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Strength Study of Concrete by Adding Strips of Stainless Steel Scrubbers

M. Lenin Sundar[#], R. Prabhakaran[*]

[#] *Professor, Department of Civil Engineering, Sri Krishna College of Technology, Coimbatore – 641 042. India.*
E-mail: m.leninsundar@skct.edu.in; lenin_mk@rediffmail.com

[*] *M.E. Student, Department of Civil Engineering, Sri Krishna College of Technology, Coimbatore – 641 042. India*
E-mail: prabhakarancivil14@gmail.com

Abstract— **Fibres are generally used for crack resistance and increasing strength of concrete. This study intended to know the mechanical behaviour and optimum quantity of stainless steel scrubbers in concrete as fibres. Tests were conducted for M25 grade concrete. Fibre content was varied by 0, 2, 3 and 4 percent by weight of cement. The test results of stainless steel fibre reinforced concrete for 7, 14 and 28 days curing revealed that there is significant strength improvement. The concrete strength increases with the increase of fibre content. 4 percent of the fibre content has given better results and it can be concluded as optimum for this study. Workability of concrete was decreased with increase in percentage of fibre content.**

***Keywords*— concrete, steel fibre reinforced concrete, scrubbers, workability, compressive strength, split tensile strength.**

I. INTRODUCTION

Concrete is the most widely used structural material in the world. For a variety of reasons, much of this concrete is cracked. The reason for concrete to suffer cracking may be attributed to structural, environmental or economic factors, but most of the cracks are formed due to the inherent weakness of the material to resist tensile forces. When concrete is restrained shrinkage cracks are developed. Steel fibre reinforcement offers a solution to the problem of cracking by making concrete tougher and more ductile. Fibre is a small piece of reinforcing material possessing certain characteristics and properties. The weak matrix in concrete gets strengthened, when reinforced with steel fibres which are uniformly distributed across its entire mass and behave as a composite material with properties significantly different from conventional concrete. Steel fibres improve the compressive strength of concrete marginally about 10 to 30%; significant improvement is achieved in several other properties of concrete. The efficiency of steel fibres in concrete depends in proportion to increasing fibre content, fibre strength, aspect ratio and bonding efficiency of the fibres in the concrete matrix.

An experimental study was conducted by Neves and Fernandes [1] to investigate the influence of matrix strength, fibre content and diameter on the compressive behaviour of steel fibre reinforced concrete. Two types of matrix and fibres were tested. Concrete compressive strengths of 35 and 60 N/mm^2, 0.38 and 0.55 mm fibre diameter, and 30 mm fibre length, were considered for this study. The volume of fibre in the concrete was varied up to 1.5%. Test results indicated that the addition of fibres to concrete enhances its toughness and strain at peak stress, but can slightly reduce the Young's modulus. Simple expressions are proposed to estimate the Young's modulus and the strain at peak stress, from the compressive strength results, knowing fibre volume, length and diameter. An analytical model to predict the stress-strain relationship for steel fibre concrete in compression is also proposed. The model results are compared with experimental stress-strain curves.

The study conducted by Milind V. Mohod [2] on effect of fibres on the strength of concrete for M 30 grade by varying the percentage of steel fibres as 0.25, 0.50, 0.75, 1, 1.5 and 2 percents by volume of cement in concrete. Cubes of size 150mmX150mmX150mm and beams of size 500mmX100mmX100mm were casted for checking compressive strength and flexural strength respectively. All the specimens were cured for the period of 3, 7 and 28 days before testing. From the results of 3, 7 and 28days curing on varied percentage of fibre; it has been found that there is significant strength improvement in steel fibre reinforced concrete. The optimum fibre content for

the compressive and flexural strength is 1 and 0.75 percent respectively. Also, it has been observed that with the increase in fibre content to the optimum value increases the strength of concrete. Slump cone test was adopted to measure the workability of concrete. The Slump cone test results revealed that workability gets reduced with the increase in fibre content.

Critical investigation was done by Shende et.al. [3] 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 and Split tensile strength of steel fibre reinforced concrete (SFRC) containing fibres of 0, 1, 2 and 3 percent volume fraction of hook tain. Steel fibres of 50, 60 and 67 aspect ratio were used. A result data obtained has been analysed and compared with a control specimen (0% fibre). A relationship between aspect ratio vs. Compressive strength, aspect ratio vs. flexural strength, aspect ratio vs. Split tensile strength represented graphically. Result data clearly shows percentage increase in 28 days Compressive strength, Flexural strength and Split Tensile strength for M-40 Grade of Concrete. It has been found that different type of fibres added in specific percentage to concrete improves the mechanical properties, durability and serviceability of the structure. One of the important properties of Steel Fibre Reinforced Concrete (SFRC) is its superior resistance to cracking and crack propagation.

Amit Rana [4] carried out the test on steel fibre reinforced concrete to check the influence of fibres on flexural strength of concrete. From the exhaustive and extensive experimental work, it was found that with increase in steel fibre content in concrete, there was a tremendous increase in Flexural strength. Even at 1 percent steel fibre content flexural strength of 6.46 N/mm^2 was observed against 5.36 N/mm^2 at 0 percent; hence increase of 1.1 percent flexural strength was obtained.

Based on literatures and studies, stainless steel scrubbers were taken as the steel fibres in concrete in this study. Also, the study intended to know the workability, compressive and tensile strengths of steel fibre reinforced concrete beyond 2 percent of steel fibres by the weight of cement.

II. METHODOLOGY

Mix design was done for M25 grade concrete based on IS: 10262 – 2009 [6]. Water cement ratio adopted as 0.40. No admixtures used for this study. Materials used for this are as follows:

Cement: Ordinary Portland Cement, 53 grade conforming to IS: 12269 – 1987 [7] was used. Specific gravity of cement used is 3.15.

Fine aggregate: locally available river sand confined to grading zone – II of IS: 383 – 1970 [5] was adopted. Specific gravity of fine aggregate is 2.6.

Coarse aggregate: locally available crushed blue granite stones conforming to graded aggregate of nominal size 12.5mm as per IS: 383 – 1970 [5] was used. Its specific gravity is 2.75.

Fibres: stainless steel scrubbers were taken as steel fibres for this study. These are made of high-grade stainless steel with four sided strands, giving for cleaning edges to handle toughest jobs. Since each scrubber is made of a single strand of stainless steel, they will not tear or splinter. Also, they will not corrode. It has a good tensile strength and the fibre strips length vary by 1, 1.5 and 2 inches. These fibres will improve toughness, durability and tensile strength of concrete. The picture of scrubber is shown in Fig.1.

Fig.1. Stainless Steel Scrubber

The specifications of scrubbers used in this study are as follows:

Material	-	Stainless Steel
Length used	-	40 to 60mm
Diameter	-	0.5mm

Aspect ratio - 30
Available form- winded
Colour - silver thin wires

The mix proportions adopted for this study is given in Table 1.

TABLE 1
MIX PROPORTIONS VARIOUS MIXES

Mix	% of Scrubbers	Cement kg/m^3	Fine Aggregate kg/m^3	Coarse Aggregate kg/m^3	Water in litre	Weight of Scrubbers kg/m^3
M0	0	480	648.98	1118.48	192	-
M1	2	480	648.98	1118.48	192	9.6
M2	3	480	648.98	1118.48	192	14.4
M3	4	480	648.98	1118.48	192	19.2

Concrete cubes of size 150mm x 150mm x 150mm and cylinders of size 150mm diameter and 300mm height were casted for the above proportions of concrete to test the compressive strength and split tensile strength.

III. RESULTS AND DISCUSSIONS

Workability of steel reinforced concrete mixes were tested by slump cone test. The results of that are shown in fig.2. The slump value decreased as the percentage of steel fibre increases. Compressive strength and split tensile strength were tested after 7, 14 and 28 days curing and the results are presented in fig. 3 and 4.

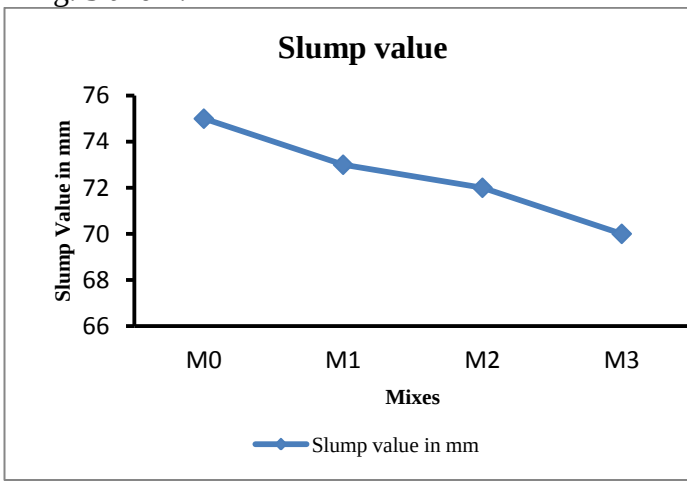

Fig 2. Slump value for various mixes

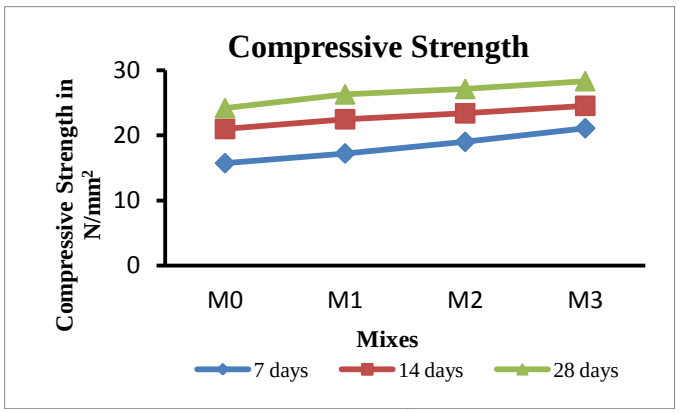

Fig 3. Compressive Strength results for various mixes

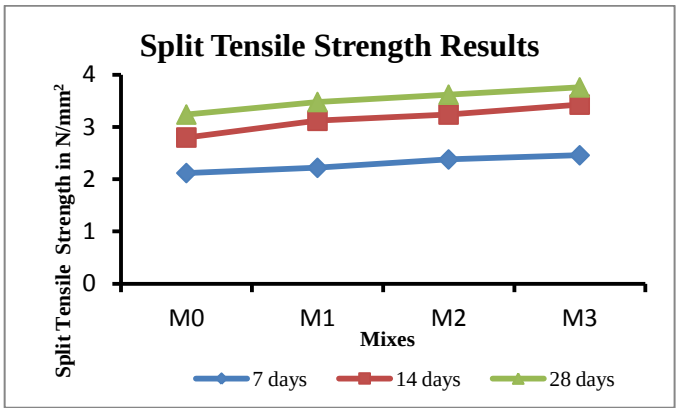

Fig 4. Split Tensile Strength results for various mixes

Compressive strength test results exhibited that the strength increases with the increase of steel fibre. When compared with the strength of nominal mix (M0), the other mixes M1, M2 and M3 had shown 8.8, 12.2 and 17.2 percents increase in 28 days compressive strength respectively. Similarly, the 28 days split tensile strength of M1, M2 and M3 increased as 7.4, 11.7 and 16 percents respectively compared with M0 mix.

IV. CONCLUSIONS

- It is observed that the workability of concrete decreased with the increase in percentage of steel fibres.
- Addition of steel scrubbers as fibre in concrete leads to an increase in compressive strength and split tensile strength.
- Maximum compressive and split tensile strength were obtained for 4 percent of steel fibre.

- By adding 4 percentage of steel scrubbers as fibre by the weight of cement in concrete, the compressive and split tensile strength of concrete increased by 17.2 and 16 percent respectively.

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