

Review on Performance of Hybrid (Industrial + Recycled) Fiber Concrete

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Abstract— As the demand of construction material is increasing, more amount of researches are dedicated to explore various grey areas in sustainable material technology. Literature survey has shown various waste materials that have potential to be used as replaceable material in concrete. Among those materials Industrial steel fibers and Tyre steel fiber can be used in mass construction. This paper shows study of various literatures which gives information about feasibility of use of Industrial steel fibers and Tyre steel fibers for preparing the concrete.

Key words: Hybrid Fiber, Steel Fibers, Tyre, Fiber Reinforced Concrete

I. INTRODUCTION

India is a Developing country, it proposes multipurpose development projects causing extensive use of tyres in automobile industry has resulted in accumulation of large quantities of used tyres that have to be disposed at the end of their useful life. The use of recycled waste tyres is less in construction industry which needs to get improve. The steel fibers present in tyres are useful which can be added to the concrete to improve its properties. On the other hand the use of industrial fibers is increasing rapidly with different size and shape. Influence of steel fibers on concrete when added to concrete, steel fibers improves its qualities by increasing its energy absorption capacity. Also, steel fibers increase the flexural strength and compressive strength of concrete. A comparison of concrete containing steel fibers with conventional concrete it is observed that concrete containing steel fibers gives more strength. It has also been reported that adding steel fibers in concrete prevents the macro-cracks as well as provides some resistance to dynamic and impact load. The main objective is to find alternative source of raw products in concrete technology, as this would reduce an adverse environmental impact of production of concrete component, while at the same time preserving natural resources.

A. Hybrid Fibre Reinforced Concrete

A composite can be termed as hybrid, if two or more types of fibres are rationally combined in a common matrix to produce a composite that drives benefits from each of the individual's fibers and exhibits a synergetic response. Addition of short discontinuous fibres plays an important role in the improvement of mechanical properties of Concrete. It increases elastic modulus; decreases brittleness controls cracks initiation and its subsequent growth and propagation. Deboning and pull out of the fibre require more energy absorption, resulting in a substantial increase in the toughness and fracture resistance of the materials to the cyclic and dynamic loads.

B. Advantages of Hybrid Fibre Reinforced Concrete

- 1) To provide a system in which both types of fibres, which are stronger, stiffer and are also flexible and ductile, improves the cracks stress and ultimate strength, which leads to improved toughness.
- 2) To provide hybrid reinforcement in which if one type of fibre is smaller, so that it bridges the micro cracks of which growth can be controlled. This leads to a higher tensile strength of the composite and if the second type of fibre is larger, so that it arrests the propagating micro cracks and can substantially improve the toughness of the composite.
- 3) To provide a hybrid reinforcement, in which the durability of fibre type is different. The presence of the durable fibre can increase the strength and toughness relation after age while the other type is to guarantee the short term performance during transportation and installation of the composite elements.

C. History of Hybrid Fibre Reinforced Concrete

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 once 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 till today.

D. Types of Fibre Reinforced Concrete

- 1) Steel Fibre Reinforced Concrete
- 2) Polypropylene Fibre Reinforced Concrete
- 3) Glass Fibre Reinforced Concrete
- 4) Carbon Fibre Reinforced Concrete
- 5) Nylon Fibre Reinforced Concrete

E. Application of Hybrid Fibre Reinforced Concrete

Can be used in any kind of construction because of its unique Properties and also as it very easy to obtain high range of strength values. Some of the pioneering applications are as follows

- 1) Bridges
- 2) Tunnel linings
- 3) Building components like column
- 4) Sandwich structure like steel concrete structure
- 5) Industrial flooring
- 6) Machine foundation

F. Tyre (Recycled) Steel Fiber

Fibers vary in type, geometry, properties and availability in construction industry. Most common type of fibers are steel

fibers, glass fibers and polypropylene fiber. There usage many alter in concrete for differential application. The fibers are selected from their properties like effectiveness, cost and availability. The waste management of used tyre is of major concern for many environmental bodies and agencies worldwide. Tyre production is increasing every year due to the increase of vehicle sales. The generation and disposal of waste are inherent to life itself and have presented very serious problems to the human community. Waste shredded tyres have found their use in various geotechnical applications such as soil stabilization, slope stability, increasing bearing capacity of soil and many more but the steel wires are not being used effectively. Hence an attempt will be made to convert steel wires in to tyre fibers by cutting then in certain aspect ratio so that they can be added into a concrete matrix.



Fig. 1 – Stacked Tyre



Fig. 2 – Tyre steel fibers

G. Industrial Steel Fiber

The rigid pavements which are made up of concrete shows some detrimental structural characteristics such as a very low tensile strength, limited ductility, little resistance to cracking, brittle failure mechanism in tension etc. due to these undesirable characteristics of concrete, generally the reinforcement is provided in the form of continuous steel bars placed in concrete structure in the appropriate position to withstand the imposed tensile and shear stresses. Fibers on the other hand, are short and discontinuous, and randomly distributed throughout the concrete member to produce a composite construction material known as fiber reinforced concrete. In steel fiber reinforced concrete fibers are dispersed and distributed randomly in the concrete during mixing, and thus improve concrete properties in all directions. The plain concrete structures cracks into two

pieces when the structure is subjected to the peak tensile load and cannot withstand further load or deformation. The fiber reinforced concrete cracks at the same peak tensile load, but does not separate and can maintain a load to very large deformations. Steel fiber reinforced concrete satisfies two of much demanded requirements of pavement material in India, economy and reduced pollution. It also has several other advantages like longer life, low maintenance cost, fuel efficiency, good riding quality, increased load carrying capacity.



Fig. 3: Industrial Fibers

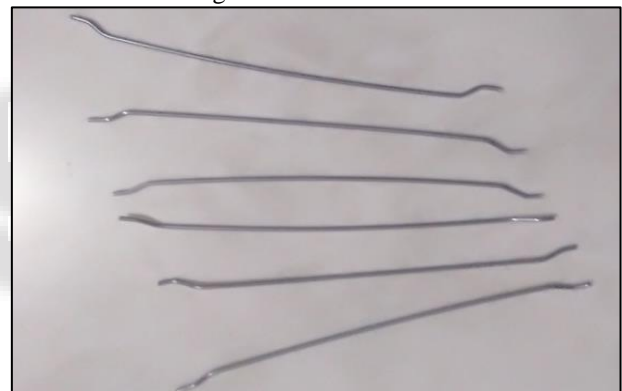


Fig. 4: Industrial Fibers Pieces

II. LITERATURE REVIEW

R.H.Mohankar A study on the mechanical performance of hybrid fiber reinforced concrete (HFRC) is done. The addition of small closely spaced and uniformly dispersed fibers to concrete would act as crack resistor and would substantially improve its properties. This type of concrete is known as Fiber Reinforced Concrete. The addition more than one type of fiber in concrete is known as Hybrid Fibre Reinforced Concrete. In this study steel fibers and polypropylene fibers are used. Fibers have been used to reinforce materials that are weaker in tension than in compression. Steel fiber and polypropylene fiber are used as Hybrid fibers. They are used in different proportions as 0.25%, 0.5%, 0.75%, and 1%. In this study Experiments were conducted to study the effect of steel fibre and polypropylene fibre in different proportions in hardened concrete. Compressive strength tests on cube and Flexural strength test on beam were carried out to study the properties of hardened concrete.

S. Kumaravel -The fibre reinforced concrete can improve the strength properties of hardened concrete. Cement concrete is weak in tension, to increase tensile strength by addition of fibers in concrete. Investigation is to find the mechanical properties of Hybrid Fibre Reinforced Concrete with steel (hooked end) and polypropylene fiber in various volume fractions. The steel fiber of various ratio (0.5 to 1.25%) and polypropylene fiber of various ratios (0.05 to 0.125) are mixed in based on volume of concrete. The concrete mix design is used as per IS: 10262-2009 in M 25 grade. To determine the compressive strength and flexural strength of control concrete (CC) and hybrid fiber reinforced concrete (HYFRC). The compressive strength of the HYFRC can improve 19% than, and the flexural strength of the HYFRC can improve 32% than the control mix.

M.V.Mohod studied the replacement of tyre steel fibers and marble dust with cement for M30 grade of concrete. In the concrete mix tyre steel fibers replaced with varying percentage of fibers ranging from 0%, 0.5%, 1%, 1.5% & 2%. After conducting the test it is found that compressive strength, flexural strength & split tensile strength increases at certain optimum percentage of replacement of fibers. As the project covers all the aspects of pavements analysis and design, Fatigue analysis has been performed. Variation in temperature during night and day have been studied for different thickness of cubes(150mm, 200mm, 250mm, 300mm, 350mm, 400mm) and it is found that the present work is good contribution in the field of pavement engineering-structural engineering.

B. Siva KondaReddy presents the article on effect of addition of steel fibers on strength and durability of high performance concrete. This paper presents an experimental investigation carried out to study the combined effect of addition of micro-silica and steel fibers on the strength and durability High performance concrete (HPC). A high performance concrete of M60 grade is considered and rapid chloride penetration tests were conducted to find the durability of HPC. Test results indicate that the addition of steel fibers to HPC increased strength and durability testing has also demonstrated the enhanced characteristics of HPC. Rapid chloride penetration results have ranged from extremely low to very low exhibits a high resistance to this form of environmental attack

Hasan Jasim Mohammed research paper is accomplished to study the effect of using waste fibers in properties of concrete. Steel lathe waste fibers are added by percentages of (4, 6 and 8 %) from weight of concrete and a percentages of concrete coarse aggregate are replaced by rubber tires waste fibers in a ratios of (5, 10 and 15%) by volume . Besides to that, the combined fibers are used steel lathe waste fibers by adding (4, 6 and 8 %) with constant replacing of rubber tires waste fibers of (10 %). The results showed that adding of steel lathe waste fibers in plain concrete enhances its strength under compression about (15%) and tension about (20%), while rubber tires waste reduced both of compression about (80 %) and tension about (51%) strengths .Also the compression and tension strengths are reduced (88% and 30%) respectively with using combined fibers . The dry concrete density of lathe waste fibers concrete is (2345-2365kN/m³), the rubberized

concrete density is (2130-2240kN/m³) and for combined fibers concrete density (2025-2180 kN/m³).

Uttam B. Kalwane presents the article on shear strength of polymer modified steel fiber reinforced concrete. An experimental investigation to study the effect on shear test of steel fibers and polymer latex in concrete is studied. Varying volume fraction of steel fibers from 0% to 7% at the interval of 1% of fiber and SBR latex polymer of fixed volume of 15% by weight of cement were used. Prisms of size 150 mm×150 mm×700 mm, double L-type blocks of size 150 mm ×150 mm ×450 mm were prepared. The larger broken part of specimen after the flexure test was used for double shear test. Push-off shear test and double shear test on grooved specimens were carried out.

Patil Shweta presents the paper on study of flexural strength in steel fiber reinforced concrete. Concrete possesses a very low tensile strength, limited ductility and little resistance to cracking. Various types of fiber reinforced concrete are being used against plain concrete due to their higher flexural strength, better tensile strength, modulus of rupture and crack resistance. In the present investigation properties of steel fiber reinforced concrete like flexure and compressive strength are studied. Tests were conducted to study the flexural and compressive strength of steel fiber reinforced concrete with varying aspect and varying percentage of fiber. In the experiments conducted four aspect ratio were selected i.e. 40,50,60,70 and percentage of steel in each case varied from 0.5% to 2.5% at interval of 0.5%. The various strength parameters studied are compressive strength and flexural strength as per the relevant IS standards. The experimental results indicate that the addition of steel fiber into concrete significantly increases the flexural strength. It also indicates that at constant percentage of fiber, that is 1.5% by increasing the aspect ratio of fiber from 40 to 70, flexural strength increased from 36.7% to 58.65%. The research paper proposes that due to these properties of steel fiber reinforced concrete, it can be used for the design of curvilinear forms.

Vikrant S Vairagade presents the paper on comparative study of steel fiber reinforced over control concrete. This paper deals with Experimental investigation for M-20 grade of concrete to study the compressive strength, and tensile strength of steel fiber reinforced concrete (SFRC) containing fibers of 0% and 0.5% volume fraction of hook end Steel fibers of 50 and 53.85 aspect ratio were used. A result data obtained has been analyzed and compared with a control specimen (0% fiber). A relationship between Compressive strength vs. days, and tensile strength vs. days represented graphically. Result data clearly shows percentage increase in 7 and 28 days Compressive strength and Tensile strength for M-20 Grade of Concrete.

R Vasudev studied steel fiber reinforced concrete which were used as scraps from lathe shop. Experimental investigation and analysis of results were conducted to study the compressive & tensile behaviour of composite concrete with varying percentage of such fibers added to it. The concrete mixes adopted were M20 & M30 with varying percentage of fibers ranging from 0% , 0.25%, 0.5%, 0.75%, and 1% respectively.on the analysis of test results the concrete with turned steel fibers had improved performance as compared to the concrete with conventional steel.

Dipan Patel studied the use of steel fibers in rigid pavement. M20 grade concrete mix was prepared with the crimped end steel fibers with 25mm length and 0.5mm diameter (A/R 50). Cube specimens were casted and tested for 0.4% & 0.5% of volume of concrete. The results showed that the compressive strength of steel fiber reinforced concrete increased when compared to the plain cement concrete. By the addition of steel fibers in concrete, the pavement thickness is increased by 23% and which is economical compared to the plain cement concrete slab.

III. SUMMARY

The conclusion from above research papers gives following points to discuss

- Hybrid Fiber Reinforced Concrete improves the properties of concrete, and the performance of Hybrid fiber reinforced concrete is better than that of single fiber reinforced concrete.
- Addition of steel fibers increases the compressive strength, flexural strength and tensile strength which ultimately improve durability of concrete.
- Using steel fibers will not only benefit construction industry but will also benefit producers and recyclers of used tyres.

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