AN EXPERIMENTAL STUDY ON COMPRESSIVE AND FLEXURAL STRENGTH BEHAVIOR OF STEEL FIBER REINFORCED CONCRETE

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***Abstract* —** This paper deals with experimental investigation on mechanical properties of M30 grade concrete by incorporating steel fibers in the mix. Crimped steel fibers of 1%, 2%, 3% and 4% by the weight of cement are added to the mix. A comparative analysis has been carried out for conventional concrete to that of the fiber reinforced in relation to compressive and flexural strengths. Up to 20% increment in compressive strength of the concrete was achieved and up to 40.82% increment in the flexural strength in concrete was achieved with the 4% of crimped steel fibre addition in normal concrete for curing period of 28days. The results shows that as the fiber content increases compressive and flexural strengths are proportionally increasing.

Keywords — Steel Fiber Reinforced Concrete, Mix proportions, Compressive strength, Flexural strength.

I. INTRODUCTION

Concrete is most widely used construction material in the world due to its ability to get cast in any form and shape. It consists of cement, sand and aggregate (e.g., gravel or crushed rock) mixed with water. The cement and water form a paste or gel which coats the sand and aggregate. Fiber Reinforced Concrete (FRC) is composite material consisting mixtures of concrete or cement-mortar with discrete, discontinuous, uniformly dispersed suitable fibres.

Steel Fiber reinforced concrete (SFRC) is defined as concrete made with hydraulic cement containing fine and coarse aggregate and discontinuous discrete fibre. In SFRC, thousands of small fibres are dispersed and distributed randomly in the concrete during mixing, and thus improve concrete properties. Addition of steel fibers in the concrete mix will increases the initial first cracking strength, high impact resistance, increases in flexural strength and etc.

A M Shende et al., (2012) studied on Steel Fiber Reinforced Concrete. In this study, steel fibre of 0%, 1%, 2% and 3% by weight of cement were used with different aspect ratio. It was observed that compressive strength, split tensile strength and flexural strength are on higher side for 3% fibres. All the strength properties are observed to be on higher side for aspect ratio of 50 as compared to those for aspect ratio 60 and 67. The authors observed that compressive strength increases from 11 to 24%, flexural strength increases from 12 to 49% and split tensile strength increases from 3 to 41% with addition of steel fibres. Yaseen Patel et al., (2017) studied the effect of different types of steel fibres on strength parameters of self-compacting concrete. Straight fiber, crimped fiber and hooked fibers of 1%, 2% and 3% by volume of cement were used. Results shows that increase of strength in Compressive strength, Flexural strength and Split Tensile strength up to 3% of addition of steel fiber for M-40 Grade of Concrete and the optimum percentage of different type of steel fibre was found to be 2 percentage. In this research work, an attempt has been made to study the behaviour of crimped steel fibres in concrete by conducting compression and flexural test.

II. EXPERIMENTAL PROGRAMME

2.1 Material used

The materials used for this experimental work are cement, sand, coarse aggregate, water, and crimped steel fibres.

Cement: Ordinary Portland cement of 43 grade was used in this experimentation conforming to conforming to IS: 8112-2013.

Sand: Locally available sand zone II with specific gravity 2.58, conforming to IS: 383-2016.

Coarse aggregate: Crushed angular aggregates having specific gravity of 2.60, conforming to IS: 383-2016.

Water: Potable water was used for the experimentation.

Steel fibres: In the present work crimped steel fibres of length 30mm and diameter 0.6mm were used with an aspect ratio of 50.

2.2 Methodology

The mix design procedure adopted in the present work to obtain M30 grade concrete is accordance with IS: 10262-2009. The obtained mix proportion was 1:1.44:2.47. The w/c ratio was 0.45. For compressive strength test, cube specimens of dimensions 150 x 150 x 150 mm were cast for M30 grade of concrete. The moulds were filled with 0%, 1%, 2%, 3% and 4% fibres. Vibration was given to the moulds using table vibrator. The top surface of the specimen was levelled and finished. After 24 hours the specimens were demoulded and were transferred to curing tank wherein they were allowed to cure for 28 days. After 28 days curing, these cubes were tested in compression testing machine as per IS: 516-1959. The failure load was noted. In each category three cubes were tested and their average value is reported. The compressive strength was calculated as follows.

Compressive strength (MPa) = Failure load / cross sectional area.

Fig. 2.1: Testing of compressive strength test specimen

For flexural strength test beam specimens of dimension 150x150x700 mm were cast. The specimens were demoulded after 24 hours of casting and were transferred to curing tank wherein they were allowed to cure for 28 days. These flexural strength specimens were tested under two point loading as per IS: 516-1959, over an effective span of 600 mm on Flexural testing machine. In each category three beams were tested and their average value is reported. The flexural strength was calculated as follows.

Flexural strength (MPa) = (P x L) / (b x d2),

Where, P = Failure load, L = Centre to centre distance between the support = 600 mm, b = width of specimen=150 mm, d = depth of specimen= 150 mm.

Fig. 2.2: Testing of flexural strength test specimen

III. RESULTS AND DISCUSSION

3.1 Slump Test: The concrete slump test measures the consistency of fresh concrete before it sets. It is performed to check the workability of freshly made concrete, and therefore the ease with which concrete flows. It can also be used as an indicator of an improperly mixed batch. Slump cone test basically comprises of a steel mould in sort of frustum of a cone having the interior top diameter 10cm, base diameter 20cm and height 30cm.

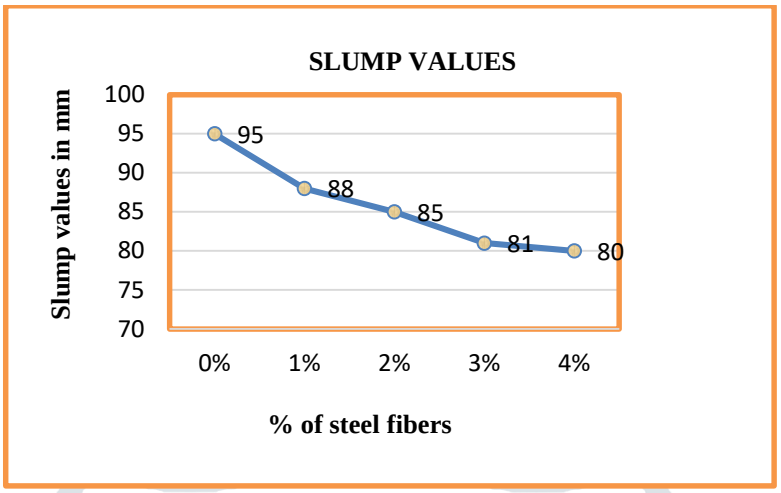

Fig 3.1: Slump variation

From the Fig 3.1 the slump value is decreasing with the increase % of steel fibers. So the usage of super plasticizers may be recommended.

3.2 Compression Strength Test

For each concrete mix, the compressive strength is determined on three 150×150×150 mm cubes at 28 days of curing. The graph chart was drawn with the compression strength test results of concrete and composite crimped steel fibre concrete produced with addition of 1%, 2%, 3% and 4%, of crimped steel fibre by weight of cement.

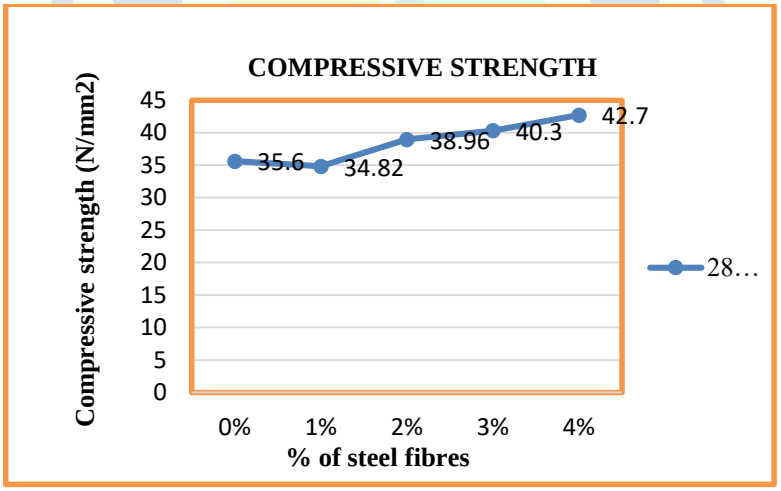

Fig 3.2: Compressive strength for normal and crimped steel fibre blended concrete for 28 days

From the Fig 3.2, it has been observed that the addition of crimped steel fiber in concrete will increase the Compressive strength. Up to 20% increment in the compressive strength of concrete was achieved with the 4% of crimped steel fibre addition in normal concrete for a curing period of 28 days.

3.3 Flexural Strength Test

For each concrete mix, the flexural strength is determined on three 150×150×700 mm beams at 28 days of curing. The graph was drawn with the flexural strength test results of concrete and composite crimped steel fibre concrete produced with addition of 1%, 2%, 3% and 4%, of crimped steel fibre by weight of cement.

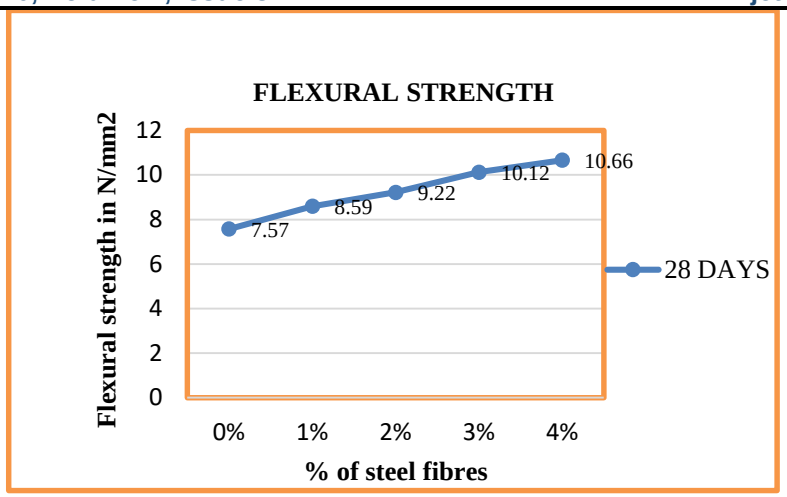

Fig 3.3: Flexural strength for normal and crimped steel fibre blended concrete for 28 days

From the Fig 3.3, it has been observed that the addition of crimped steel fiber in concrete will increase the flexural strength. Up to 40.82% increment in the flexural strength of concrete was achieved with the 4% of crimped steel fibre addition in normal concrete for a curing period of 28 days.

IV .CONCLUSION

Based on experimental results of steel fiber reinforced concrete the following conclusion can be drawn

- Workability of steel fibre reinforced concrete gets reduced as the % of steel fibres increases.
- Compressive strength goes on increasing with increase in the % of crimped steel fibre up to 4% by weight of cement at the age of 28 days of curing.
- Flexural strength goes on increasing with increase in the % of crimped steel fibres. Up to 40.82% increment in the flexural strength of concrete was achieved with the 4% of crimped steel fibre addition in normal concrete for a curing period of 28 days.

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