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Experimental View of Macro and Micro Hybrid Fibre on Strength of Concrete

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Abstract:— **Fibre reinforcement is commonly used to provide toughness and ductility to brittle cementations matrices. Reinforcement of concrete with a individual type of fibre may improve the desired properties to a limited level. A composite is termed as hybrid, if two or more types of fibres are combined to produce a composite that derives benefits from each of the individual fibres and exhibits the properties of all the fibres in concrete.**

The work carried out for study of the, behaviour of Steel fibre with micro synthetic fibre and macro-synthetic fibres with micro-synthetic fibres to improve the tensile behaviour of fibre reinforced concrete, such that this can be used for the maximum tensile and compressive behaviour of Hybrid fibre reinforced concrete.

Index Terms— **FRC, Hybrid FRC, Polypropylene Fibre, Macro synthetic Fibre, Micro synthetic Fibre**

I. INTRODUCTION

Fiber Reinforced Concrete (FRC) is concrete containing fibrous material which increases its structural integrity. It contains short discrete fibers that are uniformly distributed and randomly oriented. Fibers include steel fibers, glass fibers, synthetic fibers and natural fibers. Each one of which lends varying properties to the concrete.

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, and synthetic fibers such as polypropylene fibers were used in concrete. Research into new fiber-reinforced concretes continues today.

Fibers are usually used in concrete to control cracking due to plastic shrinkage and to drying shrinkage. They also reduce 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 so cannot replace moment resisting or structural steel reinforcement. Indeed, some fibers actually reduce the strength of concrete.

Luca [1] studied two different types of hybrid composites with steel and polypropylene Macro-Fibres as well as polypropylene and carbon Micro-Fibres. Study indicate that HYFRC can truly be engineered with suitable mix designs for various applications. Zongcai and Jianhui [2] investigated on hybrid fibres including high elastic modulus steel fibre and low elastic modulus synthetic macro-fibre (HPP) as two elements were used as reinforcement materials in concrete. The investigation of Zongcai and Jianhui [2] using high elatic modulus steel fibres and low elastic modulus synthetic macro fiber showed that when the total fibre volume fractions (V_f = 0.5) were kept as a constant (V_f = 1.5), compared with single type of steel or HPP fibres, hybrid fibres can significantly improve the toughness, flexural impact life and fracture properties of concrete. Milad [3] presents the influence of different fibre in high-performance lightweight concrete and the ductility capacity of reinforced lightweight concrete beam. Tamil and Thandavamoorthy [4] studied the strength of concrete cubes, cylinders and prisms cast using M30 grade concrete and reinforced with steel and polypropylene fibres. Also, hybrid fibres with crimped steel and polypropylene were used in concrete matrix to study its improvements in strength and durability properties.
Machine H., et.al [5] investigates the mechanical properties of Polypropylene hybrid Fibre-Reinforced Concrete. The results showed that the compressive strength, splitting tensile strength, and flexural properties of the polypropylene hybrid fibre-reinforced concrete are better than the properties of single fibre-reinforced concrete. Rashid H., et.al [6] gives contribution towards the flexural properties of metallic-hybrid-fibre reinforced concrete. The test results on hybrid-fibre-reinforced concrete showed that the two metallic fibres

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when used in hybrid form result in superior performance compared to their single-fibre reinforced counterparts. Harsh [7] studied SFRC which has the ability of excellent tensile strength, flexural strength, shock resistance, fatigue resistance, ductility and crack arrest. Darole J. S., et.al [8] studied Hybrid fibre can provide reinforcement at all the range of strains. Combination of low and high modulus fibres can arrest cracks at micro level as well as macro level. David J. C. (2013) studied the benefits of fibre reinforced concrete (FRC). David focussed on steel FRC subjected to monotonic loads.

In this work investigated the compressive behaviour of macro synthetic structural fibres as reinforcement for concrete elements, in comparison to the behaviour exhibited by steel fibres.

Experimental Work

Casting and testing of concrete cubes, cylinders, beams were done as per IS code recommendations (IS Code 10262 : 2009, Concrete Mix Design). The proportioning of concrete mixes consists of determination of the quantities of respective ingredients necessary to produce concrete having adequate, but not excessive, workability and strength for the particular loading and durability for the exposure to which it will be subjected. Emphasis is laid on making the most economical use of available materials so as to produce concrete of the required attributes at the minimum cost. The basic assumption made in mix design is that the compressive strength of workable concrete is governed by the water cement ratio. The concrete mix adopted was M20 and M30 concrete with varying percentage of fibres ranging from 0, 0.25, 0.5, 0.75 & 1%. Even though the mix design need not be done for the basic mixes of M20 it was verified by designing it.

The ingredients of the concrete used include: tap water, Cement (Portland Pozzolana Cement), coarse aggregates with diameters in the range of 10-20mm, medium graded with aggregate size within 4-10mm, fine sand and polypropylene micro, Polypropylene macro fibers and steel fibers.

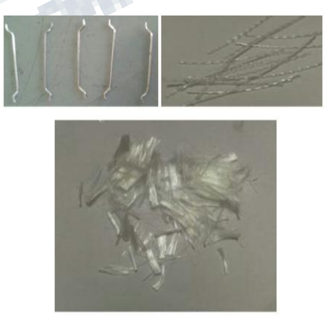

Fig 1: Steel fibers, Macro Polypropylene fibers and Micro Polypropylene fibers

Properties of Fibres

a) Steel Fibre

Type of Fibre:
- Shaktiman MSH 10050 Hook End Steel Fibre

Compliance:
- Conform to ASTM A820, Type I cold drawn wire
- Testing conform with ASTM A820

Nominal dimension:
- Diameter D = 0.7mm
- Length L = 35
- Aspect Ratio L/D = 50
- Hook depth h & h' =1.80mm, +1/-0mm
- Hook length l & l' = 1-4 mm
- Bending angle α & α' = 450
- Torsion angle = <300
- Tensile strength of wire 1100 MPa
- Strain at failure < 4%

b) Polypropylene Macro Fibre:

Type of fibre
- Embossing fibre

Nominal dimension:
- Diameter D = 0.5mm
- Length L = 35 mm
- Aspect Ratio L/D = 70
- Tensile strength = 30.20 kgf

c) Polypropylene Micro Fibre:

Type of fibre
- monofilament fibre

Nominal dimension:
- Length L = 12 mm
- Diameter D = 30 micron

Tensile strength = 4.5 kgf

Mix Proportions

Six types of concrete cubes were prepared according to mix proportion as Cement : Fine Aggregate : Coarse Aggregate : Water (1 : 1.71 : 2.36 : 0.45). The mix proportion classified as shown in Table 1 according to the use of fiber. The concrete coded as M0 to M5. Concrete M0 stands for the conventional Concrete without fiber and other concrete (i.e. M1, M2 M3, M4, M5) have the variation of the steel fiber, Polypropylene Macro fiber and Polypropylene Micro fibers

Table 1 : - Mix Proportion of Concrete Cube

Type of Concrete	% of Steel Fiber	% of Polypropylene Macro Fibre	% Polypropylene Micro Fibre
M0	0	0	0
M1	1	0	0
M2	0	1	0
M3	0.5	0.5	0
M4	0.7	0	0.3
M5	0	0.7	0.3

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Scope of Present Investigation

The purpose of this study was to compare the macro synthetic structural fibres as reinforcement for concrete elements, in comparison to the behaviour exhibited by steel fibres.

Test Method

The slump test for all types of concrete mixes was performed with a targeted slump flow of 100 mm±10mm. Table 2 shows the slump of mix. Compressive strength test by casting 150x150x150mm cubes,

Table 2 :- Slump of Mix

Type of Concrete	Slump (mm)
M0	100
M1	95
M2	98
M3	96
M4	95
M5	98

Result and Discussion

The test results of Steel fibers, Macro Polypropylene fibers and Micro Polypropylene fibers are compared with conventional Concrete (M0) at 07 and 28 days of curing. The comparison of compressive strength of concrete specimens is given in Table 3.

Table 3 Compressive strength at 7 and 28 days Curing

Sr. No	Mix	Average Strength (7 Days)		Average Strength (28 Days)	
		Obtained N/mm 2	Increased (in %)	Obtained N/mm 2	Increased (in %)
1	M0	23.24	**0.000**	36.74	**0.000**
2	M1	25.25	**8.649**	41.62	**13.283**
3	M2	27.11	**16.652**	37.77	**2.803**
4	M3	26.59	**14.415**	45.18	**22.972**
5	M4	28.15	**21.127**	35.7	**-2.831**
6	M5	28.58	**22.978**	35.85	**-2.422**

From Table 3, the results shows that the % increase in the compressive strength higher with the addition of 0.5 % steel fiber and 0.5% Polypropylene Macro Fibre at 28 days but at 7 days the compressive strength is low as compared to the 0.7% of Polypropylene Macro Fibre and 0.3% Polypropylene Micro Fibre.

CONCLUSION

Following conclusions are drawn from the present investigation:

- It is evident from the present investigation that the use of various type of fibres at one mix proves to be better as compared to use of unique fibers.
- There was 22% increase in the compressive strength as a result of use of multiple fibers.
- The improved mechanical properties of steel fibers and macro Polypropylene fiber would result in reduction of warping stresses, short and long term cracking and reduction of slab thickness.

REFERENCES

[1] Luca S., "Static and Dynamic Responses of Hybrid Fibre Reinforced Concrete", International Conference on Advance in Concrete and structure, Xuzhou (China), pp.25-27, 2005.

[2] Zongcai D. and Jianhui L., "Mechanical behaviours of concrete combined with steel and synthetic macro-fibres", International Journal of Physical Sciences,China, Vol. 1 (2), pp. 057-066, 2006.

[3] Milad A., "Ductility in Lightweight Concrete with Fibre", Det Teknisk- Naturvitenskapelige Fakultet, pp.1-86, 2011.

[4] Tamil M. S. and Thandavamoorthy T.S., "Studies on the Properties of Steel and Polypropylene Fibre Reinforced Concrete without any Admixture", International Journal of Engineering and Innovative Technology (IJEIT), Chennai, ISSN, Volume 3, Issue 1, 2277-3754, 2013.

[5] Machine H., Chijen T. and Songb P.S., "Mechanical properties of polypropylene hybrid fibre-reinforced concrete", Elsevier, Materials Science and Engineering A 494, pp. 153–157, 2008.

[6] Rashid H., Anaclet T., Frédéric D., Alain S., "Study on the flexural properties of metallic-hybrid fibre reinforced concrete", Maejo International Journal of Science and Technology, France, 4(02), pp.169-184, 2010.

[7] Harsh R., "Steel Fibre Reinforced Concrete: An Analysis", the inquisitive Meridian multidisplinary journal, ISSN- Vol. 1, Issue 2, 2347-6257, 2013.

[8] Darole J. S., Kulkarni V.P., Shaikh A.P. and Gite B.E., "Effect of Hybrid Fibre on Mechanical Properties of Concrete", International Journal of Engineering Research and Applications (IJERA), Vol. 3, Issue 4, pp.1408-1411, 2013.

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