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## RESEARCH ARTICLE

# BEHAVIOUR OF SFRC WITH VARYING COMPOSITE MIXES AND PERCENTAGES OF FIBRES

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**ABSTRACT**

Concrete is one of the most common versatile building materials. It can be cast in any structural shape from a cylindrical water storage tank to a rectangular beam or column in a high-rise building, and also used as pre-stressed and post-stressed concrete. It is readily available in urban areas at relatively low cost. Concrete is strong under compression yet weak under tension. To counter the weakness in tension, a form of reinforcement is required. The most common type of concrete reinforcement is via steel bars. The concept of using fibres to improve the characteristics of matrix is as old and well established as adding straw or horsehair to mud bricks. The principal role of fibers is to bridge pre-cracks and resist their formation. The advantage of adding fibers into a matrix include enhancement of compressive strength, tensile strength, fatigue strength, flexural toughness, shear strength, durability, resistance to impact and minimize thermal cracks etc. Present study is to ascertain the behaviour of steel fiber reinforced concrete with varying composite mixes and percentages of fibers. The experiments were conducted on concrete mixes of M20, M25 and M30 grades. Straight fibers of length 28 mm and diameter of 0.28 mm with aspect ratio of 100 was used. Every grade of mix was further reinforced with different percentage of above mentioned fibers i.e. 0%, 0.5%, 0.75% and 1% by volume. A total of 36 cubes of standard size 150 mm x 150 mm x 150 mm and 36 cylinders of 150 mm diameter and of 300 mm high.



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## INTRODUCTION

reinforcement is always required. The most common type of concrete reinforcement is via steel bars. The concept of using fibers to improve the characteristics of matrix is as old and well established as adding straw or horsehair to mud bricks. The fibre reinforced matrix can continue to carry a considerable amount of load after cracking has occurred. The principal role of fibers is to bridge pre-cracks and resist their formation. The advantage of adding fibers into a matrix include enhancement of compressive strength, tensile strength, fatigue strength, flexural toughness, shear strength, durability, resistance to impact and minimize thermal cracks etc. The objective underlining the execution of this experimental program is to study the behaviour of SFRC with varying concrete grade and percentages of fiber. Three different mixes of M20, M25 and M30 were designed. These mixes individually contained four different percentages of fibers namely, 0%, 0.5%, 0.75% and 1.0% by weight.

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## LITERATURE REVIEW

Faisal F. Wafa and S.A. Ashour [1992] carried out experimental investigations on properties like, cube compressive strength, splitting tensile strength and modulus of rupture of concrete by incorporating hooked - end steel fibres with 0% to 1.5% as volume fraction. They concluded that addition of 1.50% by volume of hooked end fibres resulted in 4.6% increase in compressive strength, 59.80% increase in split tensile strength and 67% increase in modulus of rupture of plain cement concrete. Also they developed equations for predicting the experimental results. Singh, A.P. & Dr. Singhal, D. [1998] After studying the permeability of steel fibre reinforced concrete by using plain steel fibres at various percentages (0% & 4%) they observed that permeability is decreasing significantly with the addition of fibres and it continued to decrease with the increase in fibre content. Also linear relationship was observed between permeability and compressive and tensile strength for plain cement concrete. Yaghoub Mohammadi S.P. Singh &Kaushik S.K. [2008] carried out an experimental programme in which various tests such as inverted cone time, Vee-Bee time and compaction factor were conducted to investigate the properties of plain concrete and fibre reinforced concrete in fresh state. Compressive strength, split tensile and static flexural strength tests were conducted to investigate the properties of concrete in the hardened state.

## EXPERIMENTAL PROGRAMME

An extensive experimental program has been executed to ascertain the behaviour of steel fiber reinforced concrete (SFRC) with varying composite mixes and percentages of fibers. The experiments were conducted on concrete mixes of M20, M25 and M30 grades. Every mix was further mixed with different percentage of fibers i.e. 0%, 0.5%, 0.75% and 1% by volume. The experiment was designed to study the compressive strength as well as splitting tensile strength of the concrete reinforced with fibers.

***Properties of Concrete Constituents:*** The properties of the constituents of concrete is necessary to determine to ensure that they do not contain any deleterious element which may affect the behavior of the composite or they may not conform to the specified requirement necessary to achieve a standard of performance. Ordinary Portland cement of 43 grade was used in the experimental investigation. The IS 4031: (1999) have been strictly adhered to during the investigation. The experimental values are as given in Table -1. The coarse sand as fine aggregate used was locally available lying in grading zone II. The specific gravity and fineness modulus were determined as 2.45 & 2.83 respectively. The test procedures as mentioned in IS 383: (1970) were followed to determine the properties of fine aggregate. The coarse sand as fine aggregate used was locally available lying in grading zone II. The specific gravity and fineness modulus were determined as 2.45 & 2.83 respectively. The test procedures as mentioned in IS 383: (1970) were followed to determine the properties of fine aggregate. Crushed stone aggregate of 10 mm and 20 mm was used as coarse aggregate which was locally available and mainly quartzite in mineralogical composition. The fineness modulus and specific gravity of 10 mm and 20 mm aggregate as determined as per IS code is given in table – 2. The water used for mixing and curing of concrete was free from deleterious materials as per the recommendations of IS: 456 (2000). Potable water was used in all operations to take care of water quality. Steel wires as available in the market were used as fibers and cut in the length of 2.8 cm (0.28 mm dia, aspect ratio = 100) and mix in the concrete in the proportion of 0%, 0.5%, 0.75% and 1.0% by volume.

**Mix Design Procedure:** The normal strength concrete mixes of M20, M25 and M30 were designed as per the guidelines of IS-10262: (1982). Plain steel fibers were added at the rate of 0%, 0.5%, 0.75% and 1.0% by volume to the normal strength mixes to obtain normal strength fiber reinforced concrete.

**Mixing, Casting and Curing:** The constituents of concrete were tested in the laboratory to confirm the suitability of ingredients and when the design mixes were found satisfactory, the casting the cubes and cylinders was taken up. Equipment's as available in the laboratory were used in the completing of the experimental program.

**Table 1. Material Properties**

| S. No. | Experimental parameters | Results | Recommended Values |
|---|---|---|---|
| 1 | Normal Consistency | 29.5% | 30% |
| 2 | Setting Time | | |
| | Initial setting time Initial setting time | 34 Minutes | 30 Minutes |
| | | < 600 Minutes | 600 Minutes |
| 3 | Specific gravity | 3.15 | 3.15 |
| 4 | Soundness ( by Le-Chatelier's Test ) | 2 mm | 10 mm (max) |
| 5 | Compressive strength At 7 days | | |
| | At 28 days | 21 MPa | 33MPa |
| | | 40 MPa | 43 MPa |

**Table 2. Properties of Stone Aggregate**

| S.No. | Size of stone aggregate | Results | |
|---|---|---|---|
| | | Fineness modulus | Specific gravity |
| 1 | 10 mm | 2.92 | 2.98 |
| 2 | 20 mm | 2.60 | 2.64 |

**Fig. 1 Details of dial gauge positions and test setup**

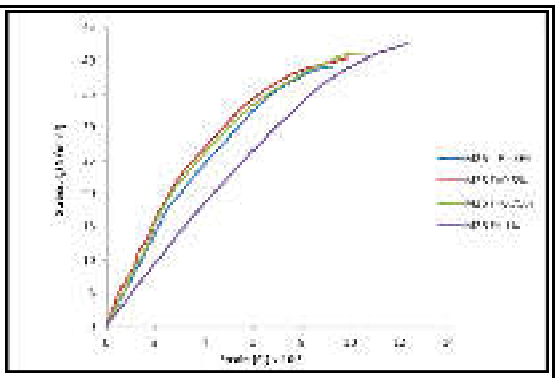

**Fig. 2. Combined stress strain curve for M25 cubes with different fiber content**

**Fig. 3 Details of dial gauge positions test setup**

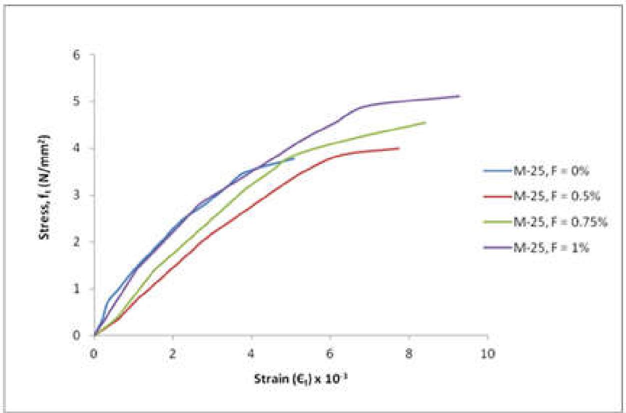


**Fig. 4. Combined Stress strain curve for M25 cylinders with and different fiber content**

The mixing of the concrete was carried over as per IS-10262: (1982). After casting, the specimens were taken out from molds after 24 hours and then the marking on the specimen was done. Now the specimens were put under water in curing tank for a period of 28 days. The concrete specimens were taken out from curing after 28 days and dried sufficiently and were tested at room temperatures. The cubes and cylinders were then tested and the load and deflection readings were noted.

**Testing of Specimens:** The experiment involves the assessment of the ultimate compressive load and splitting tensile load as well as deflection. For this, arrangements are made to read the deflection during loading on cubes and cylinders as shown in fig. 1.

**Measurement of Compressive Strength of SFRC cubes:** When curing was done for 28 days curing, the cubes were taken out from curing tanks and dried sufficiently to be tested under uni-axial compression for the measurement of compressive strength at room temperature. Also, the longitudinal deformations were measured using two dial gauges placed on the opposite faces on the cubes. The strains were evaluated using these dial gauge readings. Graphs were plotted between the mean strain and mean stress to bring out the stress strain relationship in varying concrete mixes with different percentages of fibers as shown in Fig. 2.

**Measurement of Splitting Tensile Strength of SFRC Cylinders:** The fiber reinforced concrete cylinders were tested to assess their splitting tensile strength. In the process, the cylinders were placed on the compression testing machine in a lying down position with the longitudinal axis of the cylinders perpendicular to the longitudinal axis of the loading arrangement. The position is displayed in the Fig.3. The deflections were measured at two diametrically opposite points using dial gauges having a least count of 0.01 mm and mean deformation was evaluated. Graphs were plotted between the mean strain and mean stress to bring out the stress strain relationship in varying concrete mixes with different percentages of fibers as shown in Fig. 4.

## RESULTS AND DISCUSSION

An experimental program has been conducted extensively to determine the compressive strength and splitting tensile strength of cubes and cylinders having different percentages of fibers (0%, 0.5%, 0.75% and 1.0%) by volume as well as different composition in terms of mix proportions (M20, M25 and M30). Three cubes have been tested for a particular fiber content for each mix. The compressive and splitting tensile strength were determined after testing the specimens in the compression testing machine. All the specimens were tested by applying load gradually either up to failure or when extensive cracking is visible and the corresponding deflections were observed by using dial gauges placed along opposite faces in the case of cubes but in case of cylinders the dial gauges were placed diametrically opposite to each other. The data was recorded in the form of load & deflection for each specimen and then the stress – strain data has been calculated. The mean strains for each mix for a particular percentage of fibers have been evaluated. Using these stress strain values, graphs have been plotted for uni-axial compression as well as splitting tensile strength.

### Conclusion

On the basis of limited experimental investigation undertaken, following conclusions are drawn:

- With the increase in the percentage of fibers from 0% to 1%, the ultimate compressive strength increases with the improvement in mixes from M20 to M30. The increase is in the range as 8.4%, 8.8% and 12.5% for M20, M25 and M30 concrete mixes respectively as the fiber content increases from 0.0% to 1.0 %.
- The ultimate compressive strain increases in the range of 25.5%, 33.3% and 31.3% with the increase in the percentage of fibers content from 0.0% to 1%, for M20, M25 and M30 concrete mixes respectively.
- With the increase in the percentage of fibers content from 0% to 1%, the ultimate splitting tensile strength also increases from 33.3%, 35.1%, and 37.7% for M20, M25 and M30 grade of concrete mixes respectively.
- Similarly the ultimate splitting tensile strain also increases from 160.6%, 82.8% and 55.1% with the increase in percentage of fibers content from 0% to 1%, for M20, M25 and M30 grade of concrete mixes respectively.
- Split tensile strength, compressive strength and ductility of the concrete increases when the fibers are added in the concrete as well as when grade of concrete is improved from M20 to M30.

- When the fibers are added in the concrete as well as when grade of concrete is improved from M20 to M30, the ultimate compressive strain and ultimate splitting tensile strain increases.

## REFERENCES

Faisal Wafa & Samir et al. 1992. "Mechanical properties of high strength fiber reinforced concrete", *ACI Materials Journal*, September – October, pp. 449-454.

IS 456-2000 "Indian code of practice for plain and reinforced concrete (Fourth Revision)".

IS: 10262-2009 "Indian code for recommended guidelines for concrete Mix design".

*Journal of the Institution of Engineers (India),* Vol 79, December 1998, pp. 136-139.

Singh A.P. & Singhal D., "Effect of fibre shapes on compressive and bond strength of steel reinforced concrete",

Yaghoub Mohammadi, S.P. Singh & Kaushik S.K., "Properties of steel fibrous concrete containing mixed fibres in fresh and hardened state", *Journal of Construction and Building Material,* Vol. 22, No.5, May 2008, PP-956- 965.

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