Civil Engineering, Vol.28, pp.787-793, 2001.
7. Nataraja, M.C., Dhang, N. and Gupta, A.P. "Steel Fiber Reinforced Concrete under Compression", The Indian Concrete Journal, pp.353-356, 1998.
8. Kumar, V., Suman, S.D. and Mohammad Shamim, "Statistical Prediction of Compressive Strength of Steel Fibe Reinforced Concrete", ICI Bulletin, No.60, pp.31-36, 1997.
9. ZiadBayasi and PavizSoroushian, "Effect of Steel Fiber Reinforcement on Fresh Mix Properties of Concrete", ACI Materials Journal, Vol.89, No.4, pp.369-374, 1992.
10. Balaguru, P.N. and Shah, S.P. "Fiber Reinforced Cement Composites" McGraw Hill, In., New York, 1992.
11. Faisal Wafa, F. and Samir Ashour, A. "Mechanical Properties of High Strength Fiber Reinforced Concrete" ACI Materials Journal, Vol. 89, No. 5, pp.449-455, 1992.
12. Ganesan, N. and Ramana Murthy, "Strength and Behaviour of Confined Steel Fiber Reinforced Concrete Columns", ACI Materials Journal, Vol.87, No.3, pp.221-227, 1990.
13. PavizSoroushian and Cha-Don Lee, "Distribution and Orientation of Fibers in Steel Fiber Reinforced Concrete", ACI Materials Journal, Vol.87, No.5, pp.433-439, 1990.
14. Goash, S., Bhattacharya and Ray, S.P. "Tensile Strength of Steel Fiber Reinforced Concrete", IE (I) Journal-CI, Vol.69, pp.222-227, 1989.
15. Kukreja, C.B., Kaushik, S.K., Kanchi, M.B. and Jain, O.P. "Tensile Strength of Steel Fiber Reinforced Concrete", Indian Concrete Journal, pp.184-188, 1980
16. http://home.iitk.ac.in/
17. http://www.wikipedia.org/
18. http://shodhganga.inflibnet.ac.in/bitstream/10603/29847/7/07_chapter2.pdf
19. IS 456:2000 "Code of Practice for Plain and Reinforced concrete"

20. IS 516: 1959 Method of Tests for Strength of Concrete
21. IS 10262:2009 Concrete design Mix

AUTHORS PROFILE

SABIR KHAN Completed His B.Tech Civil Engineering And M.Tech Structural Engineering From Aligarh Muslim University Aligarh. He has more than 6 years of teaching experience. He Published 6 International Journal Paper.

Dr. Shiv Kumar obtained PhD from IIT Roorkee in Environmental Engineering. He has more than 12 years of teaching & 5 years.of research experience and published more than 14 papers in various International and National journals and conference