EFFECT ON STRENGTH OF STEEL FIBER REINFORCED CONCRETE WITH VARIATION IN THE LENGTH OF STEEL FIBER

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Abstract - *The purpose of this research is based on the investigation of the use of steel fibers in structural concrete to enhance the mechanical properties of concrete. The objective of the study was to determine and compare the differences in properties of plain concrete and concrete with fibers . Also to see the compressive and split tensile strength of concrete with variation of length of fiber in compare to different percentage of steel fiber .Comparison of 0.50%, 0.75%, 1.0%percentages of steel fiber by weight of concrete with 30mm, 50mm, 75mm length of fiber. 'Crimped' steel fibers were used to determine the enhancement of mechanical properties of concrete. Also how the addition of fibers affect the workability of the concrete has also been looked into.*

***Key Words*: steel fiber reinforced concrete, aspect ratio variation, length variation, percentage variation**

1. Introduction

Concrete is a construction material composed of cement , aggregate (generally a coarse aggregate such as gravel, limestone, or granite, plus a fine aggregate such as river sand),and water. Apart from its excellent properties, concrete shows a rather low performance when subjected to tensile stress. Therefore, several discrete fiber were developed for concrete reinforcement, namely, steel, glass, synethic and natural fibers. Steel fibers are the most used in concrete application due to the following main reason: economy, manufacture facilities, reinforcing effects and resistance to the environment aggressiveness.

1.1 Need to use steel fiber reinforced concrete

- Fibers are used in concrete to control plastic shrinkage cracking and drying shrinkage cracking in the concrete.
- Steel fiber lowers the permeability of concrete and thus reduce bleeding of water in concrete.
- After matrix crack initiation, the stresses are absorbed by bridging fibers, and the bending moments are redistributed. The concrete element does not fail spontaneously when the matrix is cracked; the deformation energy is absorbed and the material becomes pseudo-ductile.
- The steel fiber reinforcement not only improves the toughness of the material, the impact and the fatigue resistance of concrete, but it also increases the material resistance to cracking.
- SFRC used in tunnel structures represents an attractive technical solution with respect to the conventional steel reinforcement, because it reduces both the labor costs (e.g. due to the placement of the conventional steel bars) and the construction costs (e.g. forming and storage of classical reinforcement frames, risks of spalling during transportation and laying).
- Plain, un-reinforced concrete is a brittle material, with a low tensile strength and a low strain capacity. The role of randomly distributes discontinuous fibers is to bridge across the cracks that develop provides some postcracking "ductility" and increase tensile strength of the concrete.
- If the fibers are sufficiently strong, sufficiently bonded to material, permits the FRC to carry significant stresses over a relatively large strain capacity in the post-cracking stage.
- Use of steel shows good increase compressive strength, tensile strength, and flexural strength.

2. Physical properties of concrete

The project initially consisted of designing concrete mix. Constituent materials like cement, aggregate, steel fiber and water play an important role in imparting strength to the concrete. Any variation in the properties of this constituents after the properties of concrete considerably. Hence to ascertain the quality of concrete properties of constituent was needed to be tested. Therefore, tested values of properties of concrete materials concrete mix are shown below in table form.

Table 1: Physical properties of cement

Physical properties	Results
Specific gravity	3.15
Consistency	27%
Intial setting time	35 min
Final setting time	10 hour
Fineness	230 m^2/kg

Table 2: Physical properties of sand

Physical properties	Result
Specific gravity	2.65
Type	Limestone
Material finer than 75 microns	.80%

Table 3: Physical properties of coarse aggregate

Physical properties	Results
Specific gravity	2.77
Shape	Angular
Size of aggregate	20mm

2.1. Steel fiber

Different types of steel fibers can be used to reinforced concrete. Hooked end and crimped steel fiber has proven to give the best performance. Therefore, in this experiment crimped steel fiber is used because it gives good friction and bond to the concrete. Diameter of steel fiber used is measured with micro gauge and length with scale. Aspect ratio(L/D) of steel fiber used varies form 90 to 300.

Table 4: Physical properties of steel fiber

Physical properties	Results
Diameter	.33mm
Lengths of fiber	30mm, 50mm, 75mm
Appearance	Bright in clean wire
Shape	Crimped
Modulus of elasticity	200MPa
Aspect ratio	90.9,151.51,227.27
Specific gravity	7.8

Figure 1: Steel fiber of crimped shape with different length

3. Experimental program

3.1. Casting of test specimens

The program consisted of arriving at mix proportions, weighing the ingredients of concrete accordingly, mixing them manually and then testing for the fresh properties of respective concrete. If fresh properties satisfy standard specifications, Standard cubes of dimensions 150 mm x 150 mm x 150 mm and standard cylinder of dimensions cylinder of 150 mm diameter and length of 300 mm were cast to check whether the target compressive strength is achieved at 7-days and 28- days curing. If either the fresh properties or the strength properties are not satisfied, the mix is modified accordingly. Standard cube moulds of 150 mm X 150 mm X 150 mm made of cast iron were used for casting standard cubes and cylinder of 150 mm diameter and length of 300 mm were made. The standards moulds were fitted such that there are no gaps between the plates of the moulds. The moulds then oiled and kept ready for casting. After 24 hours of casting, the specimen were demoulded and transferred to curing tank where in they were immersed in water for the desired period of curing.

For comparing strengths for M_{20} grade, standard concrete and steel fiber reinforced standard concrete, a total of 60cubes, and 60cylinders were casted. Where 6cubes and 6cylinders have been casted for standard concrete, out of which 3cubes and 3cylinders were for 7 days and rest for 28 days and 54cubes and 54cylinders for steel fiber reinforced standard concrete, out of which 27 cubes and 27cylinders were for 7 days and rest for 28 days. Similar cylinders were casted.

Percentage of fibre by weight of concrete	Strength of concrete 30 mm length of Fiber	Strength of concrete 50 mm length of Fiber	Strength of concrete 75 mm length of Fiber
1%	3 sample	3 sample	3 sample
0.75%	3 sample	3 sample	3 sample
0.50%	3 sample	3 sample	3 sample

As described above 3 sample for each percentage of fiber cubes and cylinders were casted for each length of steel fiber reinforced concrete.

3.2. Testing of Specimens

After curing for 7 and 28 days, the specimens were tested f0or compressive strength and tensile strength of concrete in a 2000-Ton compression testing machine. The cubes, and cylinders were tested. The bearing surfaces of the compression testing machine were wiped clean. The cubes and cylinders to be tested were placed concentrically and in such a manner that the load was applied to the opposite sides of the cube as cast, that is, not on the top and bottom. Then the load was applied without shock and increased

continuously at a rate of approximately 5.2 kN/sq cm/minute until the resistance of the cube to the increasing load breaked down and no greater load could be sustained. The maximum load applied to the cube was then noted down.

Figure 2: Compression testing machine testing cube

Figure 3: Compression testing machine testing of cylinder

4. Result and discussion

4.1. Compressive strength for 7 days

The compressive strength values of cube of standard concrete and steel fiber reinforced concrete for 7 days is shown below in graph with variation of percentage of steel fiber by the weight of the concrete with strength of cube of varied length of fiber.

Form graph, it is observed that there is enhancement of compressive strength of 23%, 41.6%, and 33.69 % for 30mm, 50mm and 75mm length of steel fibers respectively for 7 days test and maximum strength have shown by .75% of fiber fraction with 50mm length of steel fiber .

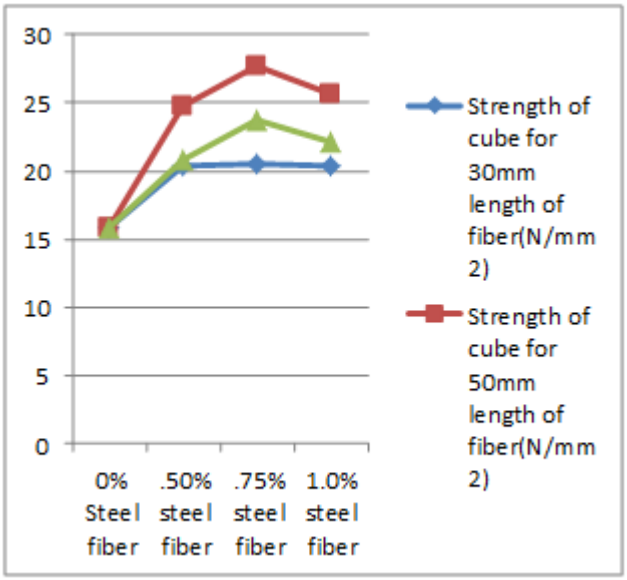

Chart 1: Compressive strength of cube for 7 days

4.2. Compressive strength for 28 days

The compressive strength of values cube of standard concrete and steel fiber reinforced concrete for 28 days is shown below in graph with variation of percentage of steel fiber by the weight of the concrete with strength of cube of varied lengths of fiber.

Form graph, it is observed that there is enhancement of compressive strength of 24%, 40%, and 40.57 % for 30mm, 50mm and 75mm length of steel fibers respectively for 28 days test and maximum strength have shown by .75% of fiber fraction with 50mm length of steel fiber.

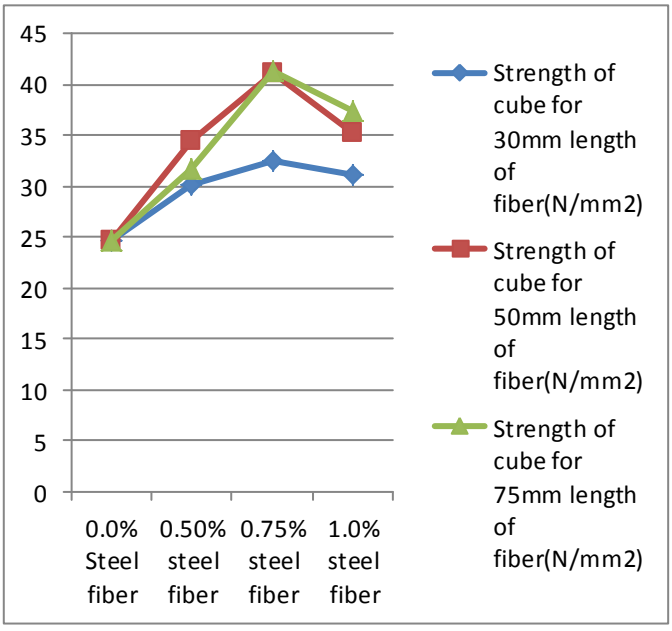

Chart 2: Compressive strength of cube for 28 days

4.3. Tensile strength for 7 days

The split tensile strength of values cylinder of standard concrete and steel fiber reinforced concrete for 7 days is shown below in graph with variation of percentage of steel fiber by the weight of the concrete with strength of cylinder of varied length of fiber.

Form graph, it is observed that there is enhancement of split tensile strength of 32.51%, 39.39%, and 43.59 % for 30mm, 50mm and 75mm length of steel fibers respectively for 7 days test and maximum strength have shown by 1.0% of fiber fraction with 75mm length of steel fiber.

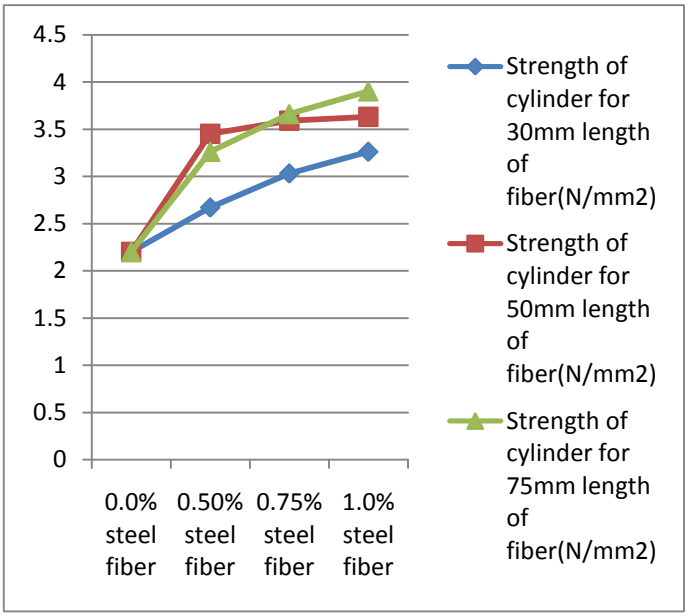

Chart 3: Split tensile strength of cylinder for 7 days

4.4. Tensile strength for 28 days

The split tensile strength of values cylinder of standard concrete and steel fiber reinforced concrete for 28 days is shown below in graph with variation of percentage of steel fiber by the weight of the concrete with strength of cylinder of varied lengths of fiber

Form graph, it is observed that there is enhancement of split tensile strength of 26.28%, 37.11%, and 42.24 % for 30mm, 50mm and 75mm length of steel fibers respectively for 28 days test and maximum strength have shown by 1.0% of fiber fraction with 75mm length of steel fiber .

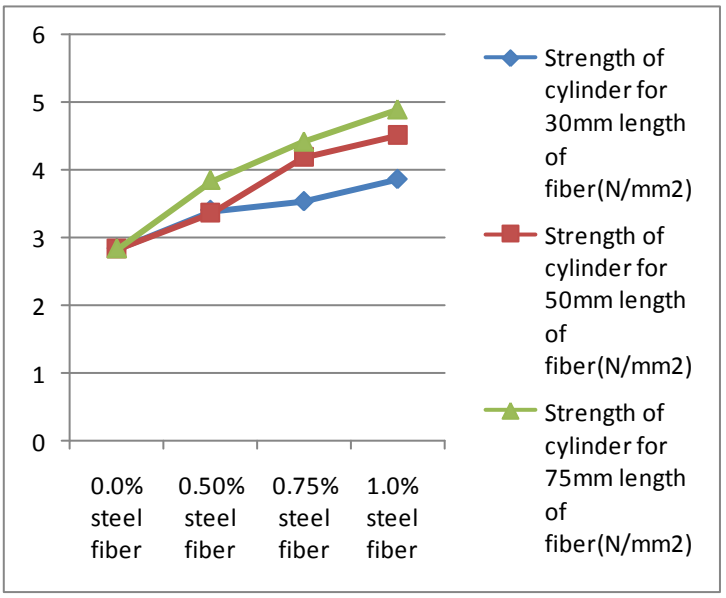

Chart 4: Split tensile strength of cylinder for 28 days

5. Summary

In this project, through experiment, investigation has been done to see the effect of steel fibers on the compressive and spit tensile strength of hardened concrete. The project aims at optimizing the manner of addition of steel fibers in concrete by simultaneous variation of percentage of steel fibers, length and aspect ratio. In the experiment a number of cube and cylinder were made with percentage variation of steel fiber by the weight of the concrete in cube and cylinder and different percentage variation were 0%, .50%, .75%, and 1%. In every percentage variation, there was variation in the length of the steel fiber. The varied lengths are 30mm, 50mm, and 75mm had used with constant diameter. The mould of standard size have been used cube size 15cm x15cm x 15cm and cylinder size of 15cm diameter and 30 cm length. The testing have done in 7 and 28 days. The shape which had used for steel fiber is crimped with the aspect ratio of 90.9, 151.51, and 227.27.

6. Conclusions

- Compressive strength, which has been done with compression testing machine of Steel fiber reinforced concrete was improved with an increase in fiber percentage and aspect ratio. Compared to plain concrete, the ultimate compressive strengths of specimens had improved by 23%, 41.6%, and 33.69 % for 30mm, 50mm and 75mm length of steel fibers respectively for 7 days test .But for 28 days, there is ultimate compressive strengths of specimens are maximally improved by 24%,40%, and 40.57 % for 30mm, 50mm and 75mm length of steel fibers respectively
- By comparing the values of all length of fiber maximum compressive strength was shown by 50mm length steel fiber in both 7 and 28 days of steel fiber with 0.75% of fiber by the weight of the concrete.

- Split tensile strength, which has been done with compression testing machine of Steel fiber reinforced concrete was improved with an increase in fiber percentage and aspect ratio. Compared to plain concrete, the ultimate split tensile strengths of specimens are maximally improved by 32.51%, 39.39%, 43.59 % for 30mm, 50mm and 75mm length of steel fibers respectively for 7 days test .But for 28 days, there is ultimate split tensile strengths of specimens are maximally improved by 26.28%, 37.11%, and 42.24 % for 30mm, 50mm and 75mm length of steel fibers respectively.
- By comparing the values of all length of fiber maximum split tensile strength was shown by 75mm length steel fiber in both 7 and 28 days of steel fiber with 1.0% of fiber by the weight of the concrete.
- While preparing the mix ,If has been observed that for same water-cement ratio there is decrease in workability with increase in steel fiber content because of the fluidity decreases with increase in steel fiber content.
- When the split tensile test had done, it has been observed that the bond strength of concrete and steel fiber was increased with increase in the length of fiber .This can be confirmed from the observation that plain concrete breaks in two part while testing but steel fiber reinforced concrete do not breaks into two parts but instead they had some bond between their parts.

7. References

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