Improvement of Mechanical Properties of Concrete Using Fibers

Pramol Waychal[1] , Dr. Nagesh Shelke[2]

[1]PG Student (ME Civil- Structural Engineering), Dr D Y Patil School of Engineering & Technology, Lohgaon, Pune, Maharashtra, India

[2]Assistant Professor, Dr D Y Patil School of Engineering & Technology, Lohgaon, Pune, Maharashtra, India

ABSTRACT

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 of which lend varying properties to the concrete. In addition, the character of fiber-reinforced concrete changes with varying concretes, fiber materials, geometries, distribution, orientation, and densities. 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 mudbricks. 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.

Keywords : Fiber reinforced concrete, types of fiber, Admixtures, concrete mix design M40, compression test, flexural test

I. INTRODUCTION

Civil structures made of steel reinforced concrete normally suffer from corrosion of the steel by the salt, which results in the failure of those structures. Constant maintenance and repairing is needed to enhance the life cycle of those civil structures. There are many ways to minimize the failure of the concrete structures made of steel reinforce concrete. The custom approach is to adhesively bond fiber polymer composites onto the structure. This also helps to increase the toughness and tensile strength and improve the cracking and deformation characteristics of the resultant composite. But this method adds another layer, which is prone to degradation. These fiber polymer composites have been shown to suffer from degradation when exposed to marine environment due to surface blistering. As a result, the adhesive bond strength is reduced, which results in the de-lamination of the composite.

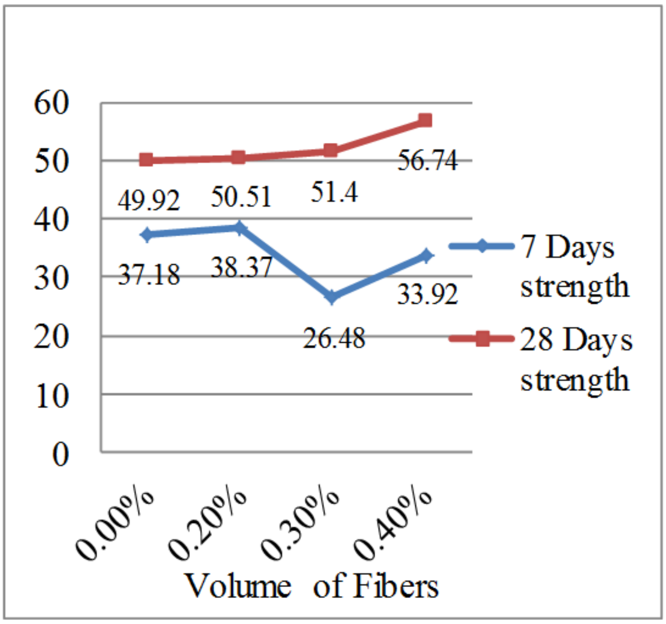
Fiber-Reinforced Concrete (FRC) results from the addition of either short discrete fibers or continuous long fibers to the cement based matrix. Due to the superior performance characteristics its use by the construction industry has significantly increased in the last 5 years. For highway pavement applications, concretes with early strength are attractive for potential use in repair and rehabilitation with a view towards early opening of traffic.

Their main purpose is to increase the energy absorption capacity and toughness of the material, but also increase tensile and flexural strength of concrete. There is considerable improvement in the post-cracking behaviour of concretes containing fibers. Compared to plain concrete, fibre reinforced concrete is much tougher and more resistant to impact. It may also contain pozzolona and other admixtures commonly used in conventional concrete. Fibers of various shapes and sizes produced from steel, plastic, glass, and natural materials are being used; however, for most structural and nonstructural purposes, steel fiber is the most commonly used of all the fibers.

For many applications, it is becoming increasingly popular to reinforce the concrete with small, randomly distributed fibers.Concrete containing a hydraulic cement, water, fine or fine and coarse aggregate and discontinuous discrete fibers is called fiber-reinforced concrete (FRC).

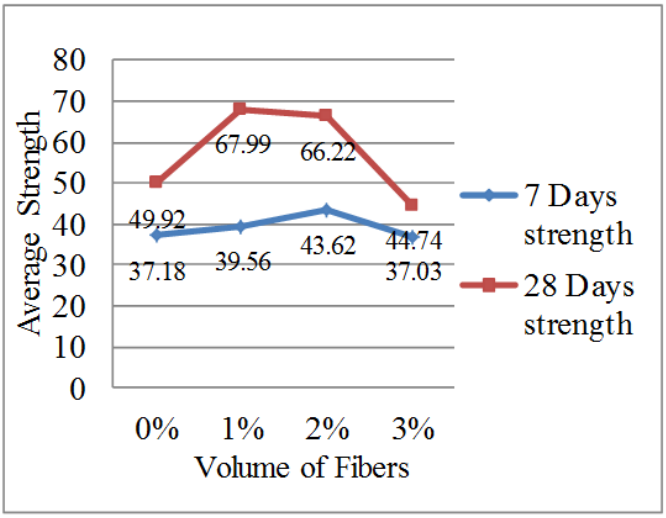
We are dealing with analysis of strength & cost of design by respected results obtained from trials taken as per above mix design. Every result is shown by graph representing strength due to course of time in 7 & 28.

Compressive strength analysis of PPF Concrete:



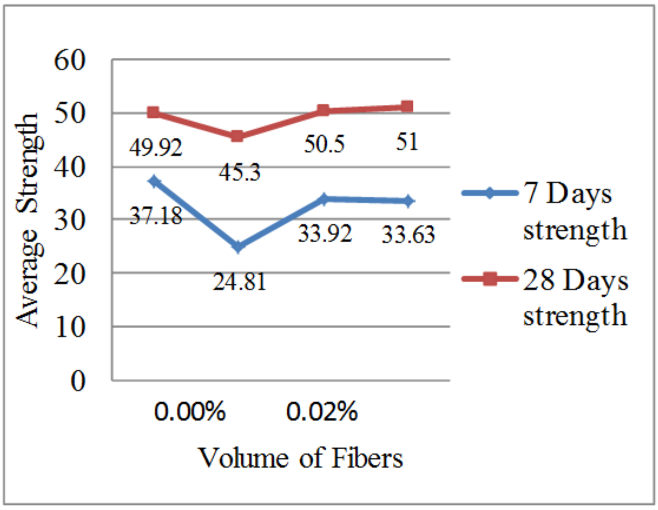
The graph shows that early strength is achieved by member having 0.2% vol.ofpolypropylene fiber. Member got maximum compressive strength by use of 0.4% of polypropylene fiber for 28 days.

Compressive strength analysis of SYN.F concrete:-



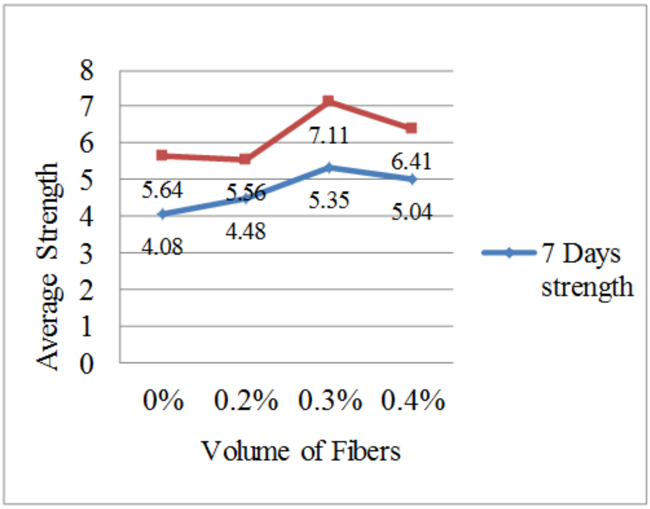
The graph shows that early strength is achieved by member having 2% vol. of steel fiber. Member got maximum compressive strength by use of 1% of steel fiber for 28 days

Compressive strength analysis of SYN.F concrete

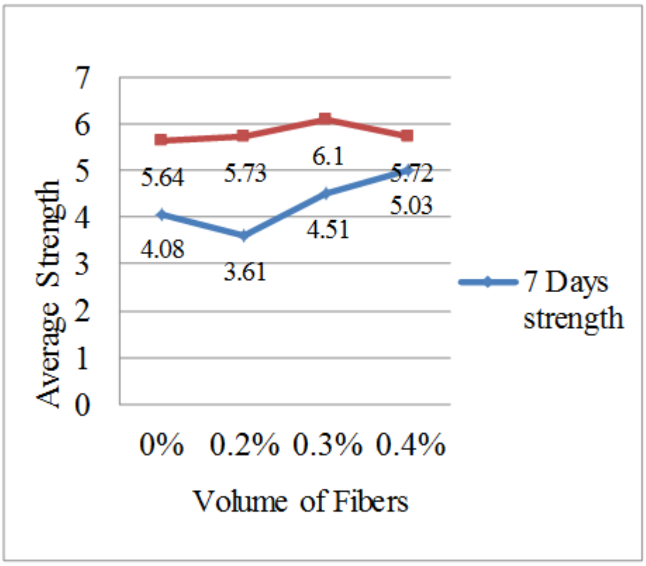


The graph shows that early strength is achieved by member having 0.3% vol. of synthetic fiber. Member got maximum compressive strength by use of 0.4% of synthetic fiber for 28 days.

Flexural strength analysis of PPF concrete

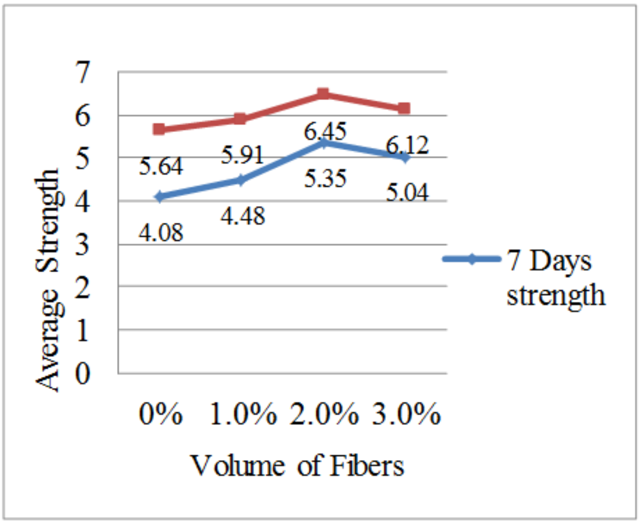


The graph shows that early strength is achieved by member having 0.3% vol. of polypropylene fiber. Member got maximum compressive strength by use of 0.3% of polypropylene fiber for 28 days.



The graph shows that early strength is achieved by member having 0.4% vol. of synthetic fiber. Member got maximum compressive strength by use of 0.3% of synthetic fiber for 28 days.

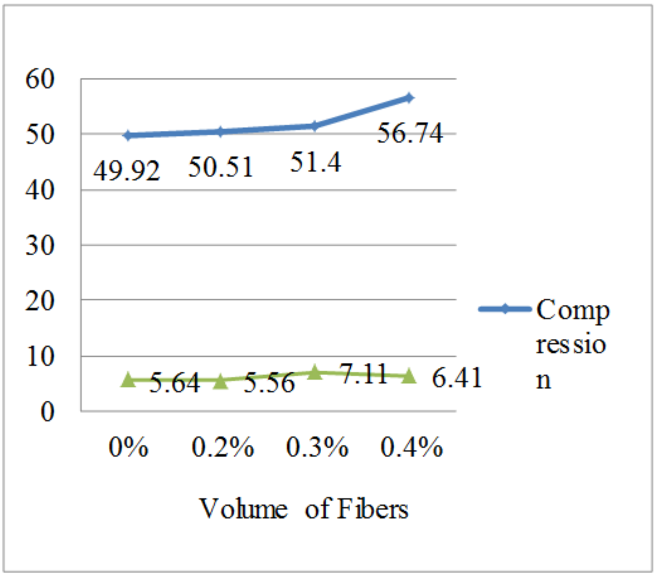
Flexural strength analysis of SF concrete



The graph shows that early strength is achieved by member having 2% vol. of steel fiber. Member got maximum compressive strength by use of 2% of steel fiber for 28 days

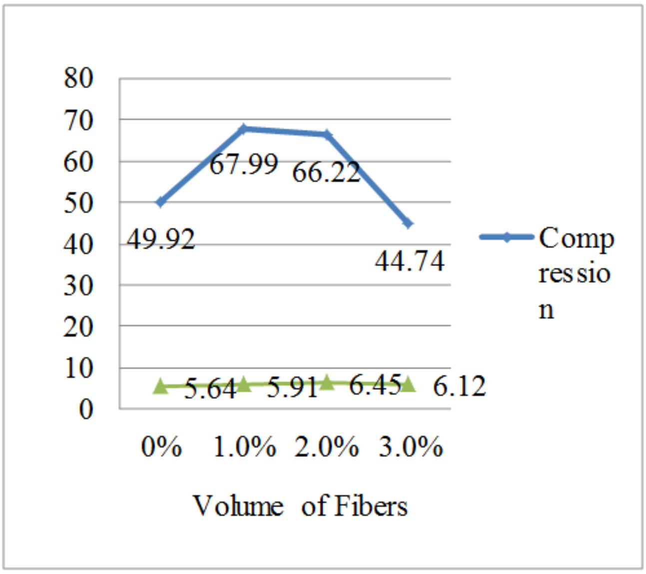
Flexural strength analysis of SYN.F concrete

Strength analysis of Polypropylene Fiber Reinforced Concrete for 28 days



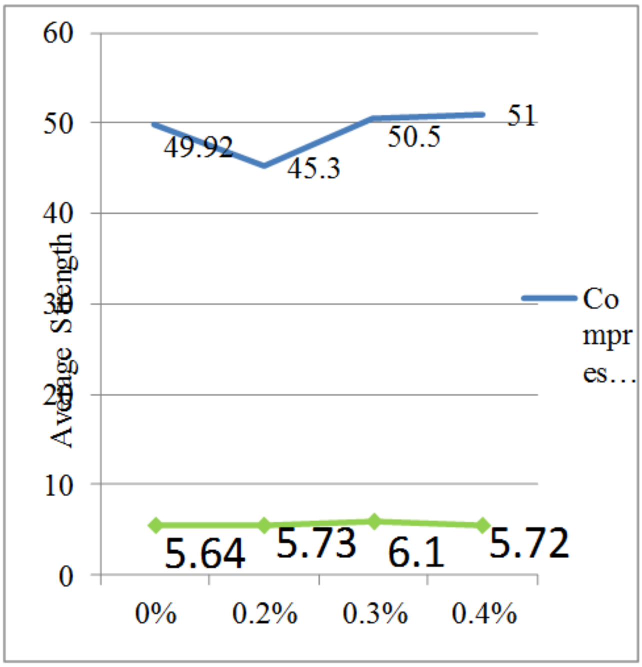
The graph shows that how all the 28 days strengths vary by changing percentage of polypropylene fibers.We can say that flexure strength doesn't vary that much but Compressive strength is considerably increased at 0.4%

Strength analysis of Steel Fiber Reinforced Concrete for 28 days



The graph shows that how all the 28 days strengths vary by changing percentage of steel fibers. We can say that flexure strength increases up to 2% of volume of fibers but beyond that it decreases. This is because workability decreases with increase in volume of fibers after certain limit.

Strength analysis of Synthetic Fiber Reinforced Concrete for 28 days



The graph shows that how all the 28 days strengths vary by changing percentage of synthetic fibers. We can say that flexure strength increases up to 0.3% of volume of fibers but beyond that it decreases. Compressive strength increases after 0.3% of volume of fibers

Cost Analysis:

Cost of concrete is depending upon the quantity, quality & proportion of materials used. As M40 grade concrete id high grade concrete, use of cement is more to achieve early high strength. Reinforcement of fibers in concrete not only changes the strength property of concrete but also changes the cost of that particular design.

Here we have done cost analysis for steel fibers reinforced concrete & polypropylene fibers reinforced concrete& synthetic fiber reinforced concrete for 2% & 0.4%& 0.3% respectively which have maximum strength.

Material	**Rate (Rs.)**	**Cost of concrete (Rs.)**			
		P.C.C.	**Steel**	**Polypropylene**	**Synthetic**
Cement	360/Bag	2628	2628	2628	2628
Steel Fiber	135/Kg	-	1215	-	-
PPF	80/Kg	-	-	144	-
Synthetic	85/kg	-	-	-	153
Fly ash	1.9/Kg	161.5	161.5	161.5	161.5
Crushed Sand	1.69/Kg	1396	1396	1396	1396
10mm Aggregate	1.5/Kg	637.5	637.5	637.5	637.5
20mm Aggregat	1.4/Kg	900	900	900	900
Admixture	35/Kg	126	126	126	126
	Total	**584**	**706**	**5993**	**6002/-**

II. CONCLUSION

1. Polypropylene fiber reinforced concrete
   - ✓ From graph 1, we conclude that early strength is achieved by member having 0.2% vol. of polypropylene fiber. Member got maximum

compressive strength by use of 0.4% of polypropylene fiber for 28 days.

- ✓ From graph 4, we conclude that early strength is achieved by member having 0.3% vol. of polypropylene fiber. Member got maximum compressive strength by use of 0.3% of polypropylene fiber for 28 days.

2. Steel Fiber reinforced concrete
   - ✓ From graph 2 ,we conclude that early strength is achieved by member having 2% vol. of steel fiber. Member got maximum compressive strength by use of 1% of steel fiber for 28 days.
   - ✓ From graph 5, we conclude that early strength is achieved by member having 2% vol. of steel fiber. Member got maximum compressive strength by use of 2% of steel fiber for 28 days.
   - ✓ Strength of steel fiber reinforced concrete decreases if volume fraction of fibers is increased beyond 2%.
3. Synthetic fiber reinforced concrete
   - ✓ From graph 3 , we conclude that early strength is achieved by member having 0.3% vol. of synthetic fiber. Member got maximum compressive strength by use of 0.4% of synthetic fiber for 28 days.
   - ✓ From graph 6 , we conclude that early strength is achieved by member having 0.4% vol. of synthetic fiber. Member got maximum compressive strength by use of 0.3% of synthetic fiber for 28 days.
4. Economy Consideration
   - ✓ From table 7.1,we may conclude that cost of concrete is increased by 22% using 2% of steel fibers , 3% using 0.4% polypropylene fibers & 3% using 0.3% synthetic fibers.
   - ✓ Though use of steel fibers increases cost of concrete by 22% it also enhances the mechanical properties of concrete for example up to 36 % while use of polypropylene fiber gives 13% increased strength at the 3% increased cost so that of normal concrete.
   - ✓ Use of PPF could be advised over steel fiber where flexural properties are focused same could be done for synthetic fibers
   - ✓ Use of steel fibers is heavily recommended for heavy structures.

III. REFERENCES

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IV. Authors

1.  
2. Dr Nagesh Shelke Mr. Pramol Waychal
3. (Guide) (PG Students)
4. Asst. Professor ME Civil (Struct)
5. Civil Engineering Civil Engineering
6. DYPSOET, Pune DYPSOET, Pune