INFLUENCE OF HYBRID FIBRE ON PROPERTIES OF CONCRETE

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ABSTRACT

Concrete is by far the most widely used construction material today. It is versatile, has desirable engineering properties, can be moulded into any shapes and more importantly is produced with cost-effective materials. There is an old saying that broken stone, sand, and cement make good concrete. But the same proportion of broken stone, sand and cement also make bad concrete. To make good concrete, now variety of innovative materials such as fibres, admixtures and construction chemicals, pozzolanas and different concrete making techniques are adopted in present day construction. In recent years, intensive research has resulted in advances and innovation in the technology of fibres such as glass, polypropylene, carbon etc. and more basic knowledge has been gained on the behaviour of cement concrete containing these fibres. Concrete containing hydraulic cement, water, aggregate and discontinuous discrete fibres is called fibre-reinforced concrete. The incorporation of short discrete fibres i.e. steel, polypropylene, glass, carbon, etc. can lead to useful improvements in the mechanical behaviour of tension weak concrete.

Keywords: Fiber reinforced concrete, Compressive strength, Flexural strength, Split tensile strength

I. INTRODUCTION

The concept of using fibres as reinforcement is not new. Fibres have been used as reinforcement since ancient times. Historically, horsehair was used in mortar and straw in mud bricks. In the early 1900s, asbestos fibres were used in concrete. There was a need to find a replacement for the asbestos used in the concrete and other building materials as the health risks associated with the substance were discovered. By the 1960s, steel, glass, and synthetic fibres such as polypropylene fibres were used in concrete and research in to new fibre reinforced concretes continues today. Cement mortar and concrete made with Portland cement is a kind of most commonly used construction material in the world. These materials have brittle nature and some disadvantages such as weak in tension in the practical usage. So there is need to improve in tensile strength and flexural strength of concrete.

Fibre Reinforced Concrete is type of concrete containing fibrous material which increases its structural integrity. It contains short discrete fibres that are uniformly distributed and randomly oriented. Fibres includes steel fibres, glass fibres, synthetic fibres and natural fibres.Each of which lend varying properties to the concrete. In a hybrid, two or more different types of fibres are rationally combined to produce a composite that derives benefits from each of the individual fibres. The hybrid combination of metallic and non-metallic fibres can offer potential advantages in improving physical properties of concrete. Fibres having lower modulus of elasticity are expected to enhance strain performance whereas fibres having higher modulus of elasticity are expected to enhance the strength performance. Moreover, the addition of hybrid fibres makes the concrete more homogeneous and therefore it is transformed from brittle to more ductile material. The usefulness of hybrid fibre reinforced concrete in various civil engineering applications i.e. precast concrete pipe, highway pavement, airport runway, industrial flooring, etc. Hence this study explores the feasibility of hybrid fibre reinforcement with a given grade of concrete.

This research work focuses on hybrid fibre reinforced concrete (HFRC) consisting of steel, polypropylene and glass fibres. These are used in different proportions. The test specimens are going to be cast and tested. Then the results will be analyse and best optimum mix proportion of fibre will be find out

II. LITERATURE REVIEW

[1]**.Rama Mohan Raoet al., (2012) –**In this experimental investigation, they have studied the effect of hybrid fibre on the properties of class C fly ash based concrete.They have investigated in this paper for M40 grade of concrete and Class C Fly ash with combination of steel fibre and palmfibre (Natural fibre) in various proportions. Steel fibres (SF) and palm fibre were taken as 0.0% + 0.0%, 1.0% + 0.0%, 0.8% + 0.2%, 0.6% + 0.4%, 0.4% + 0.6%, 0.2% + 0.8%by the volume of concrete respectively. Compressive strength test on cube, flexural strength on beam and split tensile strength test on cylinder were carried out to study the properties of hardened concrete.

[2]**.A. M. Shendeet al., (2012) -** In this experimental investigation, they have studied the combination of steelfibrein M40 grade of concrete. The various proportion of steel fibrewere taken as follows 0%, 1%, 2%, and 3% by volume fraction of concrete. Compressive strength test, Flexural strength test and split tensile strength test were performed and results were analysed and graphically presented with respect to aspect ratios.

[3]**.PriyankaDilip.P et al., (2014) -** They have studied the combination of different fibres such as steel fibre and polyolefin fibre in M25 grade of concrete. They have used these fibre in four different proportions as 0%, 0.5%, 1%, 1.5% and 2% to study the effect of steel and polyolefin in hardened concrete. Compressive strength test, flexural strength test and split tensile strength test were performed and optimum proportion giving best results was found out.

[4].**Ahsana Fatima K M. et al., (2014)** – In this research paper, behavioral study of steel fibre and polypropylene fibre in reinforced concrete was studied. Three types of fibres were used i.e. hooked end steel fibre of length 30mm, crimped steel fibre of length 25mm and enduro-600 polypropylene of length 50mm with aspect ratio 50. The main aim of this experiment was to study the strength properties of steel fibre and polypropylene fibre reinforced concrete of M30 grade with 0%, 0.25%, 0.5%, and 0.75% by volume of concrete. This study consist of compressive strength test and split tensile strength test on hybrid fibre reinforced concrete with 0.5% polypropylene fibres and 0.75% steel fibres.

[5]**.S. Eswari (2015) –** In this paper, the flexuralperformance of hybrid fibre reinforced concrete was studied. Theinfluence of fibre content on the strength and ductilityperformance of hybrid fibre reinforced concrete

specimenshaving different proportions of steel (S) and polyester (P)fibres was investigated. Steel fibres (SF) and polyester fibre were taken as 0.0% + 0.0%, 1.0% + 0.0%, 0.8% + 0.2%, 0.6% + 0.4%, 0.5% + 0.5%, 0.0% + 0.1% by volume fraction of concrete respectively. Flexural behaviour i.e. Ultimate load, service load, flexural strength and energy ductility were found out.

[6]**.Devika C P et al., (2015) -** In this paper, flexural behavior of hybrid fiber reinforced geopolymer concrete beams were studied. The main objective of this study was to investigate the impact of steel fibresand hybrid polypropylene- steel fibres on the mechanical flexural behavior of geopolymer concrete (GPC). Crimped steel fibre with varying percentages (0%,0.25%, 0.5%, 0.75% and 1%) were adopted in this study and then polypropylene fibre was added to the optimum steel fibre mix with varyingpercentages (0%, 10%, 20%, 30% & 40%). The addition of fibres changed its brittle behavior to ductile with significant improvement intensile strength, tensile strain, toughness and energy absorption capacities. Compressive strength test, Flexural strength test and split tensile strength test were performed and results were analysed and optimum proportion was found out

[7]**.SudheerJirobe et al., (2015)**-In this paper, hybrid fibres with crimped steel and polypropylene were used in concrete matrix to study its improvements in strength and durability properties.The specimens incorporated steel and polypropylene fibres proportions as 0.0-0.0%, 0.25-0.25%, 0.5-05% and 0.75- 0.75% by volume fractionrespectively in M25 grade of concrete. Compressive strength test, flexural strength test, Impact strength, sorptivity test and split tensile strength test were carried out in experimental investigation.

[8].**T.SaiKiranet al., (2016) -**They have conducted study on research on the mechanical properties of glass fiber reinforced concrete.In this research they have used glass fiber in M30 grade of concrete in various proportions i.e. 0%, 5%, 6% and 7% by weight of cement. Compressive strength test on cube, split tensile strength on cylinder and flexural strength test on beam were carried out to study the properties of hardened concrete.

[9]**.BinniBabuji et al., (2016)**- In this experimental investigation, the study on the performance of hybrid fibre reinforced concrete at elevated temperatures was done. They have used hybrid fibers consists of two different types of fiber combinations i.e. steel fibre and recron 3S fiber used in M30 grade of concrete of ordinaryportland cement (OPC) as per IS 10262-2009.The specimens incorporated steel fibre and recron 3S proportions as 0.0% - 0.0%, 1.0% - 0.0%, 1.0% - 0.1%, and 0.0% - 0.1% by volume of concrete. Compressive strength test, ultrasonic pulse velocity and split tensile strength test were performed and results were analysed and graphically presented at different temperatures.

[10] **.Manisha M. Magdum et al., (2016) -**In this research the contribution of mineral admixture i.e.Alccofine-1203 to the mechanical properties of hybridfiber reinforced concrete with high strength and workability is investigated. Fiber volume fraction (VF) 1.5% byvolume of concrete was added with Alcoffine-1203 contribution of 5%, 7.5% and 10% by weight of cement.Hybrid fibers i.e. steel fibre and polypropylene fibre were used in different proportion that their combination forms 1.5% by volume of concrete in M60 grade of concrete. Compressive strength test and flexural strength test were performed and results were analysed and graphically presented and the best combination was found and compared to other proportions.

III. METHODOLOGY

[1]**.Rama Mohan Rao et al., (2012)–**In this Experimental study,various test were conducted on materials used i.e. cement, fine aggregates and coarse aggregate. Ordinary Portland cement (OPC) 53gradewas used confirming to IS 12269-1987 and various tests were conducted as per IS 4031-1988 i.e.initial, final setting and specific gravity. Fly ash was obtained from Neyveli Lignite Corporation Limited,(NLC) Tamilnadu, India belonging to Class C category as per ASTM C 618 having specific gravity 2.51. Crushed angular granite of 12.5 mm size was used as coarse aggregate having specific gravity and fineness modulus as 2.68 and 7.66 respectively. The sand was procured from local source of zone III having specific gravity and fineness modulus as 2.61 and 2.51 respectively. Ceraplast 300 was used as super plasticizer to make the concrete more workable. A volume fraction of 0.5% of binder content was added throughout this study.Mix design was adopted from ACI 311.Compressive strength test, Flexural strength test and tensile strength test were carried out on hardened concrete at 28 days on digital compression testing machine.

[2]**.A. M. Shende et al., (2012)-** In this Experimental study, various test were conducted on materials used i.e. cement, fine aggregates and coarse aggregate. Ordinary portland cement of 53 grade confirming to IS 12269-1987 was used.Locally available coarse aggregate of crushed granite stones of 10mm size having specific gravity 2.70, fineness modulas 2.92 confirming to IS 383-1970 were used. Locally available sand zone II with specific gravity 2.65, water absorption 2% and fineness modulus 2.92, conforming to I.S. – 383-1970 was used.Potable water was used for experimentation. To impart additional workability superplasticizer (Rheobuild 1100) 0.6 % to 0.8% by weight of cement was used. Compressive strength test, split tensile test and flexural strength test were carried out on hardened concrete at 28 days on universal testing machine as per IS 516-1959.

[3]**.PriyankaDilip.P et al., (2014) -** In this experimental, study various test were conducted on materials used i.e. cement, fine aggregates and coarse aggregate. Ordinary portland cement of 53grade was used. Coarse aggregate was crushed granite of 20mm as per IS 383-1970 having specific gravity 2.81, loose density 1.47 and roded density 1.68 was used. Locally available fine aggregate of zone-II having specific gravity 2.8, loose density 1.72 and roded density 1.61 was used. Mix design was adopted from IS 10262-2009. Compressive strength test, flexural test and tensile strength test were carried out on hardened concrete at 28 days on universal testing machine as per IS 516-1959.

[4].**Ahsana Fatima K M. et al., (2014)-** In this experimental study, various test were conducted on materials used i.e. cement, fine aggregates and coarse aggregate. Ordinary Portland cement (OPC) 53grade having specific gravity 3.14, standard consistency 35%, initial setting time 129mins and final setting time 320min was used. Coarse aggregate of 20mm and 12mm size having specific gravity 2.67 and fineness modulus 2.24 was used. Fine aggregate having specific gravity 2.50 and fineness modulus 3.015 falling in zone-II was used. 1% dosage of super plasticizer as a chemical admixture was used. Mix design was adopted from IS 10262-2009.Compressive strength test, flexural strength test and tensile strength test were carried out on hardened concrete at 7 and 28 days on universal testing machine as per IS 516-1969.

[5]**.S. Eswari (2015)-**In this experimental study,cement concrete having cube compressive strength of 26.80 MPa was used for casting the specimens. For concrete with fibres, superplastizer (High range water reducing admixture-Conplast® SP337) was used in appropriate dosage to main the workability of concrete mix.

A reinforced concrete specimen S0 P0 was used as plain concrete. S100 P0, S80 P20, S60 P40 S50 P50 and S0 P100 were cast with a total fibre volume fraction of 1.0%. The proportion of and S (Steel) and P (Polyester) being 100-0, 80-20, 60-40, 50-50 and 0-100 for all the specimens. 100 x100 x 500 mm prisms were tested in a loading frame. The test program was designed to study the strength and ductility performance of concrete specimens with and without fibres. Flexural behaviour i.e. Ultimate load, service load, flexural strength and energy ductility was studied and optimum proportion was found out.

[6]**.Devika C P et al., (2015) -**In this experimental study, various test were conducted on materials used i.e. cement, fine aggregates and coarse aggregate. Class F flyash of specific gravity 2.36 obtained from Mettur thermal power plant was used for the experiments and Ground Granulated Blast Furnace Slag obtained from steel plant, Karnataka of specific gravity 3.08 was used for the study and 50% of flyash was replaced with GGBS in this study. Sandpassing through 4.75mm IS sieve conforming to grading zoneII of IS 383:1970 having specific gravity 2.38 and fineness modulus 2.84 was used. Locally available coarse aggregate of 20mm size was used. Potable water was used for experimentation. Energy absorption, load deflection behavior and deflection ductility were calculated to study the flexural behavior.

[7]**.SudheerJirobe et al., (2015)-**In this experimental study, various test were conducted on materials used i.e. cement, fine aggregates and coarse aggregate. Ordinary Portland cement (OPC) 53grade was used confirming to IS 10262-2009. Test carried on cement werespecific gravity,normal consistency, soundness, initial and final setting time of cement. Coarse aggregate of maximum 20mm sizewhich was locally available was used and locally availablefine aggregate of zone-II as per IS 383-1978 was used and following tests were performed on both fine and coarse aggregate i.e. fineness modulus, slit content, specific gravity, bulk density and surface moisture. Potable water available in laboratory was used as per IS 456-2000. Mix design was adopted from IS 10262-2009, considering water-cement ratio 0.50. Compressive strength test, flexural strength test, Impact strength, sorptivity test and split tensile strength test were carried out on 28days on hardened concrete and increase in percentage was studied.

[8].**T. SaiKiran et al., (2016) -**In this experimental study, various test were conducted on materials used i.e. cement, fine aggregates and coarse aggregate. Portland Pozzolana cement having initial setting time 160min, final setting time 220min and soundness 0.50mm conforming to IS 1498-1991 was adopted in this work. Machine crushed angular granite metal passing through 20 mm sieve and retained on 10 mm sieve free from impurities conforming to IS 383-1970 coarse aggregate was used. Locally available dry river sand of zone-II, conforming to IS 383-1970 was used. Testing on sand was according to IS 2386-1963. Locally available potable water with pH value of 7.65 was used in the present work and it conforms to IS: 3025-1986. Mix design was adopted from IS 10262-2009, considering water-cement ratio 0.45. Compressive strength test, flexural strength testand split tensile strength test were carried out on 1, 3, 7, 28 and 56 days on hardened concrete and variations in results were studied.

[9]**.BinniBabuji et al., (2016)-**In this experimental study, various test were conducted on materials used i.e. cement, fine aggregates and coarse aggregate.Ordinary Portland cement (OPC) 53 grade*having a specific gravity of 3.14* was used. Coarse aggregate of 20mm and 10mm size having specific gravity 2.67was used. Fine aggregate having specific gravity 2.40 and fineness modulus 2.76 falling in zone-II as per IS 383-1970 was

used. Compressive strength test was conducted on cube of size 150 mm as per IS 516:1959.The test was done after 28 days of water curing and heating. Specimens were tested only after cooling it to room temperature. Split tensile strength test was conducted on cylinders of size 150 mm diameter and 300 mm height as per IS 5816:1999 after exposure to high temperatures and cooled to room temperature. Nondestructive ultrasonic pulse velocity test values are used to determine the properties of concrete. Tests were conducted on cubes as per IS 13311: 1992 (Part 1).

[10]**.Manisha M. Magdum et al., (2016) -**In this experimental study, various test were conducted on materials used i.e. cement, fine aggregates and coarse aggregate. Ordinary Portland cement 53 grade was used for the concrete mixtures. Alccofine-1203 obtained from Ambuja cement, India and used for the high strength concrete mixtures. River sand conforming to zone-I with a specific gravity of 2.6 was used as the fine aggregate, while crushed aggregate of specific gravity 2.7 was used as coarse aggregate. A super plasticizer was added to obtain the desired workability. Dramix glued hooked steel fibers and Strongcrete polypropylene fiberswere was used as hybrid fibers.Test for compressive strength on cube of 150x150x150mm and flexural strength on beam of 100x100x500mm were done as per IS: 516-1959 on hardened concrete was done.

IV. CONCLUSION

1. The hybrid fibre concrete mix consists of steel and palm fibres (0.8:0.2) %V_f shows better strength characteristics compared with other combination of steel and palm fibre concrete mixes.
2. All the strength properties are observed to be on higher side for aspect ratio of 50 as compared to those for aspect ratio 60 and 67. It was observed that compressive strength, split tensile strength and flexural strength are on higher side for 3% fibres as compared to that produced from 0%, 1% and 2% fibres.
3. GPC mix i.e. geopolymer concrete without fibres did show maximum workability. The workability of concrete had been found to decrease with increase of fibre content in concrete. It might be due to viscous nature of geopolymer concrete and uneven distribution of fibres in the mix. Hybrid fibre reinforced concrete showed an increase in flexural strength. The appearance of first crack was lower when compared to SFRGPC. But the ultimate flexural strength is higher for HFRGPC. This is due to the finer polypropylene fibres bridging the micro cracks more effectively than the steel fibres.
4. It was found that the 1% HFRC with 80-20 Steel – Polyolefin combination performed better than plain concrete and other HFRC specimens.
5. Fibre reinforced concrete with crimped steel fibre of 25mm length with aspect ratio 50, yields better compressive and flexural strength than hooked end steel fibre of 30mm length with aspect ratio 50.
6. A hybrid proportion of 60–40 Steel-Polyester combined, significantly improves the overall performance of reinforced concrete specimens.
7. The optimum percentage of fibers addition is 1.5%. Addition of fibers up to 1.5% gives best results in all strength parameters compare to other mix proportion.
8. It is observed that out of three trials of 5%, 6% and 7% of glass fiber, addition of 7% of glass fiber resulted in the maximum increase of compressive strength. However, there is not much change in the compressive

strength with change of glass fiber percentage. Overall it is observed that addition of 6% of glass fiber resulted in the maximum increase of strength properties of concrete.

9. Strength loss increases with increase in exposed temperature. Addition of Recron 3s fibre has little influence on splittensile strength but 14% increase in compressive strength while addition of 1% steel fibre increased compressivestrength to 6%. Addition of hybrid fibre doubled split tensile strength and 18% increase in compressive strength.
10. Experiments with M60 grade of concrete suggest that 7.5% replacement of cement with Alccofine-1203 and 1.5% hybrid fibers (80% steel fiber and 20% polypropylene fiber) resulted in best concrete compressive strength and flexural strength. The results indicated that the use of hybrid fibers with Alccofine-1203 enhance the mechanical properties of concrete

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