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An Experimental Study on Strength Properties of Fiber Reinforced Concrete

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Abstract: **Concrete is the most widely used construction material in the world due to its ability to get cast in any form and shape. The strength and durability of concrete can be changed by appropriate changes in its ingredients like cementitious material, aggregate, water and by adding some special ingredients. However concrete has some deficiencies. The presence of micro crack in the mortar – aggregate interface is responsible for the inherent weakness of plain concrete. This weakness can be removed by inclusion of fibers in the mixture. Different types of fibers those used in traditional composite material can be introduced into the concrete mixture to increase its toughness or ability to resist crack growth. Such a concrete is called as fiber reinforced concrete. The newly developed fiber reinforced concrete named as engineered composite is 500 times more resistant to cracking and 40% lighter the traditional concrete.**

The study has been carried out by using M30 grade concrete. The combination of steel fibers and HDPE fibers with an aspect ratio of 50 and water cement ratio of 0.45 has been used. The percentage of steel fiber is kept constant i.e. 0.5% and the percentage of HDPE fiber is varied from 0.5% to 2.0% by volume of concrete. The study has been concentrated on analysis of strength characteristics the compression, tensile, flexure, shear tests are planned.

Keywords: **Fiber reinforced concrete, Steel fibers, HDPE fibers, Strength properties.**

1. INTRODUCTION

Concrete is the most extensively used construction material in the world. It is used as the second source for human needs than water source in the world. It provides good workability and it can be moulded to any shape. Concrete is a composite material containing hydraulic cement, water, coarse aggregate and fine aggregate. The resulting material is a stone like structure which is formed by the chemical reaction of the cement and water. This stone like material is a brittle material which is strong in compression but very weak in tension. This weakness in the concrete makes it to crack under small loads, at the tensile end. These cracks gradually propagate to the compression end of the member and finally, the member breaks.

The formation of cracks is the main reason for the failure of the concrete. The formation of cracks in the concrete may also occur due to the drying shrinkage. These cracks are basically micro cracks. These cracks increase in size and magnitude as the time elapses and the finally makes the concrete to fail. To increase the tensile strength of concrete many investigations have been made. One of the successful and most commonly used methods is providing steel reinforcement. Cracks in reinforced concrete members extend freely up to the bars, which need for multidirectional and closely spaced, steel reinforcement will arises. Hence practically it cannot be possible. To overcome this, Fiber reinforcement is used.

Fiber reinforcement gives the better solution for this problem so as to increase the tensile strength of concrete, under a technique of introduction of fibers in concrete is being used. Fibers are a small piece of reinforcing material possessing certain characteristics properties. These fibers act as crack arrestors and prevent the propagation of the cracks. These

fibers are uniformly distributed and randomly arranged. Hence this concrete is named as "Fiber Reinforced Concrete". The main reasons for adding fibers to concrete matrix is to improve the post cracking response of the concrete, i.e., to improve its energy absorption capacity and apparent ductility, and to provide crack resistance and crack control. Also, it helps to maintain structural integrity and cohesiveness in the material.

The concept of using fibers as reinforcement is not new. Fibers have been used as reinforcement since ancient times. Historically, horsehair was used in mortar and straw in mud bricks. In the 1900s, asbestos fibers were used in concrete. In the 1950s, the concept of composite materials came into being and fiber-reinforced concrete was one of the topics of interest. Once the health risks associated with asbestos were discovered, there was a need to find a replacement for the substance in concrete and other building materials. By the 1960s, steel, glass (GFRC) and synthetic fibers such as polypropylene fibers were used in concrete. Research into new fiber-reinforced concretes continues today.

2. EFFECT OF FIBERS IN CONCRETE

Fibers are usually used in concrete to control cracking due to plastic shrinkage and to drying shrinkage. They are also reducing the permeability of concrete and thus reduce bleeding of water. Some types of fibers produce greater impact, abrasion and shatter resistance in concrete. Generally, fibers do not increase the flexural strength of concrete, and it cannot replace moment resisting or structural steel reinforcement. Indeed, some fibers actually reduce the strength of concrete. If the fiber's modulus of elasticity is higher than the matrix (concrete or mortar binder), they help to carry the load by increasing the tensile strength of the material. Increasing the aspect ratio of the fiber usually segments the flexural strength and toughness of the matrix. However, fibers that are too long tend to "ball" in the mix and create workability problems. Some recent research indicated that using fibers in concrete has limited effect on the impact resistance of the materials. The fibers becomes dispersed during the mixing action of concrete, the result is a three dimensional, secondary reinforcement. Fibers are uniformly distributed throughout the concrete in all the directions, and provide effective secondary reinforcement for shrinkage crack control. As the concrete hardens and shrinks, microscopic cracks develop. When these micro cracks intersect a fiber, they are halted and prevented from developing into macro-cracks (visible shrinkage cracks) and further water tightness and durability of the concrete as well. This will also reduce the rate of evaporation and shrinkage and enables the concrete to gain strength without excessive moisture loss.

3. MATERIALS USED FOR THE EXPERIMENTATION

Cement : Ordinary Portland cement of 43 grade was used in this experimentation conforming to IS8112-1989.

Coarse aggregates : Locally available, maximum size 20 mm, specific gravity 2.75

Sand : Locally available sand zone-III with specific gravity 2.18, conforming to IS – 383-1970.

Water : Potable water was used for the experimentation.

Steel fibers **:** 50mm length, 1mm thick and 2mm width, Aspect ratio = 50

HDPE fibers **:** 50mm length and 4mm width, Aspect ratio = 50

4. EXPERIMENTAL STUDY AND RESULTS

In this study, the investigation is carried out on M30 grade of concrete, using 43 grade Portland cement which is conformed to Indian standards. Mix design was carried out according the IS 10262: 2009. The concrete mixed used for casting the cube, cylinder, beam, L-shape specimen is 1: 1.125: 2.42 by weight and a water cement ratio as 0.45.

The 28 days hardened concrete was tested for compressive strength, tensile strength, flexural strength and shear strength parameters and reveling the following tables and graphs gives the overall results of compressive strength, tensile strength, flexural strength, shear strength of concrete by addition of steel fibers and HDPE fibers in different percentage. Also it gives the percentage increase or decrease of compressive strength with respect to reference mix.

Table 1 Overall results of compressive strength

Combination of fibers in percentage	Compressive strength (Mpa)	Percentage increase or decrease in compressive strength compared to normal concrete
0% + 0% SF + HDPEF	34.91	0
0.5% + 0.5% SF + HDPEF	36.18	3.64
0.5% + 1.0% SF + HDPEF	39.36	12.75
0.5% + 1.5%SF + HDPEF	**42.44**	**21.57**
0.5% + 2.0% SF + HDPEF	36.97	5.9

Table 2 Overall results of tensile strength

Combination of fibers in percentage	Tensile strength (Mpa)	Percentage increase or decrease in tensile strength compared to normal concrete
0% + 0% SF + HDPEF	3.09	0
0.5% + 0.5% SF + HDPEF	3.13	1.29
0.5% + 1.0% SF + HDPEF	3.52	13.92
0.5% + 1.5% SF + HDPEF	**3.62**	**17.15**
0.5% + 2.0% SF + HDPEF	3.44	11.32

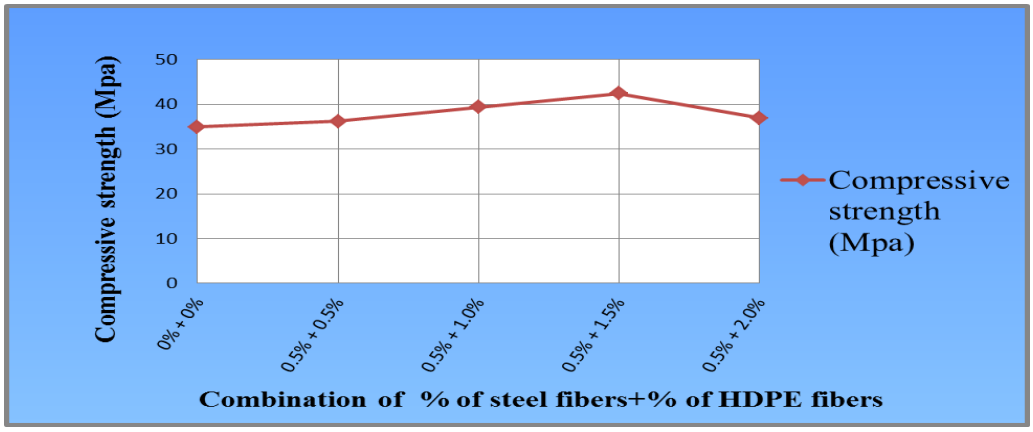
Table 3 Overall results of flexure strength

Combination of fibers in percentage	Flexural strength (Mpa)	Percentage increase or decrease in flexural strength compared to normal concrete
0% + 0% SF + HDPEF	7.80	0
0.5% + 0.5% SF + HDPEF	7.95	1.92
0.5% + 1.0% SF + HDPEF	8.16	4.62
0.5% + 1.5% SF + HDPEF	**8.89**	**13.97**
0.5% + 2.0% SF + HDPEF	7.73	-0.89

Table 4 Overall results of Shear strength

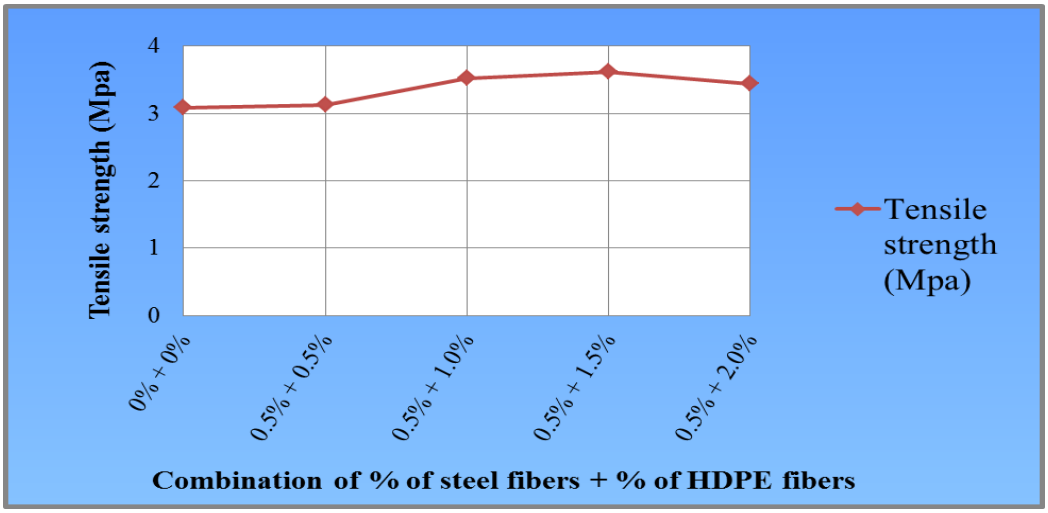
Combination of fibers in percentage	Shear strength (Mpa)	Percentage increase or decrease in shear strength compared to normal concrete
0% + 0% SF + HDPEF	6.03	0
0.5% + 0.5% SF + HDPEF	8.02	33.0
0.5% + 1.0% SF + HDPEF	10.01	66.0
0.5% + 1.5% SF + HDPEF	**12.41**	**105.80**
0.5% + 2.0% SF + HDPEF	10.69	77.28

Following Graph 1 shows the variation of compressive strength of concrete by addition of steel fibers and HDPE fibers in different percentage.



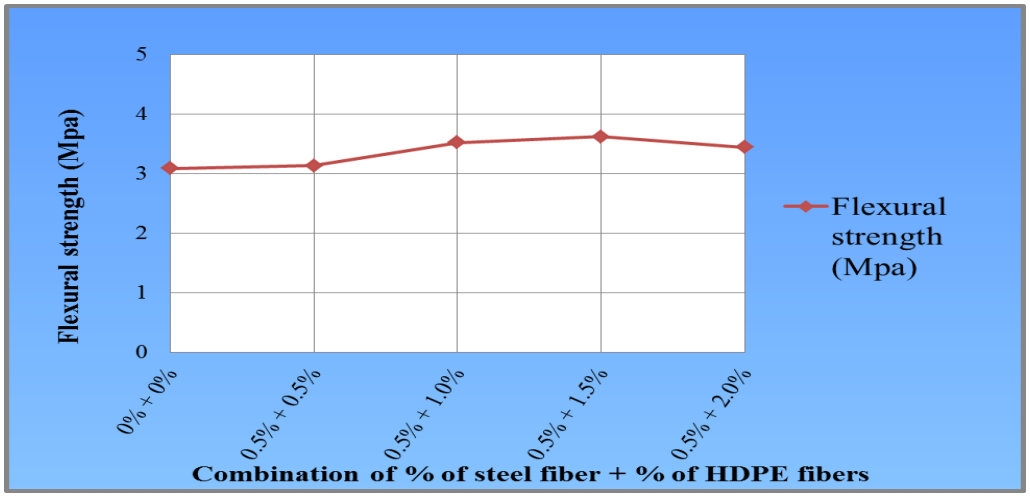
Graph 1 Variation of compressive strength

Following Graph 2 shows the variation of tensile strength of concrete by addition of steel fibers and HDPE fibers in different percentage.



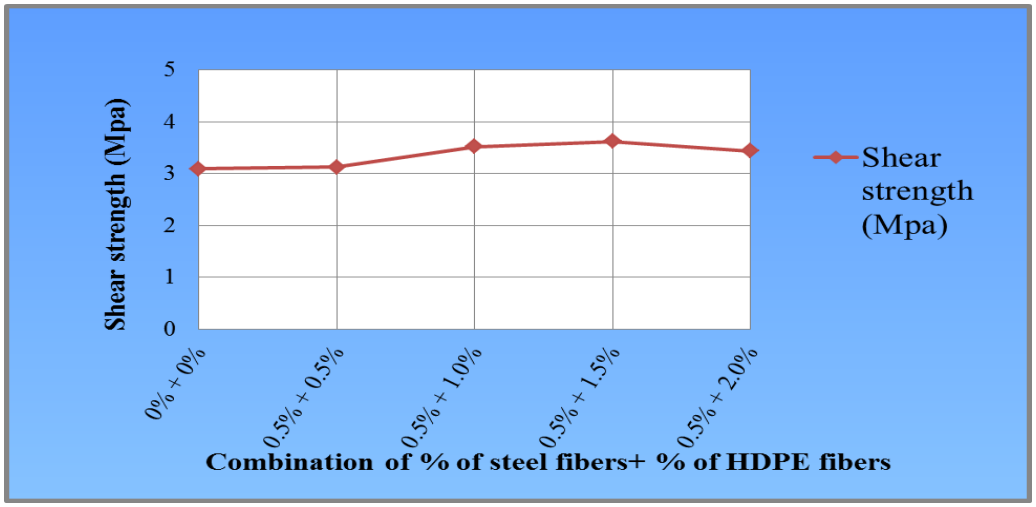
Graph 2 Variation of tensile strength

Following Graph 3 shows the variation of flexure strength of concrete by addition of steel fibers and HDPE fibers in different percentage.



Graph 3 Variation of flexural strength

Following Graph 4 shows the variation of shear strength of concrete by addition of steel fibers and HDPE fibers in different percentage.



Graph 4 Variation of Shear strength

5. CONCLUSIONS

Following conclusions may be drawn on the experimentations conducted on the strength properties of fiber reinforced concrete. The compressive strength tensile strength, flexural strength and shear strength of concrete produced with addition of 0.5% steel fiber + 1.5% HDPE fiber shows higher value than other combination. Higher percentage addition of steel fibers and HDPE fibres to the concrete reduce the workability characteristics of concrete. This problem of workability and flow property of concrete can be overcome by using suitable admixtures such as Superplasicizers.

REFERENCES

[1] "Mr. Abhay Mahadeorao Shende" And "Mr. Ananth M Pande", "Comparative Study on Steel Fiber Reinforced Cum Control Concrete Under Tension", Journal of Civil Engineering (IEB), (2012) Page No. 61-66.

[2] "Mr. Amit Rana", "Some Studies on Steel Fiber Reinforced Concrete", International Journal of Emerging Technology And Advanced Engineering, ISSN 2250-2459, (January 2013) Volume 3, Issue 1, Page No. 120-127.

[3] "Mr. A.M Shinde", "Dr. A.M Pande" and "Mr. M Gulfam Pathan", "Experimental Study on Steel Fiber Reinforced Concrete for M40 Grade", International Refereed Journal of Engineering and Science (IRJES), (Sep 2012), ISSN 2319-183X, Volume 1, Issue 1, Page No. 43-48.

[4] "Mr. B SIVA KONDA REDDY", "Effect of Addition of Steel Fibers on Strength and Durability of High Performance Concrete", Journal of Engineering Research and Studies, ISSN 0976-7916, (July - September 2012), Volume 3, Issue 3, Page No. 1-2.

[5] "Mrs. Kavita S Kene", "Mr. Vikrant S Vairagade" and "Mr. Satish Sathawane", "Experimental Study on Behavior of Steel and Glass Fiber Reinforced Concrete Composites", Bonfring International Journal of Engineering and Management Science, (December 2012) Volume 2, Page No. 125-130.

[6] "Mr. Khilesh Sarwe", "Study on Strength Property of Concrete Using Waste Plastic and Steel Fiber", International Journal of Engineering and Science (IJES), (2014), ISSN (P) 2319-1805, Volume 3, Issue 5, Page No. 9-11.

[7] "Mr. Marabathina Maheswara Rao", "Behavior of Red Sludge on the Properties of HDPE Fiber Reinforced Concrete", International Journal of Emerging Trends in Engineering and Development, ISSN 2249-6149, (July 2013), Volume 4, Issue 3, Page No. 196-201.

[8] "Mr. Milind V Mohod", "Performance of Steel Fiber Reinforced Concrete" International Journal of Engineering and Science, ISSN 2278-4721, (December 2012), Volume 1, Issue 12, Page No. 1-4.

[9] "Mr. K Srinivasa Rao", "Mr. S Rakesh Kumar" and "Mr. A Laxmi Narayana", "Comparison of Performance of Standard Concrete and Fiber Reinforced Standard Concrete Exposed to Elevated Temperatures", American Journal of Engineering Research (AJER), ISSN 2320-0936, (2013), Volume 2, Issue 3, Page No. 20-26.

[10] "Mr. Vikrant S Vairagade", "Mrs. Kavita S Kene" and "Mr. Tejas R Patil", "Comparative Study of Steel Fiber Reinforced Over Control Concrete", International Journal on Scientific and Research Publications, (May 2012), ISSN 2250-3153, Volume 2, Issue 5, Page No. 1-3.

[11] "M S Shetty", "Concrete Technology", S Chand & Company Pvt. Ltd., Ram Nagar, New Delhi, Page No. 559-565.

APPENDIX - A

❖ **IS Codes:**

1) IS: 10262-2009, Concrete Mix Proportioning Guidelines (First Revision), Bureau of Indian Standards, Manak Bhavan, 9 Bahadur Shah Zafar Marg, New Delhi, July 2009.

2) IS: 456-2000, Plain And Reinforced Concrete - Code of Practice (Fourth Revision), Bureau of Indian Standards, Manak Bhavan, 9 Bahadur Shah Zafar Marg, New Delhi, October 2000.

3) IS: 8112-1989, 43 Grade Ordinary Portland Cement Specifications (First Revision), Bureau of Indian Standards, Manak Bhavan, 9 Bahadur Shah Zafar Marg, New Delhi, May 1990.

4) IS: 383-1970, Specifications for Coarse and Fine Aggregate from Natural Sources for Concrete (Second Revision), Bureau of Indian Standards, Manak Bhavan, 9 Bahadur Shah Zafar Marg, New Delhi, April 1971.

5) IS: 5816-1999, Splitting Tensile Strength of Concrete Method of Test (First Revision), Bureau of Indian Standards, Manak Bhavan, 9 Bahadur Shah Zafar Marg, New Delhi, July 1999.

6) IS: 516-1959, Methods of Tests for Strength of Concrete, Edition 1.2, Bureau of Indian Standards, Manak Bhavan, 9 Bahadur Shah Zafar Marg, New Delhi, Reaffirmed 1999.

7) IS: 2386-1963, (Part 3) Methods of Tests for Aggregate for Concrete, Bureau of Indian Standards, Manak Bhavan, 9 Bahadur Shah Zafar Marg, New Delhi, Reaffirmed 1997.

8) IS: 4031-1996, (Part 1) Methods of Physical Tests for Hydraulic Cement (Second Revision), Bureau of Indian Standards, Manak Bhavan, 9 Bahadur Shah Zafar Marg, New Delhi.

9) IS: 4031-1988, (Part 4) Methods of Physical Tests for Hydraulic Cement (First Revision), Bureau of Indian Standards, Manak Bhavan, 9 Bahadur Shah Zafar Marg, New Delhi, Reaffirmed 1995.

10) IS: 4031-1988, (Part 5) Methods of Physical Tests for Hydraulic Cement (First Revision), Bureau of Indian Standards, Manak Bhavan, 9 Bahadur Shah Zafar Marg, New Delhi, Reaffirmed 2000.

11) IS: 1199-1959, Methods of Sampling and Analysis of Concrete, Bureau of Indian Standards, Manak Bhavan, 9 Bahadur Shah Zafar Marg, New Delhi, Reaffirmed 1999.