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EFFECT OF ADDITION OF DIFFERENT TYPE OF FIBERS ON MECHANICAL PROPERTIES OF CONCRETE-A REVIEW

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Abstract*— Concrete is a brittle material when it is subjected to normal stresses and impact loads, where tensile strength is relatively low compared to compressive strength. Use of uninterrupted reinforcement in concrete enhances strength and ductility, but involves deliberate placement and labour acquisition. In this research the effect of addition of different types of fibres on mechanical properties of concrete was studied. The concept of using fibres to amend the characteristics of construction materials is very old. When concrete cracks, and arbitrarily oriented fibres start working, arrest cracks establishment and extension, and thus amend strength and ductility. Reinforced fiber concrete symbolizes the current leaning to enforce more effective crack-resistant concrete. The geometric size and modulus of fibers are the main factors influence the mechanical performance of fiber reinforced concrete. The result says that the usage of fibers in concrete mix increases the compressive strength, flexural strength, split tensile strength, ductility and impact strength.

***Keywords*— Nylon Fiber; Latex; Compressive Strength; Split Tensile Strength; Flexural Strength; Durability**

I. INTRODUCTION

Today, concrete has turned out to be one of the generally utilized development materials, fundamentally in light of its high compressive strength. In case of high performance or high strength concrete, the general performance of concrete is substantially more than that of conventional concrete. One of the main drawbacks of concrete is the brittleness of concrete, with the increase in strength brittleness of concrete increase, and it severely affects the overall performance of concrete. According to the research it is found that the high strength of the concrete can be achieved by lowering the w/c ratio, but without carrying any bad effect on the properties of other materials. So, basically the main thing is to understand the basic design of high strength concrete. Usually the main definition of high strength concrete is the concrete having high strength, high ductility and high durability. The plain concrete is a brittle material and it shows low value of strain capacity and the modulus of rapture. In order to overcome this problem lot of researches can be found to enhance the concrete properties such as durability, ductility, flexural strength, fracture toughness and impart load by inclusion of fibres in concrete mix. One of the methods to overcome this problem is the use of fibers in concrete.

Fibers are generally utilized as a part of concrete to control breaking because of plastic shrinkage and to drying shrinkage. Discrete fibers and short discontinuous fibers were added to the conventional concrete to enhance the post cracking behaviour. Addition of fibers enhances the compressive strength, flexural strength, split tensile strength, ductility and impact strength.

Blending of FRC can be refined by various numerous techniques. In order to forbid segregation, the mix should have uniform dispersion of fibers. The fiber reinforced concrete contains smaller coarse aggregate, higher fine aggregate content and high cement content.

Different types of fiber used to make Fiber reinforced concrete (FRC):

Fiber is a little bit of fortifying material having certain qualities properties. It is of flat or round. The most important parameter to identify a fiber is “aspect ratio”. The ratio of length to its diameter is known as “aspect ratio”. Generally, the aspect ratio ranges from 30 to 150.

Fiber-reinforced concrete is a concrete containing fiber material which enhances its structural unity. The fibers are arbitrarily oriented and consistently appropriated. The variation in distribution, geometry and orientation fiber shows the changes in properties of fiber reinforced concrete. The various types of fibers used in Fiber reinforced concrete are

- Steel fibers
- Glass fibers
- Polypropylene fibers
- Carbon fibers
- Basalt fibers
- Polyester fibers
- Asbestos (mineral) fibers
- Cellulose fibers
- Nylon fibers
- Coconut fibers
- Cotton fibers
- Bamboo fibers
- Aramid fibers

II. LITERATURE REVIEW

Dr. S. Suriya et al (November 2015) focuses on Polymer modified steel reinforced concrete, a recent advancement in the field of reinforced concrete. In this study the Sbr latex is used as a polymer admixture and the steel fiber is used. The results show that there is an increase in compressive strength of concrete when both Sbr latex and steel fiber is used. It has been observed, only with Sbr latex there is a decrease in compressive strength. The addition of steel fiber increases the split tensile strength and flexural strength.

Dr.G.D.Awchat and Dr.N.M.Kanhe (December 2013) has introduced the idea called steel fiber reinforced recycled concrete aggregate with modified polymer. Here the polymer used is SBR latex. From the several experimental investigations it has been concluded that the utilization of steel fibers in conventional concrete and RAC increases the split or indirect tensile strength, flexural strength up to some extent. Addition of SBR latex in concrete improves the various properties of conventional concrete, such as durability, strength, adhesion and chemical resistance. It is observed from the experimental results that steel fiber reinforced recycled concrete aggregate with 30 kg/m^3 and 5% polymer allows increase in flexural strength up to 5.43%, compressive strength about 6.86% and split tensile strength up to 4.24% by comparing it with conventional concrete.

Y Chandrasekhara Varma et al (May 2017) studies the mechanical properties of polymer modified hybrid fiber reinforced concrete. In this study the properties of M30 grade of conventional concrete and mono steel fiber concrete and polymer modified hybrid fiber concrete were analysed and the properties of polymer modified hybrid fiber concrete are compared with conventional concrete and mono steel fiber concrete. The results show that the increase in the flexural strength, split tensile strength and compressive strength of polymer modified hybrid fiber concrete compared to conventional concrete are 41%, 45% and 25% respectively. It has been observed that the combination of 0.2% polyester fiber and 0.5% steel fiber gives better results in compared to conventional concrete and mono steel fiber concrete.

Sachin Kumar et al (May 2017) has studied the strength properties of steel fiber reinforced concrete with modified polymer. In this study the polymer used is acrylic latex and the grade of concrete M25. In this study the compressive strength of the concrete is analyzed with different type of combinations of steel fiber and acrylic latex of M25 grade concrete. By using acrylic latex there is decrease in compressive strength whereas tensile and flexural strength increases, but the use of steel fiber improves the compressive strength which is due to compactness of concrete.

Faraz Khan and Juned Ahmad (September 2015) has focuses on the mechanical properties of steel fiber reinforced concrete modified with Sbr latex. In this study, the percentage of steel fiber used at an interval of 0.25% up to 1.25% and the latex was varied at a percentage of 5%, 10% and 15%. The fraction of steel fiber which gave the best result was taken.

Tehmina Ayub et al (October 2014) studied the effect of fibers on the properties of fiber reinforced concrete. The fibers used in this study are chopped basalt fibers. Three types of concrete mixes were analyzed in this study. First mix contains 100% cement content and for other two mixes the 10% cement is replaced with metakaolin and silica fume. The results show that there is significant increase in split tensile strength and flexural strength with the addition of chopped basalt fibers, while the compressive strength is slightly improved.

T. N. Janbandhu et al (April 2017) presents an experimental investigation on fiber reinforced concrete with modified polymer. The fibers used in this study are basalt fibers. In this investigation, the acrylic polymer introduced is 10% by weight of the cement and the basalt fiber content varies from 1 % to 5% by weight of cement. The results show that with the increase in the fiber content the workability of polymer modified fiber reinforced concrete decreases. At the 4% of fiber content, the compressive strength, split tensile strength and shear strength has shown better results in comparison with conventional concrete.

D.Radhakrishnan et al (March 2017) presents an experimental investigation on strength properties of latex modified jute fiber reinforced concrete. In this study, two types of jute fibers were used namely raw jute and modified jute and strength properties were compared. The proportion of fibers is by wt. of the cement. The results show that compressive strength and split tensile strength for modified jute fiber was more compared to raw jute fiber.

U. B. Kalwane et al (February 2016) focuses on the characteristics of latex modified steel fiber reinforced concrete. In this study, steel fibers were added by volume fraction at an interval of 1% by weight of cement. Sbr latex is used as a polymer in this study. From the experimental studies it was observed that at 1% fiber content the compressive toughness is maximum and at 7% fiber content the flexural toughness increases with the addition of polymer and fibers.

S.S. Kadam and V.V. Karjinni (May 2017) studies the mechanical properties of high strength steel fiber reinforced concrete under different aspect ratios (65 and 80). In this study, steel fiber is varied at an interval of 0.5% by volume. Experimental studies show that there is an increase in flexural strength when the fiber volume increases and at an aspect ratio of 80, maximum flexural strength was observed.

Ms. Karthika Kishore Koka et al (September 2014) studies the different mechanical and physical properties of latex modified steel fiber reinforced concrete. Sbr latex is used as a polymer in this study and with this polymer we can amend the properties like lower water permeability and higher strength. 5% of SBR Latex and 0.5% of steel fibers have been used. The results show that the tensile strength of concrete increases and early compressive strength of concrete also increases with the addition of fibers. It has been observed that good strength is achieved under flexure and tension with the addition of steel fibers and latex.

Fernando Pelisser et al (May 2012) presents an experimental study of recycled-bottle-PET fiber-reinforced concrete. The lengths of the fibers used in this study are 10, 15 and 20mm.From the tests it can be concluded that the modulus of elasticity and compressive strength has no effect with the addition of the fiber. The results show that with the addition of PET fiber, the impact resistance and flexural toughness increases at 28 days expect for the 0.05% volume sample. scanning electron microscopy (SEM) analysis has done during this study.

Pawan Kumar and Dr. A.K. Mishra (April 2016) focuses on the mechanical properties of polypropylene fiber reinforced concrete. In this study, polypropylene fibers were added by volume at an interval of 0.50% up to 2%. The results show that the maximum flexural strength has obtained at 2.00% of polypropylene fiber by volume of concrete. Also the compressive strength gets maximum at 1.5% and then decreases with adding the fibers.

Deepa K Venu and Prof. M. Rajalingam (April 2016) focuses on the strength properties of concrete using coir fiber and sugarcane bagasse ash. The mix design adopted in this study is M30. Sugarcane bagasse ash is used as a partial replacement for cement and coir fiber is dosed at an interval of 0.5% by volume of cement. The results show that by adding coir fiber dosage the workability of concrete increases. From the experimental study it can be concluded that the compressive strength, split tensile strength and flexural strength are maximum at 1.5% coir fiber and 10% SCBA.

Akshara S and Shibi Varghese (May 2017) focuses on mechanical properties of fiber reinforced concrete with modified latex. Polypropylene fiber and SBR latex is used in this study. The results show that with the addition of latex and fiber the compressive strength decreases. Whereas flexural strength split tensile strength and abrasion resistance increases with the addition of fiber and latex. The flexural strength can be increased at simultaneous addition of latex and fiber than with individual addition. The abrasion resistance and impact resistance are found to be maximum at a fiber content of 0.3% and at a latex content of 15%.

Pooja Shrivastava and Dr.Y.p. Joshi (December 2014) studies the workability and mechanical strength properties of steel scrap fiber reinforced concrete. Different tests were conducted on fresh and hardened concrete. The results show that at 0.5-2% steel scrap content, the split tensile strength, flexural strength, fatigue strength, compressive strength and impact strength were found to be increased. From the experimental study it can be concluded that crack resistance and shrinkage reduction are improved with the addition of steel scrap.

Aiswarya Sukumar and Elson John (September 2014) studies the strength properties of steel fiber reinforced concrete. Based on several experimental investigations maximum strength is observed for steel fibers comparing with polypropylene and glass fibers. Different types of fiber volume fractions were used in this study. The results show that there is an increase in split tensile strength, compressive strength and flexural strength with the addition of steel fiber. It has been observed that the mix containing fiber material is having less crack formation.

Dr.T.Ch.Madhavi et al (June 2014) studies the different properties of polypropylene fiber reinforced concrete. The results show that with the addition of fiber content the workability decreases and the problem of low tensile strength can overcome. From the experimental study it can be concluded that the compressive strength increases with the addition of fiber content by volume. The failure observed in this study is ductile and gradual.

Dr.R.Kumutha et al (June 2017) studies the mechanical properties of basalt fiber reinforced concrete. In this study, the compressive, flexural and split tensile strengths were analyzed for the geopolymer concrete mixes with basalt fiber and those are compared with conventional concrete. For the geopolymer concrete the fibers were added at an interval of 0.5% up to 2.5% from 0.5%. At 0.5%, 1%, 1.5% and 2% dosage of fiber content, the compressive strength values are 8.5%, 14%, 27% and 38% respectively. Similarly, at 0.5%, 1%, 1.5% and 2% dosage of fiber content, the split tensile strength values are 12%, 22%, 36% and 50% respectively. From the test results it can be concluded that with the addition of basalt fiber content, the flexural strength increases and it can be found that in case of basalt fiber reinforced geopolymer concrete the crack formation is less when it is compared with conventional concrete.

Bhupendra Kumar and Dr. S S Kuswah (Septemeber 2015) studies the properties of fiber reinforced concrete with fly ash. In this study, the cement is replaced by fly ash and the fiber used is coconut fiber. The fibers were added by weight of cement at an interval of 0.5% up to 3% and the cement is replaced by fly ash (10%, 20% and 30%). The results show that with the combined addition of fiber dosage and fly ash content there is an increment in the compressive strength results rather than with the separation addition of fiber and fly ash.

Anthony Nkem Ede and Joshua Olaoluwa Agbede (February 2015) focuses on the properties of coconut husk fiber reinforced concrete. In this study, the fibers were added to the mix at an interval of 0.25% up to 1% by weight of fine aggregates. Destructive and non - destructive compressive tests were conducted for the casted beams and these two test results were compared. The results showed that with curing age and fiber dosage there is an increment in the compressive strength results up to the fiber dosage of 0.5%, after 0.5% dosage the strength value decreases. From the experimental results it can be concluded that with the addition of fiber dosage and curing the flexural strength results were increased.

MR. Mehul J. Patel and MRS. S. M. KULKARNI (October 2013) studies the properties of high strength concrete reinforced with polypropylene fiber. The mix design used in this study is M40. In this paper, fibers were added by volume proportion (0.5%, 1.0% and 1.5%) to the mix. From the experimental results it can be concluded that with the addition of flyash and fiber dosage there is an increment in the compressive strength results. And also with the addition of polypropylene fiber content the workability of concrete decreases. Maximum split tensile strength occurred with the use of same volume fraction of long fiber.

Parveen Kumar and Parveen Singh (September 2015) studies the strength properties of polyester fiber reinforced concrete. The mix design used in this study is M25. The polyester fibers were added at a dosage of 0%, 0.3%, 0.6%, 0.9% and 1.2% by weight of cement. The results show that with the addition of fiber content the compressive strength increases up to the dosage of 0.9% and then gradually decreases with 1.2% fiber dosage. The maximum compressive strength is observed at a fiber dosage of 0.9%. Similarly, maximum flexural and split tensile strengths were observed at a dosage of 0.6%.

Kothai.P and Lakshmi narayanan. S (April 2017) focuses on the characteristics of fiber reinforced concrete. During this study, fine aggregate is replaced with marine sand and mix is designed for M60 grade concrete. The fibers were added at a dosage of 0%, 0.5%, 1%, 1.5% and 2% by weight of the cement. The results show that there is an increment in compressive strength about 5.5% at fiber content of 1% and with sea sand. From the experimental tests it can be observed that at 28 days the compressive strength, split tensile strength and flexural strength are found to be 64.05MPa, 5.72MPa and 6.515MPa respectively.

Mahendra Prasad et al (November 2013) focuses on the mechanical properties of polypropylene fiber reinforced concrete. Silica fume was added at a percentage of 0%, 5%, 10% and 15% by weight of cement. fibers were added by volume fraction (0%, 0.2%, 0.4% and 0.6%)of concrete. The results show that the flexural strength is found to be maximum at a fiber content of 0.4% and at a silica fume content of 10%. There is no significant effect on flexural strength with the addition of silica fume.

Anusha Chowdary and Mrs. Chaithra. N (August 2017) studies the strength properties of polypropylene (Recron 3s) fiber reinforced concrete. The mix design adopted in this study is M40 grade concrete. During this study cement is replaced with fly ash and fibers were added at a dosage of 0.25%, 0.5%, 0.75% and 1% by weight of the cement. The results show that with the addition of fibers the workability of concrete decreases and the split tensile strength and compressive strength increases. Up to 0.75% dosage of fiber content the test results are good; beyond 0.75% dosage of fiber content there is no significant increase in strength values. There is no significant change in compressive and split tensile strength at 28 days and 56 days curing.

Dr Sunil V Desale and Bhagyashri Sisode (July 2015) studies the mechanical properties of Recron 3s fiber reinforced concrete. During this study cement is replaced by cement at different proportions. Fibers were added at a percentage of 0.0%, 0.2%, 0.3%, 0.4% by weight of the cement and then various tests are conducted. The results show that by adding Recron 3s fiber content the split tensile strength and compressive strength decreases. The flexural strength of concrete increases with increase in fiber dosage. The optimum fly ash and fiber content are 20% and 0.4%.

Nandish S C et al (June 2015) presents the strength properties of fiber reinforced concrete. The fibers used in this study are coconut fiber and polypropylene (Recron 3s fiber) and different tests are conducted then compared with conventional concrete. The design mix used in this study is M40. The results show that with the addition of fibers there is an increment in the flexural strength of concrete. The flexural strength and split tensile strength are found to be maximum at a dosage of 2% coconut fiber and 0.4% polypropylene fiber.

Bhuvana vijaya and B. Ajitha (April 2017) presents a study on properties of coir fiber reinforced concrete. In this study, the cement is replaced by silica fume at different percentages and coir fiber is added at a dosage of 2%. The results show that with 10% silica fume and 2% coir fiber the maximum flexural strength is occurred and the value is 2.8% more than conventional concrete. From the experimental results it can be concluded that with the addition of coir fiber the flexural strength of fiber reinforced concrete increases.

A. Sumathi and K. Saravana Raja Mohan (2015) presents a study on mechanical properties of steel fiber reinforced concrete. The design mix adopted for this study is M40. The fibers were added at a dosage of 0.5%, 1%, 1.5% and 2% by volume of concrete. The results show that with the addition of fibers there is an increment in the compressive strength, split tensile strength and modulus of rupture values at 28 days and these results were compared with conventional concrete. On the durability test, at the fiber content of 1.5% the mix have more sorption co-efficient.

Athira Omana kuttan and Aruna C (February 2017) presents a study on hybrid fiber reinforced concrete. In this study, cement is replaced by rice husk ash and fly ash. Steel fiber were added at a dosage of 0.25%, 0.5% and 0.75% by volume of concrete and glass fiber were added at a dosage of 0.25%, 0.5% and 0.75% by weight of cement. The results show that the maximum compressive strength and split tensile strength was observed with 0.25% dosage of glass fiber and 0.5% dosage of steel fiber.

III. CONCLUSIONS

The most important parameters which can be used to determine the mechanical properties of fiber reinforced concrete are geometric size and modulus of fiber. The improvement of post peak ductility performance, fracture strength, toughness, impact resistance can be done with the addition of different type of fibers to the conventional concrete. It was observed that the most commonly used fibers to study the mechanical properties of concrete are steel and polypropylene fibers. The various experimental results show that with the addition of only Sbr latex there is a decrease in compressive strength of concrete. As the dosage of fiber % increases then there is a decrease in workability of concrete. From various studies it has been observed that the combination of both Sbr latex and fiber increases the compressive strength, split tensile strength and flexural strength.

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