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A Study Of Behaviour Of Macro And Micro Hybrid Fibre On Performance Of Concrete

Prabhat D. Lanjewar[1], Shobhit H. Gajbhiye[2], Mohit Singh Kathoch[3]
[1,2]*M-Tech Research Scholar (Structure), Civil Engineering Department, Tulsiramji Gaikwad-Patil Collegge of Engg. And Tech., Mohgaon, Nagpur, M.H. India*
[3]*Asst. Professor, Civil Engineering Department, Tulsiramji Gaikwad-Patil Collegge of Engg. And Tech., Mohgaon, Nagpur, M.H. India.*
mohitsingh.civil@gmail.com

***Abstract**:*

The paper presents an experimental investigation conducted to study the effect of hybrid fibre addition to Self Compacting Concrete (SCC) and compare the flexural behaviour of reinforced SCC beams without fibres, with macrofibres and with hybridfibres. The addition of two or morefibres in the concrete named as Hybrid Fibre Reinforced Concrete (HFRC) which derives more benefits from each of the individual fibres than the Single Fibre Reinforced Concrete (SFRC). Now a day, there are numerous types of fibres made of different materials that are of different geometric properties. With each type of fibre certain properties of concrete can be improved. In order to improve mechanical properties, especially the tensile and flexural strengths and long-term concrete shrinkage, steel fibres' are usually used. Hybrid fiber reinforced short columns were capable of carrying large amounts of strain than normal RC column.

Keywords
Self Compacting Concrete, Hybrid Fibre Reinforced Concrete.

1. Introduction

Concrete is a relatively brittle material when subjected to normal stresses and impact loads. It is recognized that the addition of small closely spaced and uniformly dispersed fibers to concrete act as a crack arrester and substantially increase its static and dynamic properties (Arivalagan, 2012). This type of the concrete is Fiber Reinforced Concrete (FRC). Steel fibres as additional reinforcement in beams allows substantial increase in flexural and shear strength and ductility. Recently the idea of making simultaneous use of different type of fibres with different geometry or material is gaining acceptance. Combination of steel-polypropylene fibers done by Dr.Mazin and A.Sivakumar were 100-0%, 70-30%, 50-50%, 30-70%, 0-100% and 100-0%, 90-10%, 80-20%, 70-30%.respectively.The aim of this experimental work is to investigate the possibility of improving the flexural response of reinforced SCC through additional hybrid fibre reinforcement and to compare the behaviour with that reinforced SCC beams without fibres and with single type of macro fibre.

2. Objective

1. To study the effect of hybrid fibre with 0.5% volume fraction by volume of concrete on normal concrete.
2. To study the mechanical properties of hybrid fibre with different hybridization ratio at 0.5% volume fraction of concrete.
3. To evaluate the strain energy absorbed at its ultimate level for SFRC at 0.5% volume fraction.
4. To evaluate the strain energy absorbed at its ultimate level for PFRC at 0.5% volume fraction.
5. To evaluate the strain energy absorbed at its ultimate level for hybrid fibres at 0.5% volume fraction with normal concrete.

3. Materials Used

Constituent materials used for the development of the SCC mixes were tested as per relevant Indian Standards and the properties were obtained as:

Ordinary Portland Cement of 53 grade conforming to IS 8112

Crushed stone of size 12mm and 6mm with specific gravity 2.82

River sand conforming to Zone II with fineness modulus 3.06 and specific gravity 2.58

Fly ash with specific gravity 2.10

Silica fume with specific gravity 2.34

Conplast SP 430, a sulphonated naphthalene based superplasticiser

Structuro 485, a viscosity modifying agent

Potable water

Steel macrofibres of 0.90 mm diameter with aspect ratio 30

Steel microfibres of 0.34 mm diameter with aspect ratio 30

3.1. Material Properties

Research area of flexural behavior of hybrid fiber reinforced concrete, with the use of two aspect ratios of one fiber is limited. So, an attempt was made to use steel fibers of two aspect ratio (30 and 50) with polypropylene fiber of constant aspect ratio in hybridization, at different volume percentages from 0.25% to 1.25%. And to study their flexural behavior and effect of aspect ratio on strength of concrete.

3.2. Mixing Procedure

In this study, the concrete matrix is well mixed with steel fibres. Before the hybrid fibres are added into the concrete mixture,the fibres are mixed together for 1 min. The mixing is always executed under laboratory conditions with dried and tempered aggregates and powder materials.

The room temperature while mixing and testing is constant at around 21 _C.

3.3. Properties Of Micro Steel Fiber

PROPERTY	SPECIFICATIONS
Fibre Type	Brass Coated Straight Steel Type
Dimension	Equivalent Diameter 0.2mm & Length 13mm
Aspect Ratio	33-35
Tensile Strength	2200-2850N/mm sq

4. 4. Testing

Flexural test were carried out on 18 beams, out of that each of 3 beams are tested for hybridization ratio 0-100%, 30-70%, 50-50%, 70-30%, 100-0% (Steel-Polypropylene). For all hybridization ratio fiber volume 0.5% by volume of concrete is kept constant.

Fig.1: Flexural test setup

The beams were kept on UTM as shown in fig.1 the beams were tested under gradually applied two point loading on UTM machine for flexural strength. Ultimate loads and modes of failure of beams were noted. Compressive strength and split tensile strength are carried out on cubes and cylinders respectively, tested under compression testing machine.

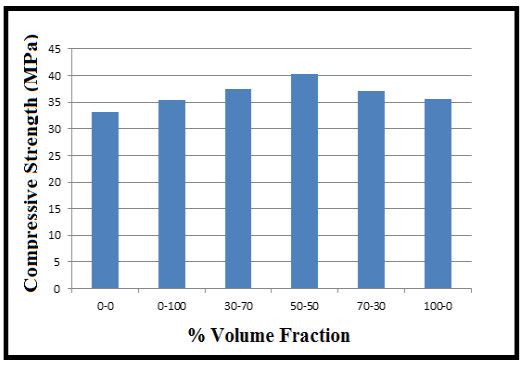
5. Discussion & Results

In present study cube compression test, split tensile test, flexural test on beams, and on plain and varying hybridization ratio of steel and polypropylene fibers reinforced concrete at 0.5% fiber volume fraction by volume of concrete are

carried out. The experimental results and discussion for various tests are described below.

5.1. Compressive Strength

The results of compressive strength test at 28 days are given in table No.1. It is seen that at 0.5% volume fraction of fibers by volume of concrete the compressive strength of Hybrid fiber reinforced concrete (HyFRC) with 50-50% (Steel-polypropylene) hybridization ratio is maximum. Fiber addition with equal percentage assures maximum availability of fiber in the fibrous matrix of concrete as regard to volume. Maximum availability of fibers are advantageous as under the axial load cracks occurs in microstructure of concrete, fiber reduces the crack formation and development. Because of high strength and stiffness, Metallic fibers (steel) are responsible to arrest the macro cracks also modulus of elasticity of steel fibers is more hence provide ductility to the concrete. Concrete is very alkaline and as such it will corrode steel fiber very quickly so that non-metallic fibers (polypropylene) are used for effective reinforcement. Use of non-metallic fiber is to arrest only a micro cracks developed due to shrinkage. Modulus of elasticity of PP fiber is less than steel fiber hence PPFRC undergoes brittle failure after loading. Due to hybridization of steel and polypropylene (50-50%) mix provide better response to arrest micro and macro cracks hence improve the compressive strength of concrete as compare to plain concrete and all other combination of hybridization ratio.



Graph no.1: Compressive strength after 28 days

6. Conclusion

1) Compressive strength of HyFRC after 28days for 50-50 % (steel-polypropylene) hybridization ratio is maximum. It is increased by 21.41% with respect to normal concrete (i.e. Hybridization ratio 0-0 %). At 28 days Compressive strength of SFRC (i.e. Hybridization ratio 100-0 %) is increased by 7.37% with respect to normal concrete & compressive strength of PPFRC (i.e Hybridization ratio 0-100%) increased by 6.68% with respect to normal concrete.

2) Split tensile strength of HyFRC concrete for 28 days increases with increasing contribution of steel fiber in hybridization ratio. Split tensile strength of SFRC (i.e. Hybridization ratio 100-0%) is maximum. Split tensile strength of SFRC (i.e. Hybridization ratio 100-0%) increases 44.41% & Split tensile strength of PPFRC (i.e. Hybridization ratio 0-100%) increases 8.16% with respect to normal concrete respectively.

3) Flexural strength of HyFRC for 50-50 % & SFRC i.e. 100-0 % after 28days is nearly same. Flexural strength of HyFRC with 50-50% hybridization ratio and SFRC i.e. hybridization ratio 100-0% is increases 81.51% & 86.27% respectively than normal cement concrete. Flexural strength of PPFRC (i.e Hybridization ratio 0-100%) increased by 41.73% with respect to normal concrete.

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