Electro Chemical Accelerated Corrosion on Steel Fiber Reinforced Concrete

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Abstract- *Cement concrete is the most broadly utilized development material on the planet. This is because it is a broad utilized material that it gives great workability and can be formed to any shape. Normal cement concrete has a low tensile strength, constrained ductility and little resistance from cracking. Internal cracks(splits), prompting to brittle failure of cement concrete. In this modern age, civil engineering constructions have their own durability and structural requirement , each structure has its own planned reason and consequently to meet this reason, modification in traditional cement bond concrete has turned out mandatory. It has been discovered that distinctive kind of fibers added in specific percentage to concrete which enhances the mechanical properties, toughness and serviceability of the structure. It is now established that one of the critical properties of Steel Fiber Reinforced Concrete (SFRC) is its better protection against cracking and crack propagation . In this paper impact of fibers on the strength of cement concrete for M40 grade have been considered by varying different percentage of fibers in cement concrete. Percentage of fibers added by 0.25%, 0.50%, 0.75% and 1% by volume of cement concrete. Specimens of size 150mmX150mmX150mm are utilized to check the compressive strength. Cylindrical specimen of size 150mm in breadth and 300mm length are utilized to check the Split Tensile strength. Every one of the specimens were cured for the time period of 3, 7 and 28 days. The results s of fiber reinforced cement concrete for 3days, 28days curing with different percentage of fiber were considered and it has been discovered that there is a significant strength improvement in steel fiber reinforced cement concrete. Likewise, it has been found that with increase in fiber content up to the optimum value increases the strength of cement concrete. And finally electro chemical corrosion test is adopted to check the strength of steel fiber towards corrosion. The corrosion test is made for time period of 45 days for every specimen. slump cone test was adopted to measure the workability of concrete. From Slump cone test it has been found that workability gets reduced with the increase in fiber content.*

Keywords- Crimped steel fibers, Steel fiber reinforced concrete, Accelerated corrosion,.

I. INTRODUCTION

A composite material like concrete which contains cement, water, coarse and fine aggregate. The subsequent material is a stone like structure which is shaped by the response reactions of chemicals like cement and water. This stone like material is a fragile(brittle) material which is solid in compression yet exceptionally powerless in tension. Due to less strength in the tension zone concrete makes it to split under little loads. The cracks bit by bit propagate to the compression end of the structural member and finally part breaks. The cracks in the concrete may likewise happen because of the drying shrinkage. These cracks are essentially small scale breaks. These cracks increment in magnitude and size as the time slips by and the at long last makes the concrete to fizzle (fails).

The development of cracks is the primary purpose behind the failure of the concrete. To build the tensile strength of cement many endeavors have been made. One of the fruitful and most normally utilized techniques is giving steel reinforcement. However Steel bars, reinforced cement concrete against tension zone. Cracks in reinforced concrete individuals expand unreservedly until the point where experiencing of bar. Therefore requirement for multidirectional and firmly divided steel reinforcement is required. That can't be for all intents and purposes conceivable. Fiber reinforcement gives the answer for this issue.

So to expand the tensile strength of cement a strategy of presentation of fibers in concrete is being utilized. These fiber filaments behave like a crack arrestors and keep the propagation of the cracks. These strands are consistently appropriated and haphazardly masterminded. This cement concrete is named as fiber strengthened cement concrete. The fundamental explanation behind adding fibers to cement concrete is to enhance the post breaking reaction of the solid, i.e., to enhance its energy absorption limit and flexibility capacity, and to give crack protection and break control. Likewise, it keeps up cohesiveness and structural integrity in the material. The underlying explores joined with the huge

volume of follow up examine have prompted the improvement of a wide assortment of material details that fit the meaning of Fiber Reinforced Concrete

II. LITERATURE REVIEW

Amit Rana[1]have expressed Fibers are generally used as resistance of cracking and strengthening of concrete. In this project, tests are conducted on steel fiber reinforced concrete to check the influence of fibers on flexural strength of concrete. According to various research papers, it has been found that steel fibers give the maximum strength in comparison to glass and polypropylene fibers. Hence, in this project he was interested in finding out the optimum quantity of steel fibers required to achieve the maximum flexural strength for M25grade concrete.

Ahsana Fathima k m[2]this paper presents the results of an experimental study investigating the effects of steel fibers and polypropylene fibers on the mechanical properties of concrete. Experimental program consisted of compressive strength test, split tensile strength test and flexural strength tests on steel fiber reinforced concrete and polypropylene fiber reinforced concrete. Three types of fibers used are hooked end steel fiber of length 30mm, crimped steel fiber of length 25mm and enduro-600 polypropylene of length 50mm with aspect ratio 50. The main aim of this experiment is to study the strength properties of steel fiber and polypropylene fiber reinforced concrete of M30 grade with 0%, 0.25%, 0.5%, and 0.75% by volume of concrete. This study consisted of compressive strength test and split tensile strength test on hybrid fiber reinforced concrete with 0.5% polypropylene fibers and 0.75% steel fibers.

Amarjit Singh[3] this paper presents the ACI–recommended method of mix design is commonly practiced in the United States, and is taught in university curricula. Though immense effort might have gone into preparing the method over many decades, there is an obvious arithmetical error in computing and recommending the starting point of the moisture to be added to the mix.

A.M. Shende[4]have studied the Critical investigation for M-40 grade of concrete having mix proportion 1:1.43:3.04 with water cement ratio 0.35 to study the compressive strength, flexural strength, Split tensile strength of steel fiber reinforced concrete (SFRC) containing fibers of 0%, 1%, 2% and 3% volume fraction of hook stain. Steel fibers of 50, 60 and 67 aspect ratio were used.

Berrocal CarlosG[5]presents various durability aspects of steel-fiber reinforced concrete (SFRC).Published research results show that due to the limited length of the fibers and the casting conditions, steel fibers embedded in concrete show no corrosion signs despite high chloride concentrations. It was also reported that due to the fibers ability to arrest crack width propagation, permeability was positively affected for cracked concrete compared with plain concrete.

2.1Research significance

The aim of our project is to use the Steel Fibers with crimped shaped as Fiber reinforcement to concrete.

Our objective is to add the Steel fibers to the concrete and to study the strength properties of concrete with the variation in fiber content. i.e., to study the strength properties of concrete (M40 Grade) for fiber content of 0.25%, 0.5%, 0.75% and 1.0% at 3,7 and 28 days. The strength properties being studied are as follows:

1. **Compressive strength.**
2. **Split Tensile Strength.**
3. **Corrosion resistance.**

2.2 Scope of work

This study is limited to investigate the compressive strength, Split Tensile Strength and corrosion resistance of the fiber reinforced concrete cubes. Four fiber volume fractions of 0.25%, 0.5%, 0.75% and 1% are used

III. TEST MATERIALS

3.1 Materials

The materials used in this present work are steel fiber, Ordinary Portland cement (53 grade), coarse aggregates and fine aggregates.

3.2 Cement

Cement is a binder, a substance that hardens and sets and can bind other materials together. It is used in construction and it can be characterized as being either non hydraulic or hydraulic, depending upon the ability of the cement to be used in the presence of water.

3.3 Aggregates

Crushed granite was used as coarse aggregate passing through 20 mm having specific gravity of 2.62 and water absorption is 0.45.The fine aggregate has specific gravity 2.44 and water absorption 1.

3.4 Steel fiber

Steel wire fibers are dispersed randomly in the cement concrete can lessen or even supplant traditional rebar and welded reinforcement which expands the rigidity or tensile strength. It can be connected in modern industrial floors, street roads, strip foundation, street surfacing, bridge spans and different developments with standard basic requests. Steel fibers of 4mm width and 50mm length are utilized.

Figure 1: Crimped steel fiber

Mix proportions

Cement = 492.5 kg/m^3
Water = 140kg/m^3
Fine aggregate = 658.3536 kg/m^3
Coarse aggregate = 1089.99 kg/m^3
Water-cement ratio = 0.4

III. EXPERIMENTAL TESTING PROCEDURE

3.1 Accelerated corrosion process

The electro chemical procedure of Corrosion test for steel is finished with various responses happening at the anodic and catholic destinations. A supply of oxygen and water is required to keep up the response. In new cement concrete the pores solution pH is around 12.5. In these conditions a steady oxide "passive" layer is formed on the surface of the steel which gives assurance from corrosion. In the event that the cement concrete carbonates to the depth of the steel as well as chlorides are available at above threshold limit the insurance can be traded off.

All specimens were put in the tank containing salt solution and associated with the positive end of the power supply at titanium poles utilizing cupper core cable. The negative connection of the circuit was given utilizing a bit of exposed steel electrode partly submerged in the arranged solution. Figures demonstrate the accelerated corrosion test setup. A consistent 16A current was gone through the NaCl solution and samples for 45 days. In this arrangement plan steel fibers went about as an expending anode to keep up the present course through the concrete samples.

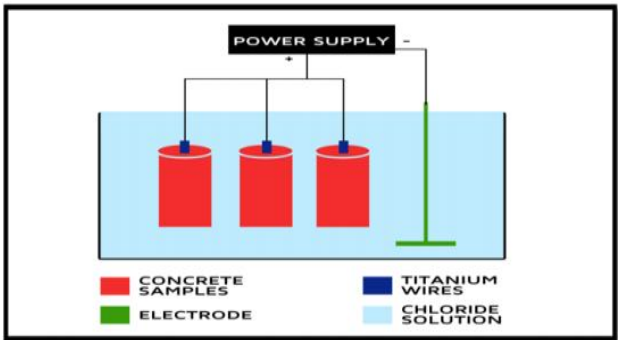

Figure 2: Schematic diagram of the accelerated corrosion test used

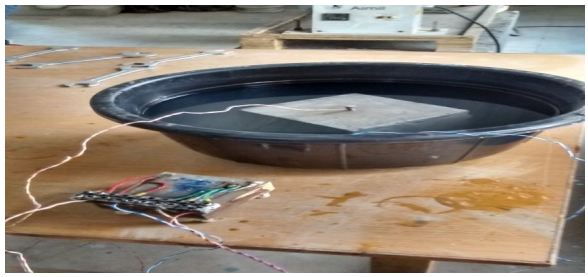

Figure 3: Accelerated Corrosion apparatus

3.2 Compressive strength

Compressive strength of cement is a standout the most critical and valuable properties of cement. In structural applications concrete is utilized principally to oppose compressive stress. In those situations strength in tension or in shear is of essential significance, the compressive strength is utilized as a measure for these properties. Along these lines, the concrete making properties of different ingredients of mix are typically measured in the terms of compressive quality.

Figure 4: Compression testing machine

3.3 Split Tensile Strength

For Split Tensile strength test, a cylindrical barrel sample of measurement 150 mm diameter across and 300 mm length were cast. The casted samples were demoulded following after 24 hours of casting and were cured in curing tank wherein they were permitted to cure for 7, 14, 28 days. These examples were tested under (CTM) compression testing machine. In every classification three Cylinder barrels samples were tested and their mean average value is taken. Split Tensile quality was computed as takes after as split elasticity:

Split Tensile quality (MPa) = $2P/\pi$ DL, Where, P = , D = distance across of chamber, L = length of chamber

IV. RESULTS AND DISCUSSIONS

The present experimental study is carried out to find out the workability, compressive strength ,Split Tensile Strength and corrosion resistance of 150mm*150mm*150mm cubes for different ratios of steel fiber to the cement. The cubes are tested for compressive strength and Split Tensile Strength at 3 days, 7 days, 28 days. The compressive strength and Split Tensile Strength values are taken as the average of the three test results. The results of compressive strength and Split Tensile Strength of specimens are presented in the tabular forms. Also the graphical representation of compressive strength and Split Tensile Strength of concrete cubes of various mixes is also presented. The cubes are immersed in Nacl solution and current is passed 5 hour duration and the compressive strength and Split Tensile Strength is reported in tabular form and the graphical representations for various ratios are presented.

4.1 Results of slump test:

The workability in the form of slump decreases with increase in dosage of steel fiber.

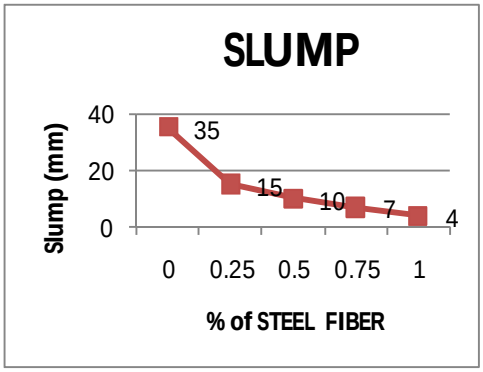

Chart 1: Variation in Slump of concrete with respect to percentage of fiber content.

4.2 Compressive strength of steel fiber reinforced concrete

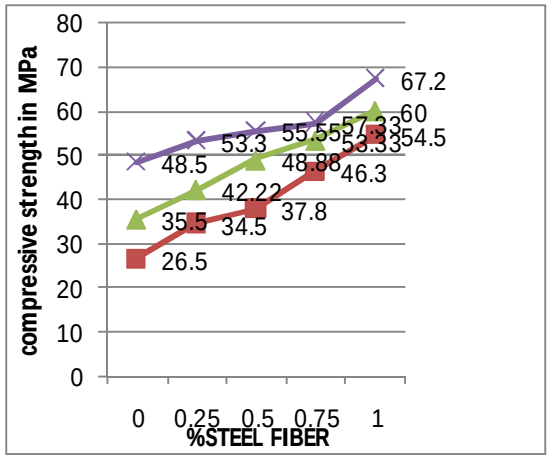

Chart 2: Variation of compressive strength of 150 mm cubes for different % of steel fiber

Referring to chart 2 , the compressive strength of 150mm cube increases with an increase in dosage of steel fiber.

4.3 Split Tensile strength of steel fiber reinforced concrete

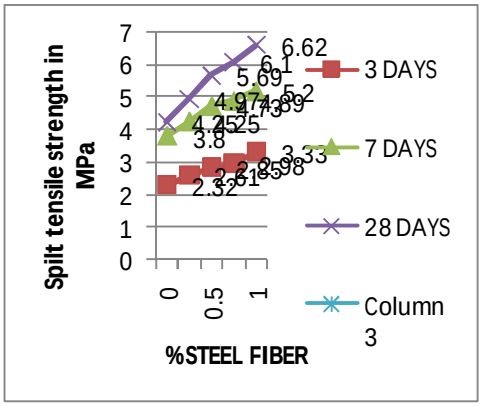

Chart 3: Variation of Split Tensile strength of cubes for different % of steel fiber

Referring to chart, the Split Tensile strength of cube increases with an increase in dosage of steel fiber.

4.4 Variation of residual compressive strength for accelerated corrosion specimen

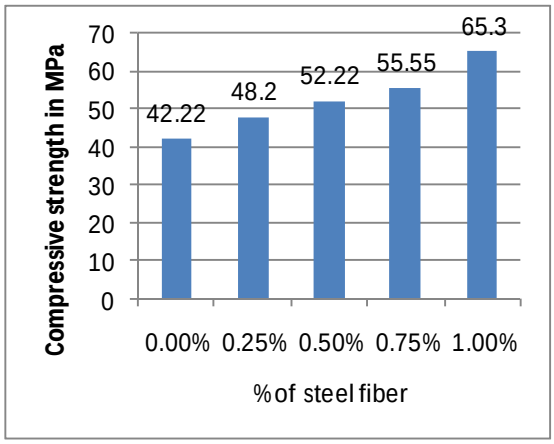

Chart 4: Variation of compressive strength of 150 mm cubes with respect percentage of steel fiber

Referring to chart 3, the Compressive strength for 150 mm cubes for accelerated corrosion test are 42.2N/mm^2, 48.2N/mm^2, 52.22N/mm^2, 55.55N/mm^{2}and 65.3N/mm^2 respectively. A slight decrease in compressive strength was observed after conducting accelerated corrosion test.This has no influence on the compressive strength of the specimens.

4.5 Variation of residual Split Tensile strength for accelerated corrosion specimen

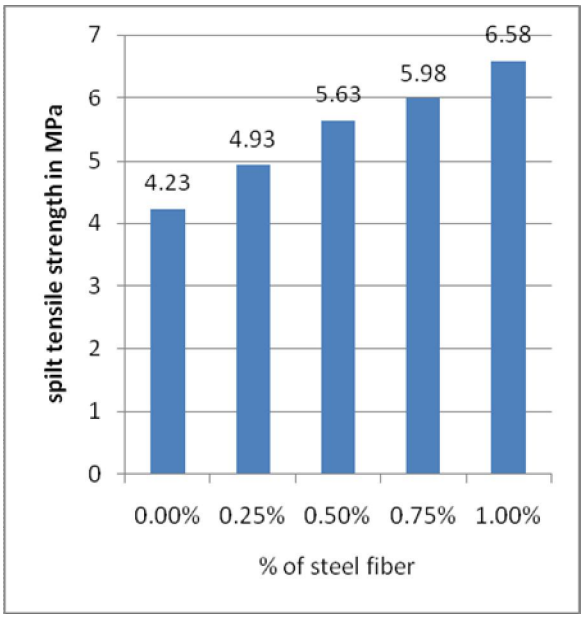

Chart 5: Variation of Split Tensile strength of cubes with respect percentage of steel fiber

Referring to chart 4, the Split Tensile Strength cubes for accelerated corrosion test are 4.23N/mm^2, 4.93N/mm^2, 5.63N/mm^2, 5.98N/mm^{2}and 6.58N/mm^{2}respectively. A slight decrease in Split Tensile Strength was observed after conducting accelerated corrosion test..

V. CONCLUSIONS

1. The current experimental procedure of Utilized for accelerates corrosion in steel fiber reinforced concrete which can be considered as a good technique to implement corrosion in concrete specimens in a small period oftime.
2. Steel fibers appear to present less damage than the normal steel bar used normally in corrosion tests.
3. It is observed that the workability of steel fiber reinforced concrete gets reduced as the percentage of steel fibers increases.
4. From compression behavior of corrosion steel fiber concrete it was observed that the performance of specimens was not reduced by corrosion attack. This has no influence on the compressive strength of the specimens.
5. From Split Tensile behavior of corrosion steel fiber concrete it was observed that the performance of specimens was not reduced by corrosion attack. This has no influence on the Split Tensile strength of the specimens.
6. Steel fiber reinforced concrete has very slight decrease in compressive strength and Split tensile Strength after conducting accelerated corrosion test at 1% dosage of steel fiber due to discontinuity of fibers. Hence it is preferable to use high dosage of steel fibers to decrease corrosion effect.

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BIOGRAPHIES

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