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Vitality of Steel and Polypropylene Fibers in High Strength Concrete

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Abstract: The main aim of this work was to investigate the influence of widely used steel fibers and polypropylene fibers on the concrete. From many studies it has been shown that, addition of fibers to the concrete has influenced the cracking of concrete, due to shrinkage, thermal insulation and bleeding of water. So, in this study we made use of ultra high strength concrete mix of M50, and we made use of both steel as well as polypropylene fibers to enhance the properties of the concrete. In this study total five concrete mixes were made with steel fiber in dosages of 2.5%, 2%, 1.5%, 1% and polypropylene fibers are in dosage 0%, 0.5%, 1%, 1.5% of the weight of concrete mix. The specimens were casted and all the specimens are tested for 7days and 28 days strength. The results have depicted a gradual increase in the strength of the concrete as the fiber content increased.

Keywords: steel fiber, polypropylene fibers, compressive strength, ultra high strength concrete.

I. INTRODUCTION

Ultra-high performance concrete is generally used for many projects like roads, bridges and structures at adverse environment conditions. High strength concretes offer greater strength and durability besides having low water cement ratio.The frost resistance of the concrete is mainly affected by its porosity, type of aggregate, fiber characteristics and environmental conditions. Many studies were done on this behavior of the concrete and have concluded stating that the low water cement ratio which is below 0.4 would reduce the effect of chlorides, and also arrests the spalling of concrete and protecting the reinforcement from corrosion.Fibers as we all know are added to the concrete, which are used as reinforcing members in the concrete. Many studies have proven the strength up gradation by adding steel fibers to the concrete. Polypropylene fiber is synthetic fiber, which have good thermal insulating property and have good elongation property. In this study we added these two fibers, say steel fibers and polypropylene fibers to the concrete and then the strength properties are evaluated.

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II. MATERIALS AND MIX PROPRTIONS

In this study materials used are cement, Fine Aggregates, Silica Fume, Ground Granulated Blast Furnace Slag, Coarse Aggregates.

A. Cement

Ordinary Portland Cement (OPC) 53 grade was used which fulfill the requirements of IS 12269-19887. A few tests are conducted on the cement. The properties of cement were given in Table I.

Table I: cement test results

Physical Property	Values of OPC used	As per IS 12269-1987
Standard consistency	30.85%	---
Initial setting time	34minutes	Maximum of 30 minutes
Final setting time	11hours	Maximum of 600 minutes
Specific gravity	3.22	---

B. Aggregates

i. Fine Aggregate:

The locally available river sand passing through IS 4.75mm sieve is used which was coming under Zone II as per IS 383-1987.The properties of sand were given in Table II.

Table II: Properties of F.A.

Physical property	values
Specific gravity	2.589
Fineness modulus	2.62
Water Absorption	1.6%

ii. Coarse aggregate:

The locally available crushed aggregate of 10mm maximum size retained on IS 4.75mm sieve has been used as per IS 2386 – 1963. The properties of aggregates were given in Table III.

Table III: Properties of C.A.

Physical property	Values
Aggregate size	10
Specific gravity	2.62
Fineness modulus	2.71
Water Absorption	0.64%
Crushing value	0.49%
Impact value	12.6

C. Polypropylene fiber*:*

Polypropylene fibers are generally synthetic fibers which have high thermal insulating properties and high elasticity and resilience. Adding these fibers to the concrete would add some special properties to the concrete. The properties of polypropylene fiber are given in Table IV.

Table IV: Properties of polypropylene fiber

Property	values
Absorption	Nil
Specific gravity	0.91
Fiber length	Single cut lengths
Electrical conductivity	Low
Acid& salt resistance	High
Melt point	324F(162C)
Thermal conductivity	Low
Ignition point	1100F(593C)
Alkali resistance	Alkali proof

D. Steel fiber:

Steel fibers are used in cement for several applications such as floors, structural elements etc. Fibers are very cost as on cement.it is a crystalline of metal reinforcement ratio of fiber diameter 20-100, with different cross-sections.

Fig.1: Steel Fibers

III. MIX DESIGN

In This experimental study design for M50 grade is from Is 10262-2009.water cement ratio is 0.45. The mix ratio has done as 1:1.7:2.6. Mix proportions as given in Table V.

Table V: Mix proportions

Constituents	CC	MIX 1	MIX 2	MIX 3	MIX 4
Cement	425	425	425	425	425
Water	191	191	191	191	191
Fine aggregate	729	729	729	729	729
Coarse aggregate	1134	1134	1134	1134	1134
Polypropylene fiber	-	0.5%	1	1.5%	2%
Steel fibers	-	2.5%	2.0%	1.5%	1%

IV. METHODOLOGY

A. Experimental Program

Specimens of five mixes are casted. One mix is a normal conventional concrete (cc) of M50grade and other four mixes are adding of polypropylene fibers and steel fibers to the concrete with the mix proportions of a given Table VIII. Firstly place the coarse aggregates, fine aggregates cement in wet dry place ,mix it for a time interval of six minutes, Then place the polypropylene fibers and steel fibers and mix it slowly ,after completion of a mixing of materials Then water is added slowly to the dry mixture, then Concrete is filled into the cubes of dimensions 150x150mm, Cylinders of the diameter150 x 300mm, Beams of the diameter 150 x 150 x 720mm To get full compaction of moulds .compact the moulds with the compaction rod to fill of gaps in a concrete. After the compaction, Place the moulds for the de moulded for 24 hrs. Then place the specimens in the curing tank for 7 and 28 days. Then the specimens are to be taken out for tests of Compressive strength, flexural strength, and split tensile strength. The specimens in curing tank as shown in Fig2.

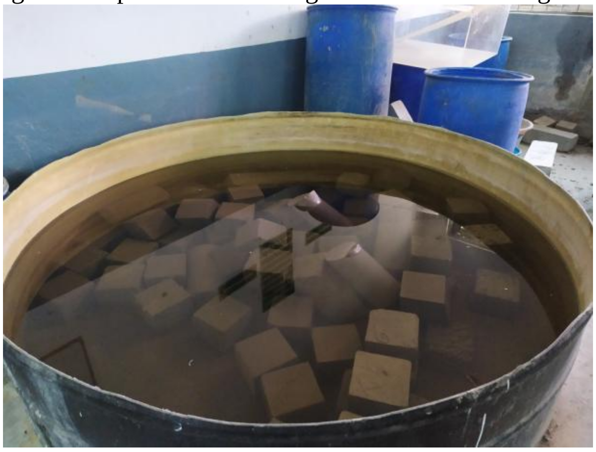

Fig.2: Specimens in curing tank

V. RESULTS AND DISCUSSIONS

A. Compressive strength

The Compressive strength results were given in Table VI.

Table VI: Compressive Strength Results.

Trial	7 Day (Mpa)	28 Day (Mpa)
Conventional concrete	5	55
Mix 1 (0.5%polypropylene fibers + 2.5% steel fibers)	52.6	55.8
Mix 2(1%polypropylene fibers + 2% steel fibers)	53.8	56.2
Mix3(1.5%polypropylene fibers + 1.5% steel fibers)	55.9	58.6
Mix4(2%polypropylene fibers + 1% steel fiber)	56.2	59.8

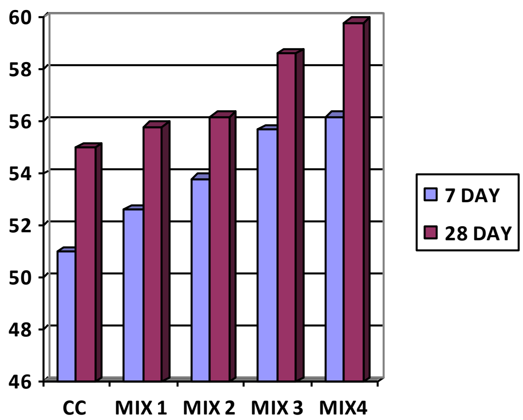

Fig3: Compressive Strength Of Concrete.

Fig4: Cube of concrete

Fig6: Cylinder of concrete

B. Split Tensile strength

The Split tensile strength results were given in Table VII.

Table VII: Split Tensile Strength Results.

Trial	7 Day (Mpa)	28 Day (Mpa)
Conventional concrete	3.26	3.42
Mix 1 (0.5%polypropylene fibers + 2.5% steel fibers	3.51	3.67
Mix 2(1%polypropylene fibers + 2% steel fibers)	3.70	3.88
Mix3(1.5%polypropylene fibers + 1.5% steel fibers)	3.92	4.01
Mix4(2%polypropylene fibers + 1% steel fibers)	4.18	4.32

C. Flexural strength

The Flexural strength results were given in Table VIII.

Table VIII: Flexural strength Results

Trial	7 Day (Mpa)	28 Day (Mpa)
Conventional concrete	4.78	4.82
Mix 1 (0.5%polypropylene fibers + 2.5% steel fibers	4.92	5.01
Mix 2(1%polypropylene fibers + 2% steel fibers)	5.18	5.26
Mix3(1.5%polypropylene fibers + 1.5% steel fibers)	5.24	5.69
Mix4(2%polypropylene fibers + 1% steel fibers)	5.41	5.88

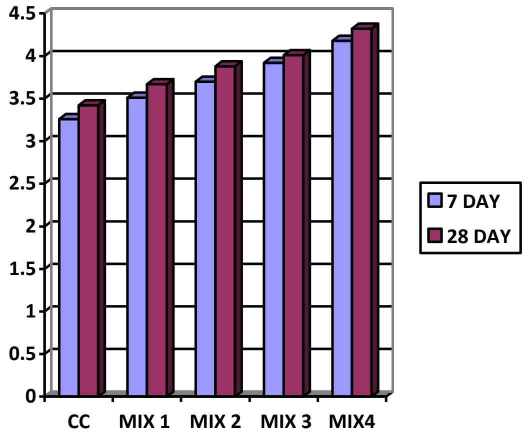

Fig5: Split tensile strength of concrete.

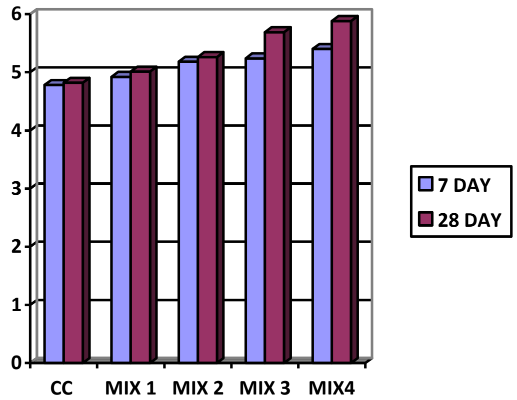

Fig7: Flexural strength of concrete.

Fig8: Beam of concrete

VI. CONCLUSION

1. The compressive strength obtained for conventional concrete at 28 days of curing is 55mpa and the compressive strength values obtained for mix1 is 55.8mpa, mix2 is 56.2mpa, and mix3 is 58.6mpa, and mix4 is 59.8mpa.
2. Results depict that 1.45%, increase in its strength for mix1, 2.18%, increase in its strength for mix2, 6.54%, increase in its strength for mix3 and 8.72%, increase in its strength for mix4. When compared to conventional concrete.
3. The split tensile strength obtained for conventional concrete at 28 days of curing is 3.42mpa, and the split tensile strength values obtained for mix1 is 3.67mpa, mix2 is 3.88mpa, mix3 is 4.01mpa and mix4 is 4.32mpa
4. Results depict that 7.3%, increase in its strength for mix1, 13.45%, increase in its strength for mix2, 17.25%, increase in its strength for mix3, and 26.31%, increase in its strength for mix4.when compared to conventional concrete.
5. The flexural strength obtained for conventional concrete at 28 days of curing is 4.82mpa, and the flexural strength values obtained for mix1 is 5.01mpa is, mix2 is 5.26mpa, mix3 is 5.69mpa and mix4 is 5.88mpa
6. Results depict that 4.2%, increase in its strength for mix1, 9.12%, increase in its strength for mix2, 18.04%, increase in its strength for mix3, 21.99%, increase in its strength for mix4. When compared to conventional concrete.

REFERENCES

1. Lijina Thomas and J.S.Jithin (2018), "Effect of Steel and Polypropylene Fibre on the Tension Stiffening of Ultra High Performance Concrete", International Journal of Engineering and Advanced Technology (IJEAT), Vol. 8(4C), Pp. 44-47.
2. Bejamin, G. and Jussara(2007) , Durability of Ultra High Performance Concrete , Journal of Materials in Civil Engineering ,Pp.848-854.
3. Josipa bosnjak, and Akanshu Sharma and Kevin Grauf(2019), "Mechanical Properties of Concrete with steel and Polypropylene fibres at Elevated Temperatures", Materials Testing Institute, University of Stuttgat,Pfaffenwaldring (4C),Pp. 1-13.
4. Abbas, A.A.;Mohsin,S.M.S.;Cotsovos, D.M.(2014),Seismic Response of Steel Fibre Reinforced Concrete Beam-Column Joints.engineering. Vol.(99), Pp.261-283.
5. Lihua Xu, Biao Li, Xiaoxiao Ding, Yin Chi, Changning Li, Biao Huang and Yuchuan Shi,(2018), "Experimental Investigation on Damage Behavior of Polypropylene fiber Reinforced Concrete under Compression", International Journal of Concrete Structures and Materials, Pp.1-20.
6. Aslani, F., & Nejadi, S.(2013).Self-Compacting Concrete Incorporating Steel and Polypropylene Fibers: Compressive and Tensile Strength, Moduli of Elasticity and Rupture, Compressive Stress-Strain Curve, and Energy Dissipated under Compression. Vol.(53), Pp.121-133.
7. Abdul Ghaffar, and Amit S. Chavhan(2014), "Steel Fiber Reinforced Concrete", International Journal of Engineering Trends and Technology(IJETT), Vol.9(15), Pp.791-797.
8. Hannant, D.J. (1978). "Fiber Cements and Fiber Concrete", John wiley and sons Ltd.,Chichester,UK, Pp.53.
9. Jean-Louis Granju and Sana Ullah Balouch(2005), "Corrosion of Steel Fibre Reinforced Concrete From the Creacks", Cement Research , Vol.(35), Pp.572-577.
10. K. B Sankeerthan Reddy, J.S.R Prasad, Venu Malagavelli (2019), "Durability and Physical Properties of Glass Fiber Reinforced Concrete Subjected to Elevated Temperatures", International Journal of Innovative Technology and Exploring Engineering, Vol. 8(11), Pp. 3845-3848.
11. E.Arunakanthi and J.D. Chaitanya Kumar(2016), "Experimental Studies on Fiber Reinforced Concrete(FRC)", International Journal of Civil Engineering and Technology(IJCIET), Vol.(7), Pp.329-336.
12. Surendra P. Shah, James I. Daniel, Darmawan Ludirdja(1987), "Toughness of Glass Fiber Reinforced Concrete Panels subjected to Accelerated aging", PCI Journal , Pp.83-88.

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