Effects Of Hybrid Fibre On Physical Properties Of Concrete

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Abstract
Concrete is most widely used construction material in the world. Plain cement concrete is good at providing reasonable compressive strength but it tends to be brittle in nature and is weak in tensile strength, minimum resistance to cracking and poor toughness. To overcome the deficiencies of concrete, fibres are added to enhance the performance of concrete. Fibre reinforced concrete (FRC) is a concrete in which small and discontinuous fibres are dispersed uniformly. The fibres used in FRC may be of different materials like steel, carbon, glass, polypropylene etc. The addition of these fibres into concrete mass can dramatically increase the compressive strength, tensile strength and flexural strength.

Keywords- Fibre reinforced concrete, compressive strength, tensile and flexural 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.

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II. LITERATURE REVIEW

[1] Vikrant S. Vairagande et al., (2012) – This paper focuses on the overall potential improvement on properties of concrete. They have investigated in this paper for M25 grade of concrete with combination of steel fibre and polypropylene fibre in various proportions. Steel fibres (SF) were taken as 0.5%, 0.6%, 0.7%, and 0.8% by the volume of concrete and polypropylene fibre (PF) were 0.5%, 0.4%, 0.3%, and 0.2% by the weight of cement and there combinations were taken to form 1% addition. Compressive strength test on cube and split tensile strength test on cylinder were carried out to study the properties of hardened concrete.

[2] Darole J. S et al., (2013) - In this experimental investigation, they have studied the combination of different fibres such as steel fibre and polypropylene fibre in M30 grade of concrete as per IS 10262-2009. The combination of fibres was as follows SF0%+PF0.0%, SF0%+PF100%, SF30%+PF70%, SF50%+PF50%, SF70%+PF30% and SF100%+PF0% to form unity in combination. Compressive strength test, Flexural strength test and split tensile strength test were performed and results were analysed and graphically presented and the optimum or best combination was found out.

[3] H S Jadhav (2013) - In this paper, flexural behavior of hybrid fibre reinforced concrete beams is investigated. Combination of steel and polypropylene fibres was used as hybrid fibres. In hybridization, steel fibres of aspect ratio 30 and 50 were used and aspect ratio of polypropylene fibres was kept constant. The reinforced concrete beams of M-25 grade concrete were casted as per IS 10262:2009. The hybrid fibres of various proportions such as 0%, 0.25%, 0.5%, 0.75%, 1% and 1.25% by volume of concrete were used. Three specimens of 0% and six specimens of each remaining percentage (0.25%-1.25%) were casted. All the beams were tested under two point loading under UTM. The results were evaluated with respect to first crack load, ultimate load, ultimate deflection, flexural strength, ultimate moment and flexural rigidity. The test result shows that use of hybrid fibre improves the flexural performance of the reinforced concrete beams.

[4] Selina Ruby (2014) -They have studied the combination of different fibres such as steel fibre and polypropylene fibre in M40 grade of concrete. The combination of fibre was as follows SF0.25%+PF0.75%, SF0.5%+PF0.5%, and SF0.75%+PF0.25% to form unity in combination. Compressive strength test, Flexural strength test and split tensile strength test were performed and results were analysed to associate with above combination of fibres. Relationship between compressive strength and split tensile strength, Compressive strength and Flexural strength were presented.

[5] Dr. Deepa A. Sinha (2014) – In this research paper, the strength characteristics of steel fibre reinforced concrete with varying percentages of fibres were found and optimum percentage of steel fibres were found out. M30 grade concrete as per IS: 10262-2009 was designed which yielded a proportion of 1:1.86: 2.41 with a w/c ratio of 0.45. The steel fibres were added at the rate of 0.5%, 0.75%, 1.0%, 1.25%, 1.50%, 1.75%, and 2.0% by volume fraction. Based on the compressive strength and tensile strength it was concluded that the optimum percentage of steel fibre to be added in the concrete mix was 1% by volume fraction.

[6] K Vamshi Krishna et al., (2014) – In this paper, experimental investigation on mechanical properties of M20 grade concrete by introducing polyester fibres in the mix was studied. Polyester fibres of 0.1%,0.2%,0.3%, 0.4% by weight of cement were added to the concrete. A comparative analysis has
been carried out for conventional concrete to that of the fibre reinforced in relation to compressive, split tensile, flexural strengths and optimum dosage were found out.

[7]. Pravin B. Shinde et al., (2015)- In this paper, hybrid fibres i.e. crimped steel and polypropylene were used in concrete matrix to study it’s improvements in strength and durability properties. This paper addresses the compressive strength, split tensile strength, flexural strength behavior of hybrid fibre reinforced concrete deep beams. The shear span to depth ratio of the beams used in this investigation was maintained as 2. The specimens incorporated steel and polypropylene fibres in the mix proportions of 00-00%, 0-100%, 25-75%, 50- 50%, 75-25% and 100-00% by volume of total concrete with fibre fraction of 1.0%.

[8]. R. H Mohankar et al., (2016) - They have conducted study on research on the mechanical performance on Hybrid fibre reinforced concrete (HFRC). The addition of one or more type of fibre in plain concrete is termed as Hybrid fibre Reinforced concrete. They have used Steel and polypropylene fibres, in different proportions as 0.25%, 0.5%, 0.75, and 1%, in there research work. The proportion to Steel fibre and polypropylene fibre were taken as SF- 0.4% and PF- 0.6% of that of above proportions and the experiments were performed in M20 grade of concrete. Experiments were conducted to study the effect of steel fibre and polypropylene fibre in different proportions in hardened concrete. Compressive strength test on cube and flexural strength test on beam were carried out to study the properties of hardened concrete.

[9]. A Annadurai et al., (2016)- In this experimental investigation, the study on the flexural behavior of high strength concrete of Grade M60 using hooked end steel fibres, polyolefin straight fibres in various volume fractions were found out. Hooked end steel fibres were added into the high strength concrete at volume fraction of 1% and 2%, steel and polyolefin fibres were added 80% - 20% and 60% - 40% combination at each volume fraction in order to cast steel fibre (single) reinforced high strength concrete and hybrid fibre (combination of steel and polyolefin) reinforced high strength concrete specimens. The steel mould of size 100 x100 x 500 mm was used for casting of all specimens i.e. beam. Ductility and Flexural toughness was found out on universal testing machine by four point loading.

[10]. Anand S et al., (2016) - In this research paper, they have studied change in strength i.e. compressive strength and split tensile strength of concrete after introduction of fibres. They have used hybrid fibres consists of two different types of fibre combinations i.e. glass and polypropylene fibres are used with M30 grade of concrete of pozzolana Portland cement (PPC) as per IS 10262-2009. The proportions of fibres were 0%, 0.25%, 0.5%, 0.75%, 1% and 1.25% by weight of cement used. Compressive strength test and split tensile strength test were performed and results were analysed and graphically presented and the best combination was found and compared to the ordinary conventional concrete.

III. METHODOLOGY

[1]. Vikrant S. Vairagande et al.,(2012)–In this Experimental study, various tests were conducted on materials used i.e. cement, fine aggregates and coarse aggregate. Ordinary Portland cement (OPC) 53grade was used confirming to IS 12269-1987. Locally available coarse aggregate of 20mm size having specific gravity 2.79 was used. Fine aggregate having specific gravity 2.28, water absorption 2% and fineness modulus 2.92 confirming to IS 383-1970 of zone-I was used. Potable water and super plasticizer as a chemical admixture was used. Slump cone and compaction factor test were carried out on fresh concrete. Compressive strength test and tensile strength test were carried out on hardened concrete at 7, 14 and 28 days on digital compression testing machine as per IS 516-1959.
In this Experimental study, various tests were conducted on materials used i.e. cement, fine aggregates and coarse aggregate. Portland pozzolana cement was used. Coarse aggregate of 20mm maximum size of basalt origin from local crusher and fine aggregate of fineness modulus 3.17 were used as per IS 383-1970. Potable water with pH value 7.1 was used in mix concrete. Mix design was adopted from IS 10262-2009. 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 516-1964.

In this Experimental study, various tests 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. Coarse aggregate i.e. crushed basalt rock of maximum 20mm size with specific gravity 2.66, water absorption 1.1% and fineness modulus 7.49 confirming IS 383-1970. Locally available natural river sand of zone I with specific gravity 2.66, water absorption 1.1% and fineness modulus 2.57 conforming to IS 383-1970. Mix design was adopted from IS 10262-2009. Flexural strength test and flexural rigidity were calculated to study the flexural behavior.

In this Experimental study, various tests were conducted on materials used i.e. cement, fine aggregates and coarse aggregate. Portland pozzolana cement of 53 grade was used and fineness, specific gravity, initial and final setting time tests were carried out on cement. Coarse aggregate of 20mm and retained on 12.5mm sieve as per IS 383-1970 were used and specific gravity test was performed. Clean and dry river fine aggregate available locally passing through 4.75mm sieve as per IS 383-1970 was used and fineness modulus and specific gravity tests were performed. 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 516-1964.

In this Experimental study, various tests were conducted on materials used i.e. cement, fine aggregates and coarse aggregate. Ordinary Portland cement (OPC) 53 grade was used. Locally available coarse aggregate of 12mm and down size having specific gravity 2.74 was used. Fine aggregate having specific gravity 2.67 falling in zone-II was used. Dosage of super plasticizer of 0.78% by weight of cement 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.

In this experimental study, various tests were conducted on materials used i.e. cement, fine aggregates and coarse aggregate. Ordinary portland cement (OPC) 53 grade confirming IS 12269-1987 was used. Locally available quartzite aggregate with a maximum size of aggregate of 20mm down size and sand were used as coarse aggregate and fine aggregate respectively. A water reducing admixture, Rheobuild 920kk is used in concrete. Mix design was adopted from IS 10262-2009. Slump cone test was carried out on fresh concrete. Compressive strength test, split tensile strength test and flexural strength test were carried out on hardened concrete at 3, 7 and 28 days on universal testing machine as per IS 516-1964 and on compressive testing as per IS 5816-1999.

In this Experimental study various test were conducted on materials used i.e. cement, fine aggregates and coarse aggregate. Ordinary Portland cement (OPC) 53 grad was used confirming to IS 12269-1987. Test carried on cement were fineness, specific gravity, standard consistency, soundness, initial and final setting time of cement. Coarse aggregate of maximum 20 mm
size which was locally available was used and locally available fine aggregate of zone-II as per IS 383-1970 was used. And following test were performed on both fine and coarse aggregate i.e. fineness modulus, slit content, specific gravity, bulk density and surface moisture. Compressive strength test, flexural strength test and split tensile strength test were carried out on hardened concrete at 28 days on universal testing machine as per IS 516-1959.

8] R. H Mohankar et al., (2016) - In this Experimental study various test were conducted on materials used i.e. cement, fine aggregates and coarse aggregate. Portland pozzolona cement of 53 grade was used and standard consistency, soundness, initial setting time tests were carried out on cement. Coarse aggregate of 20mm size and specific gravity test was performed. Bulking of sand and specific gravity tests were performed on Fine aggregate of zone-I grading as per IS 383-1970 was used. Mix design was been adopted from IS 10262-2009. Slump cone, Vee-Bee and compaction factor tests were carried out on fresh concrete. Compressive strength test and flexural strength test were carried out on hardened concrete at 7, 14 and 28 days on universal testing machine as per IS 516-1964.

9] A Annadurai 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) 53grade was used as per 12269-1987. Coarse aggregate of 10mm size having specific gravity 2.74 which was locally available was used. Fine aggregate having specific gravity 2.40 falling in zone-II was used. 0.78% by weight of cement dosage of super plasticizer as a chemical admixture was used. Mix design was been adopted from the high strength concrete mix proportions were designed with reference to American concrete institute (ACI 211-4R-1993). Flexural strength test, flexural toughness and ductility were calculated to study the flexural behavior.

10. Anand S et al., (2016) -In this Experimental study various test were conducted on materials used i.e. cement, fine aggregates and coarse aggregate. PPC fly ash based cement was used throughout the work. Test carried on cement were specific gravity, standard consistency, initial and final setting time of cement. Coarse aggregate of 20mm and down size which was locally available was used and locally available fine aggregate passing through 4.75mm IS sieve as per IS 383-1970 was used. And following test were performed on both, fine and coarse aggregate i.e. specific gravity, water absorption and fineness modulus. Compressive strength test and split tensile strength test were carried out on hardened concrete at 7 and 28 days on universal testing machine as per IS specifications was done.

CONCLUSION

1. Increasing the percentage of steel fibre in hybrid combination, reduces the slump value. To maintain the constant slump, we have to increase the super plasticizers dose in concrete. SF 0.8%+PF 0.2% gives high strength as compare to other combination in both, compressive strength test and split tensile test.

2. There is increase in flexural strength, compressive strength and spilt tensile strength by 81.51%, 21.49% and 44.41% of HFRC, 41.73%, 7.37% and 8.16% of SFRC and 41.73%, 6.68% and 8.16% of PPFRC respectively than normal cement concrete.

3. Moment carrying capacity of hybrid beams increases with increase in fibre percentage. It has 48% of maximum increment more than control beam.

4. HFRC SF 0.75+PF 0.25 i.e. 75% steel fibre and 25% polypropylene fibre was found out to be the best combination for compressive test, tensile test and flexural test.

5. Flexural strength was found to increase as the percentage of steel fibre increases and 1% steel fibre was found out to be optimum for achieving best compressive and tensile strength.
6. Addition of polyester fibre in concrete, the pavement thickness was decreased by 20% and which was economical when compared to plain cement concrete.
7. There was increase in Flexural strength, compressive strength and spilt tensile strength by 36.68%, 19.95% & 41.61% of HFRC and 8.29%, 6.12% and 6.35% of PPFRC respectively than normal cement concrete.
8. Experimental investigation shows reduction in secondary reinforcement at some level and make structure economical. It prevents spalling of concrete which result in better protection of reinforcement cover. HFRC can be used to resist seismic effects in structure, the floors additionally act as foundation slab that is bracing and carrying the entire building load.
9. Deflection ductility and Toughness index values were increased with increase in fibre content up to 2% volume fraction with 80% -20% combination of steel and polyolefin fibre.
10. It was found that crack formation was slower than conventional concrete. This shows that HFRC is better in avoiding propagation of cracks.

REFERENCE