Effect of Change of Grade of Concrete on the Percentage Increase in Compressive Strength of SFRC

Neeru Bansal
Associate Prof. CED,
RIMT,
Mandi Gobindgarh
neeru_024@yahoo.com
Research Scholar,

Harmanpreet Singh
NITTTR,
Chandigarh

ABSTRACT
Cement concrete is the most extensively used construction material in the world. The reason for its extensive use is that it provides good workability and can be moulded to any shape. This paper deals with the comparative study on percentage increase in the compressive strength of M20 and M25 grade concrete mixes after addition of various proportions of hooked and crimped steel fibers under standard curing conditions. The main aim of the investigation is to compare the different grades of concrete by adding hooked and crimped steel fibers of varying fiber content such as 0.5%, 1%, 1.5%, 1.75% by volume of concrete. The concrete specimens have been tested at different age levels for checking the compressive strength of concrete. Cube moulds of size 150mm X 150mm X 150mm to check the compressive strength have been casted. All specimens have been casted for a period of 7 and 28 days before crushing. The results of fiber reinforced concrete for 7 days and 28 days curing with varied percentage of hooked end and crimped steel fiber were studied for M20 and M25 mixes and it has been found that there is significant strength improvement in steel fiber reinforced concrete. Also, it has been found that improvement or percentage increase in compressive strength is more in case of M20 than in M25.

Keywords
SFRC, Aspect ratio, Steel fiber, Concrete, Crack

1. INTRODUCTION
Steel fiber reinforced concrete (SFRC) is defined as concrete made with hydraulic cement containing Fine and coarse aggregate and discontinuous discrete fiber. In SFRC, thousands of small fibers are dispersed and distributed randomly in the concrete during mixing, and thus improve concrete properties. It has been already established that addition of steel fibers to concrete improves the static and dynamic tensile strength, energy absorbing capacity and better fatigue strength. Milind V. Mohod[1] reported that the optimum fiber content while studying the compressive strength of cube is found to be 1 %. Janesan, P.V. Indira and S. Rajendra Prasad [2] reported the effect of steel fiber on the strength and behaviour of reinforced concrete is two-way action. They concluded an increase in ultimate strength with an increase in addition of steel fibers. ACI 544, 3R-08 [3], states that fiber volume fraction used in producing steel fiber reinforced concrete should be within 0.5% to 1.5% as addition of further fiber may reduce the workability of the mix and will cause balling or mat which will be extremely difficult to separate by vibration. According to ACI 544, 3R-08 [2], aspect ratio is referred to the ratio of fiber length over the diameter. The normal range of the aspect ratio for steel is from 20 to 100. Aspect ratio of steel fiber greater than 100 is not recommended, as it will cause inadequate workability, formation of mat in the mix and also non uniform distribution of fiber in the mix. To avoid any honeycombing, bleeding, segregation and heterogeneous features by improving the workability, use less water and paste. Generally, for structural applications, steel fibers should be used in a role supplementary to reinforcing bars. Steel fibers can reliably inhibit cracking and improve resistance to material deterioration as a result of fatigue, impact, and shrinkage.

2. METHODOLOGY
Ordinary Portland cement of 43 grade was used. The coarse aggregates used have been crushed aggregate passing through 20 mm sieve and retaining on 4.75 mm sieve size. The fine aggregate has uncrushed sand. The mix design was confirming to IS 10262:2009. The water cement ratio of 0.45 was adopted. Throughout the test the grade of concrete used was M20 and M25 and hooked end steel fibers and crimped steel fibers have been used. The fibers used were of aspect ratio 50 i.e. L/B = 50.

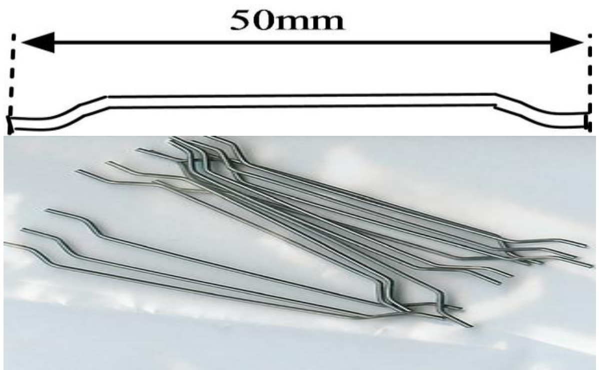

Figure 1. Hooked-end Steel Fibers

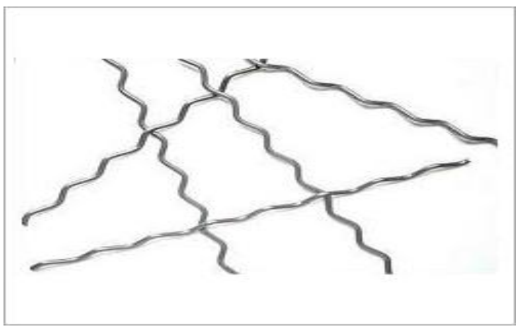

Figure 2. Crimped Steel Fibers

3. RESULTS AND DISCUSSIONS

The effect of percentage increase in compressive strength of concrete on addition of steel fiber both hooked as well as crimped were studied by volume of concrete. The observations were made for 7 and 28 days curing period were recorded and presented in form of tables and graphs.

The compressive strength was calculated as follows:

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

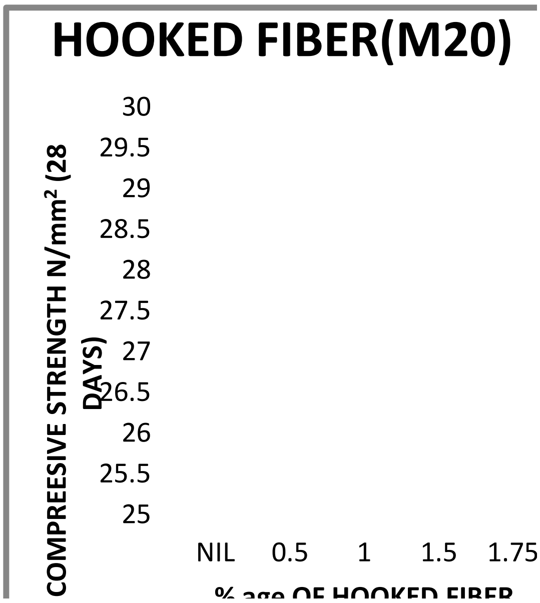

Figure 3. Variation of Compressive strength of M25 with respect to percentage of fiber

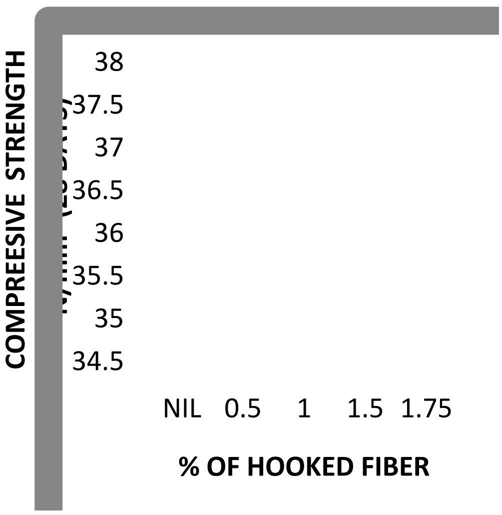

Figure 4. Variation of Compressive strength of M25 with respect to %age of fiber

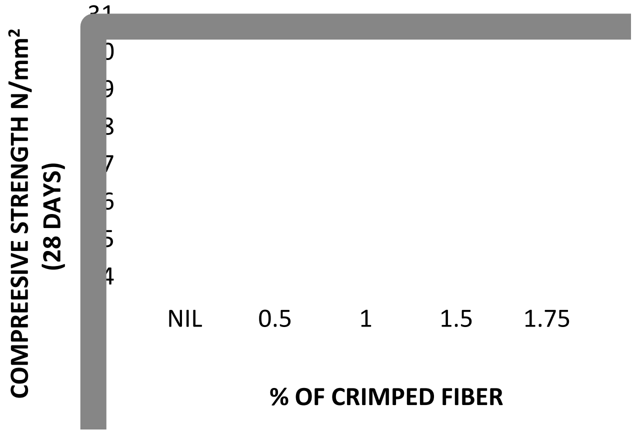

Figure 5. Variation of Compressive strength of M20 with respect to %age of fiber

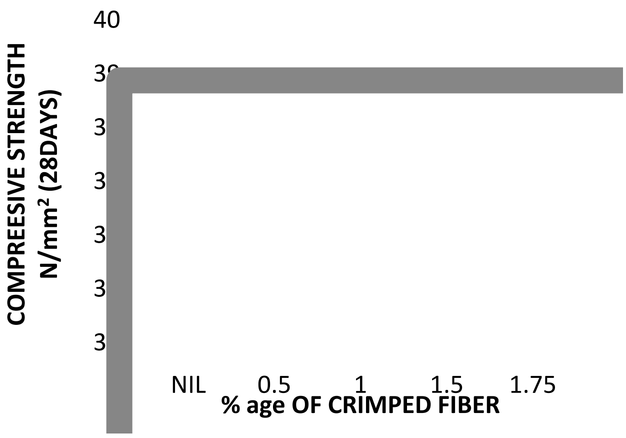

Figure 6. Variation of Compressive strength of M20 with respect to %age of fiber

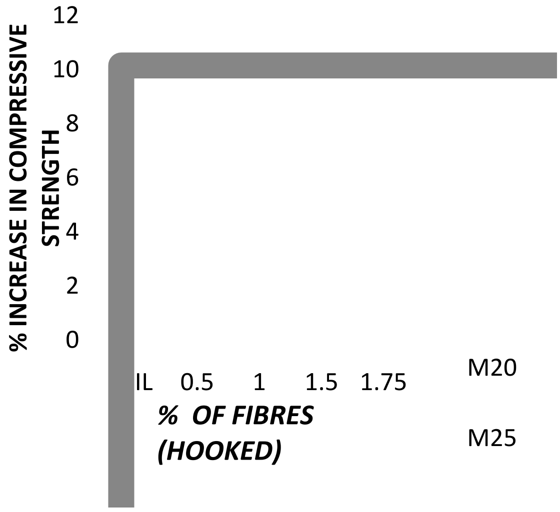

Figure 7. Variation in %age increase in compressive strength with increase in %age of fibers

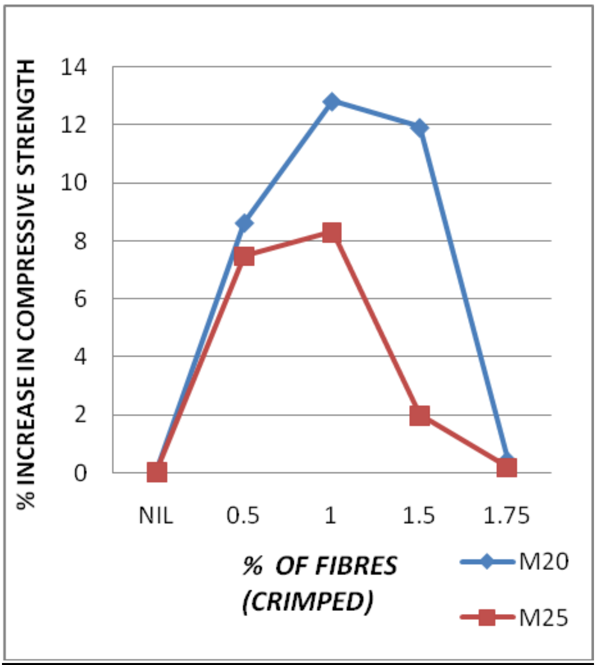

Figure 8. Variation in %age increase in compressive strength with increase in %age of fibers

4. CONCLUSIONS

4.1 The following conclusions could be drawn from present investigation :-

1. In hooked end as well as crimped fibers, the percentage increase in compressive strength is lesser in case of M25 (richer mixes) as compared to M20 (leaner mix).
2. .Percentage increase in Compressive strength keeps increasing in steel fiber percentage up to the optimum value. The optimum value of fiber content of steel reinforced concrete is confirmed as 1%.

5. FUTURE SCOPE

This paper can be treated as a supporting document for a detailed research in finding the different strength parameters.

The following studies can be initiated so as to provide a wide range of application in the field steel fibre reinforced concrete in different sustained elevated temperatures in particular.

1. The study can also be made on the effect of sustained elevated temperatures on SFRC with combinations like Fly Ash, Silica Fumes and Blast furnace slag.
2. Similarly a study can be made on the effect of freezing and thawing action on SFRC with various blends.
3. Effects of different aspect ratios and different volume fractions on the properties of SFRC when subjected to sustained elevated temperatures.
4. The effect of different types of aggregates on the properties of SFRC when subjected to sustained elevated temperatures.

6. REFERENCES

[1] Milind V. Mohod, (2012) : "Performance of Steel Fiber Reinforced Concrete."

[2] ACI committee 544, 3R-08, "Guide for specifying, proportioning, and production of fiber reinforced concrete." American concrete institute, Farmington hills, USA.

[3] N. Janesan, P.V. Indira and S. Rajendra Prasad, (2010): "Structural behaviour of steel fiber reinforced concrete with panels in two-way is plane action." Indian Concrete Journal.

[4] Perumalsamy N. Balaguru, Sarendra P. Shah, ''Fiber reinforced cement composites'', McGraw Hill International Editions 1992

[5] Colin D. Johnston, "Fiber reinforced cements and concretes" Advances in concrete technology volume 3 – Gordon and Breach Science publishes – 2001

[6] Balaguru P and Najm H (2004), "High-performance fibre reinforced concrete mixture proportion with high fibre volume fractions", Material Journal, volume 101, issue 4, July 1, 2004 pg 281-286