International Journal of Trend in Scientific Research and Development (IJTSRD)
Volume 3 Issue 6, October 2019 Available Online: www.ijtsrd.com e-ISSN: 2456 – 6470

A Review Paper on Steel Fibre Reinforced Concrete

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ABSTRACT

Generally, adding of steel fibres in concrete improves the significance of the concrete mix and it also reduces the workability of the concrete. Steel fibre reinforced concrete (SFRC) is a Composite material which is made up of hydraulic cements. It contains coarse and fine aggregate. Since, cement having well compressive and steel having tensile strength it is capable of resisting wind and earthquake forces. Although reinforcing brittle materials with fibres is not a new concept, it was started in the early 1960s. Steel fibres added to concrete, steel fibre reinforced concrete (SFRC) is formed which enhances flexural strength, tensile strength and impact resistance. As it also improves structural integrity and protects from crack deformation which impacts to extent life of the Structures. The use of Steel fibre reinforced concrete (SFRC) requires accurate configuration differ from normal concrete and workability of the concrete would be affected as the quantity of fibres increasing.

Still SFRC Structures are limited and a steel fibre is not considered to be economical and less stable as they often used in tunnel and underground structural Steel fibres mostly developed to many micro cracks to few macro cracks.

KEYWORDS: *Steel fiber reinforced concrete (SFRC), Impact resistance, SFRC Structures*

How to cite this paper *:* K. Sree Sandhya | Dr. Rajamurugadoss | Dr. G. Ganesh Prabhu "A Review Paper on Steel Fibre Reinforced Concrete" Published in International Journal of Trend in Scientific Research and Development (ijtsrd), ISSN: 2456-6470, Volume-3 | Issue-6, October 2019, pp.530-532, URL: https://www.ijtsrd.com/papers/ijtsrd29155.pdf

IJTSRD29155

I. INTRODUCTION

Rapidly increase in the usage of fibre reinforced concrete (FRC) in civil engineering due to its favourable mechanical properties. Fibre reinforced concrete acquired by adding synthetic or steel fibres to the normal concrete would enhance to resist impact blast and fatigue loadings [1]. Fibre reinforced concrete freely transfers the possession to residual tensile strength in the cracked phase. As concrete is a brittle material with imperceptible tensile capacity it required to be improved with energy absorption capacity [2] and to improve the energy absorption capacity fibres have been induced. The addition of an adequate amount of fibre in the concrete, enhancing the control ability of the concrete thus appears in an enhancement in the tensile strength of the concrete [5]

Commonly, two types of fibres are used in structures which are synthetic and steel fibres. Comparatively synthetic fibres are shorter than steel fibres, mostly synthetic fibres used for the pavements nears to industrials, factories as it reduces the crack formation in the pavement. Steel fibres are often used for heavier structural applications such as tunnel linings and pre-cast concrete structural elements. Strength can be also secured by the combination of both synthetic and steel fibres [7].

Although steel fibres have been used from past several decades continuously due to its bonding mechanical properties with concrete it always strengthens concrete [10]. Steel fibre reinforced concrete (SFRC) is a composite material with random distribution of steel fibres and mortar. Standard codes have been not available for steel fibres but still structural design of national and international guidelines can be used. Even though they have been numerous researches and application on steel fibre reinforced concreted but still the study on SFRC is limited [11].

II. LITERATURE REVIEW

1. **Abdulaziz Alsaif et. al. (2019) [1]** have been investigated the mechanical and fatigue performance of steel fibre reinforced concrete (SFRC) and steel fibre reinforced rubberized concrete (SFRRuC) as both are the particles end - of- life of tires and have the potentiality to improve the flexibility and ductility of the concrete pavements. Specimens were casted and tested by using the rubber particles as replacement of the natural aggregates in the proportions of 0%, 30%, and 60% by the volume and blending of manufactured and recycled tire steel fibers (40kg/m^3). the results have shown that as compared to the plain concrete the blending of the steel fibers enhances the compressive strength by 20% and improves the fatigue stress resistance of concrete by 11% (at 25% probability of failure) , while the flexural strength, elastic modulus of remains the same. Replacement of natural aggregates with the rubber particles improves the flexibility but at the same time reduces the compressive strength ,static flexural strength ,elastic modulus of SFFRUC and fatigue

stress resistance by 42% (at 25% probability of failure). However the combination of both improves the tensile strength capacity of (SFFRuC).

2. **Ricardo chan et.al. (2019) [2]** have analyzed the technical and environmental feasibility for using the fibre reinforced recycled aggregate concrete (FRRAC) in the pavements by conducting an experimental program to assess the mechanical behavior of (FRC and FRRAC). In the experimental program a case of study was being performed for evaluating the feasibility of using the FRRAC in the pavement design, in which the fiber content as well as CO2 emission (CE) was also being estimated. It was shown in the case study that the pavement slab higher than 0.22m requires the similar fibers if they were not being produced by the FRC and FRRAC. The results have shown that the compressive strength ,modulus of elasticity ,flexural and tensile strength are higher with nominal aggregates as compared to recycled ones but with the increase in the fiber content there is an increase in the modulus of elasticity and residual flexural strength for FRC and FRRAC.
3. **Abdulaziz Alsif et.al. (2018) [3]** have investigated the effect of the recycled steel fibers upon the fresh and mechanical properties of the rubberized concrete (RuC) comprised of waste tire rubber (WTR) as well as the free shrinkage was being examined by using ten different mixes using the waste tire rubber and fiber contents. The results have shown that by the replacement of the natural aggregates by the rubberised particles decrease the workability, unit weight as well as the mechanical properties such as compressive strength ,flexural strength and modulus of elasticity but increases the air content of the fresh concrete. When the steel fibers are being included in the conventional concrete there is an increase in the compressive strength by 30% and a slight increase in the modulus of elasticity as well as free shrinkage strain increases with the increase in rubber particles due to the lower stiffness of rubber particles. The inclusion of steel fibers in the rubberized concrete decreases the flexural strength (from 50% to 9.6%) compared to the conventional concrete but improves the compressive as well as modulus of elasticity up to 12.5% to 28.4% respectively.
4. **Beatrice Belletti et.al. (2008) [4]** studied the fracture behavior of steel fibre-reinforced concrete (SFRC) slabs used for the industrial pavements by using the finite element analyses using different codes to describe the progressive cracking behaviour of steel fire reinforced concrete slab. Primary as well as secondary cracks were being stimulated by comparing various numerical predictions with numerous observations by using the full- scale tests on the slabs of elastic subgrade under the pont loads at different positions may include the contraction as well as the construction joints. The numerical study concluded that the bearing capacity of the slabs on the grade is purely dependent opn the load ositions and the loads may6 be present anywhere irrespective of the position which should be mostly considered which are close to the construction and contraction joints and the reinforcement provided with the steel fiber at these joints increases the bearing capacity of the slabs of the inner areas of the pavements, hwen the loads are being applied from the free external borders.
5. **S.H chu et.al. (2018) [6]** have studied that the trial and error method which is being used for the different FRC mixes is a very slow process and sometimes may be frustrating because after many attempts being made the required performance may not be achieved. So, to overcome the problem a study was being conducted to find out the effects of the content of the fiber and the characteristics of the fresh and hardened properties of the steel fibre reinforced concrete which have been evolved are measured are being correlated with the regression analysis of the various factors of the fibers to identify the different governing factors for the performance of the steel fibers. By this study it has been revealed that the traditional practices of taking the fiber factor as the fiber volume times 6the aspect ratio is a simplistic and number of fiber4s being taken is more important than the fiber volume.
6. **Ahmed Hilal farhen et.al. (2018) [8]** have investigated the incorporation of the steel fibers which are being extracted from the old tires in the cement bound granular mixtures (CBGMS) which are the attractive option for increasing the load carrying capacity and sustainability of a highway pavements. The study was conducted by incorporating these steel fibers with different cement content (3%, 5%, and 7% by the weight of the aggregate and fibers) and two reinforcement content (0% and 0.5% by the volume of the aggregates) which may affect the tensile properties of the pavement design. By using the combination of macro-surface cracks, fractal analysis and both the image monitoring and processing techniques time-dependent fracture and damage propagation were also being examined. The results of the investigation have concluded that for the longer life period and less pavement thickness it is sensible to use fiber at higher cement content though both the reinforced and unreinforced cement stabilized mixtures have improvement in their tensile strength with increase in the cement content. The toughness of the investigat5ed mixtures was more with the highly cement contains mix and increased more with the inclusion fibers ,so it is advised that 5% or more cement content is better or else ductility may occur. There was higher crack propogation speed in the mix without fiber but it reduced with the inclusion of fibers. So, it is recommended to reinforcement should be used not less than 5% of cement content.
7. **Chuanqing Fu et.al. (2018) [7]** have investigated the mechanical behavior (compressive, flexural, tensile strength) and toughness of the steel-fiber-reinforced rubberized concrete by using the different content of the rubber and the steel fibers including the age of curing for the different mixes. By 8using the both the four-point bending unnotched and the three-point bending notched methods the toughness of the (FR-RC) was being investigated and were being quantified by using the toughness indexes proposed in ASTMC1018 and Double-K fracture model. The results of the investigation have concluded that the compressive strength of the (FRRC) is dependent on both the rubbr and fiber dosages whereas the flexural and tensile strength is mainly dependent on the fiber content whereas the modulus of elasticity is being controlled by the rubber content. Both

the toughness and the strength increases with the age of curing. The peak strength of both the notched and unnotched bending tests are based on the rubber content and the inclusion of the fiber whereas the straining hardness and the softening behaviours of the (FRRC) are dependent on the steel fibers mainly. The rubber content initially dominates the initial fracture toughness thereafter the steel fibers dominates the unstable fracture toughness according to the K-fracture model.

8. **Jun.Mo yang et.al. (2017) [9]** examined the effects of implication of the amorphous metallic fibers showing on the mechanical and long term sustainability of the concrete pavements. In the study two different types of amorphous metallic fibers were been considered and incorporated in the concrete and has been compared with the conventional concrete without fibers. The results have shown that all the mechanical properties (i.e. compressive, flexural, and tensile and toughness) were being increased with the increase in the amorphous metallic fibers. The flexural strength as well as the flexural ratio was being much higher by using 5 and 10kg/m^3 amorphous metallic fibers which results in decrease in the thickness of the concrete pavement when designed for the airway runways. There was an increase in the resistance cracks occurrence for the pavement designed for the repetitive wheel loading by using the amorphous metallic fiber which gives longer service life about 1.2 to 3.2 times of the pavement when 5 to 10kg/m^3 fibers were being considered. The initial construction cost of the pavement including the amorphous metallic fibers was high but significantly decreased the maintenance cost and work zone delay therefore it is concluded pavement with these type of fibers exhibits the lower life cycle cost for high volume of traffic as compared to the plain concrete pavements.
9. **Tayfun Uygunolu (2011) [5]** studied the effect of the steel fiber length (aspect ratio) and the content used ojn the bleeding of the steel fibre reinforced concrete (SFFC) by using the two different types of steel fiber (both hooked end) with the ratio of 0%, 0.3%, 0.64%, 1% and 1.3% by the volume of the concrete. Properties like Ve-be test slump, air content and unit weight were being determined by using the experimental analyses. Specimens were being prepared by using the standard moulds 150*150*150mm and bleeding of water was being examined and measured for (30-180) min at an interval of 30min for each observation after starting the test. The results have concluded that bleeding of te SFRC purely depends upon the steel fiber content as the highest bleeding was found when the SFRC volume fractions was higher. It was also found that at the first 1.5h the speed of bleeding was very fast as the upward layer was being detroited rapidly. On the other hand the workability of SFRC was being decreased with increase in the steel fibers and the unit weight was being increased due to the specific gravity of the steel fiber. Some of the coefficients were being developed for with or without steel fiber as a function of time dependent.

III. CONCLUSION

The following concluded were drawn from a broad overview of the literature review.

A. Compressive strength, Flexural strength and split tensile strengths were slightly increased as percentage of steel fibre content increased in the contrete and it is observed that the workability of steel fibre reinforced concrete gets reduced as the percentage of steel fibres increases and the experimental work also showed that the workability of SFRC gets reduced as we increased the fiber amount.
B. SFRC is a sustainable improvement inside the present technology. SFRC is used for foremost, high budget tasks only because Steel fibres are value effective.
C. The studies concluded that the steel fibre content present in concrete not only improves the strength but also prolongs the the durability of structures.

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