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# BEHAVIOUR OF FIBRE REINFORCED CONCRETE UNDER IMPACT AND FLEXURE LOADING

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## ABSTRACT

**The present study examines the behavior of fiber reinforced concrete when exposed to flexural loading by varying the type and percentage of fiber in the designated M-25 concrete mix design. The designated M-25 concrete mix was designed using the IS 10262 (2009) and types of fiber used were 6mm chopped polyester and glass fiber. After conducting several lab tests it was found that the flexural strength of concrete was increased by marginal 10 % by using the fibers mentioned. This type of concrete can be used not only to withstand compressive load but it can take nominal amount of tensile load also. In conventional concrete, micro-cracks develop before structure is loaded because of drying shrinkage and other causes of volume change. When the structure is loaded, the micro cracks open up and propagate because of development of such micro-cracks, results in inelastic deformation in concrete. Fibre reinforced concrete (FRC) is cementing concrete reinforced mixture with more or less randomly distributed small fibres. In the FRC, a numbers of small fibres are dispersed and distributed randomly in the concrete at the time of mixing, and thus improve concrete properties in all directions. The fibers help to transfer load to the internal micro cracks. FRC is cement based composite material that has been developed in recent years.**

**KEYWORDS:** Fibre Reinforced Concrete.

Fibres have been used to reinforce materials that are weaker in tension than in compression since ancient times. Straw reinforced mud bricks were used in the Middle East as long as 10,000 years ago, and sun-dried adobe bricks (a mixture of sand, clay and straw) were long used in the Americas by the indigenous inhabitants, particularly in the American Southwest and inparts of South America. The first modern FRC was asbestos cement, which was introduced in about 1900 with the development of the Hatschek process. However, serious theoretical studies of FRC began only in the early 1960‟s, with the work of Romualdi and his colleagues [e.g.Romualdi& Batson 1963; Romualdi& Mandel 1964].

Today, FRC is very widely used, with annual production now approaching about 100 $m^3$. The principal applications are slabs on grade, shotcrete, and precast members, as well as a number of specialty applications. Until now, most of the production of FRC has been for "non-structural" applications, with the fibres added primarily for control of cracking due to plastic or drying shrinkage.

There is an innovative change in the Concrete technology in the recent past with the accessibility of various grades of cements and mineral admixtures. However there is a remarkable development, some complications quiet remained. These problems can be considered as drawbacks for this cementatious material, when it is compared to materials like steel. Concrete, which is a „quasi-fragile material‟, having negligible tensile strength.

Several studies have shown that fiber reinforced composites are more efficient than other types of composites. The main purpose of the fiber is to control cracking and to increase the fracture toughness of the brittle matrix through bridging action during both micro and macro cracking of the matrix.. In the beginning of macro cracking, bridging action of fibers prevents and controls the opening and growth of cracks. This mechanism increases the demand of energy for the crack to propagate. The linear elastic behavior of the matrix is not affected significantly for low volumetric fiber fractions.

At initial stage and the hardened state, Inclusion of fibers improves the properties of this special concrete. Considering it, researchers have focused on studied the strength and durability aspects of fiber reinforced SCC which are:

1. Glass fibre
2. Steel fibre
3. Polyester fibre etc.

## MECHANISM

The composite will carry increasing loads after the first cracking of the matrix if the pull-out resistance of the fibers at the first crack is greater than the load at first cracking. At the cracked section, the matrix does not resist any tension and the fibers carry the entire load taken

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by the composite. With an increasing load on the composite, the fibers will tend to transfer the additional stress to the matrix through bond stresses. This process of multiple cracking will continue until either fibers fail or the accumulated local debonding will lead to fiber pull-out.

The randomly-oriented fibers assist in controlling the propagation of micro-cracks present in the matrix, first by improving the overall cracking resistance of matrix itself, and later by bridging across even smaller cracks formed after the application of load on the member, thereby preventing their widening into major cracks (Fig. 1).

## CHARACTERSTICS OF FIBRES

1. The fibers are generally distributed throughout a cross-section, whereas steel bars are only placed where needed.
2. The fibers are relatively short and closely spaced, whereas the steel bars are continuous and not as closely placed.
3. It is generally not possible to achieve the same area of reinforcement with fibers as with steel bars.
4. It is much tougher and more resistant to impact than plain concrete.

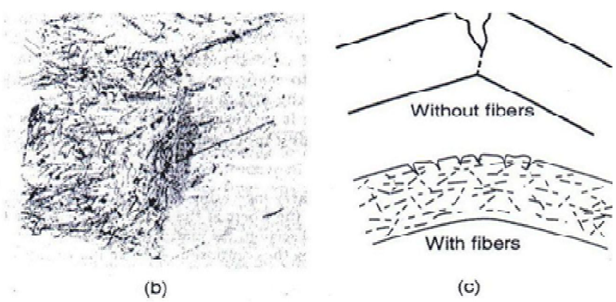



**Figure 1: Failure mechanism and the effect of fibers**

## EXPERIMENTAL PROGRAM

### Materials and Properties

The materials selected for this experimental study includes normal natural coarse aggregate, manufactured sand as fine aggregate, cement, superplasticizer, polyester, glass and steel fiber and portable drinking water. The physical and chemical properties of each ingredient has considerable role in the desirable properties of concrete like strength and workability.

Cement: The cement used for this project work is Portland slag cement. It gives low heat of hydration (table 1).

**Table 1: Physical Properties of Cement**

| | |
|---|---|
| Brand of cement | ULTRATECH |
| Standard consistency | 34% |
| Initial setting time (in mins) | 147 |
| Final setting time (in mins) | 325 |
| Specific gravity | 2.91 |

Fine aggregates**:** It should be passed through IS Sieve 4.75 mm. It should have finess modulus 2.50-3.50 and silt contents should not be more than 4%. Manufacturer's sand has been used for the present investigation; it is also called M sand. Manufactured sand has been regularly used to make quality concrete for decades in India and abroad. M-sand is crushed aggregates produced from hard granite stone which is cubically shaped with grounded edges, washed and graded with consistency to be used as a substitute of river sand. . It confirms to IS 383-1970 which comes under Zone II (table 2).

**Table 2: Physical Properties of fine aggregates**

| | |
|---|---|
| Specific Gravity | 2.54 |
| Water absorption | 11% |

Coarse aggregates: It should be hard, strong, dense, durable and clean. It must be free from vein, adherent coatings and injurious amount of disintegrated pieces, alkalis, vegetable matters and other deleterious substances. It should be roughly cubical in shape. Flaky pieces should be avoided. It should confirm to IS 2838(I). Coarse Aggregate used are of two sizes 20 mm maximum size and 12.5 mm maximum size (table 3).

**Table 3: Physical Properties of coarse aggregates**

| | |
|---|---|
| Specific Gravity | 2.778 |
| Water absorption | 0.25% |

Water: Water should be free from acids, oils, alkalies, vegetables or other organic impurities. Soft waters also produce weaker concrete. Water has two functions in a concrete mx. Firstly, it reacts chemically with the cement to form the cement paste in which the inert aggregates are held in suspension until the cement paste has hardened. Secondly, it serves as a lubricant in the mixture of fine aggregates and cement.

Fiber: Percentage volume fraction of fibres was varied from 0.1% to 0.6Chopped fibers of 0.75mm diameter with 6mm length is used. All the fibres have been made from different manufacturer's where the polyester fibre has been made by Reliance Group while the other two have been made by some local manufacturer.

### Experimental Work

The mix design is carried out as per IS 10262:2009.The proportioning is carried out to achieve strength at specified age, workability of fresh concrete and durability requirements. Relationship between strength and free water cement ratio should be preferably being established for the materials actually to be used. Mix designing is carried out to arrive at the quantities required for 1 $m^3$ of concrete as shown below table 4.

**Table 4: Quantities required for 1 $m^3$ of concrete**

| W/C | Fiber kg/$m^3$ | Water (kg) | Cement (kg) | $F_A$ (kg) | $C_A$ (kg) |
|---|---|---|---|---|---|
| 0.45 | 0 | 191.5 | 452.7 | 536.4 | 1263.5 |
| | 10 | | | | |
| | 30 | | | | |
| | 60 | | | | |

To study the effect of fiber, cubes of size 150mm x150mmx150mm, cylinders of diameter 150mm and height 300mm, beam of sizes 500x100x100mm were tested. Casting of the concrete specimens were done according to IS 516-1959 .

## RESULTS

In the present investigation an attempt has been made to determine the effect of fiber by examining the slump, compressive strength and flexural strength of the sample. For that cubes, and beams were casted using fibers. The mixing was done in a traymixer. The compression test was conducted by the compression testing machine which has a capacity up to 200 Tones.

### EFFECT ON WORKABILITY

**Table 5: Details of Mixes Corresponding To Slump**

| Mix | Water/cement | Superplasticizer | Slump (mm) |
|---|---|---|---|
| designation | ratio | (% of cement) | |
| PC | 0.45 | 1 | 123 |
| CP1 | 0.45 | 1 | 117 |
| CP2 | 0.45 | 1 | 108 |
| CP3 | 0.45 | 1 | 98 |

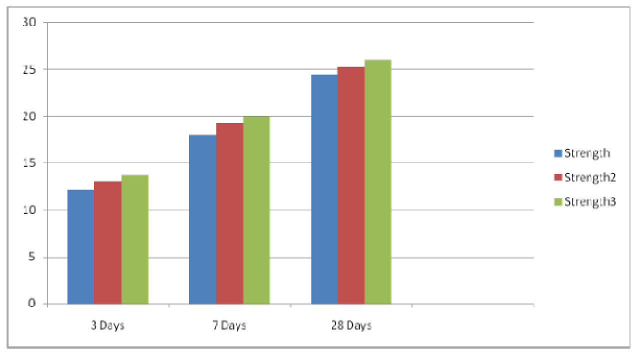
Here we can see that as fiber content increases slump decreases, which means workability decreases.

## COMPRESSIVE STRENGTH

To study the 3, 7 and 28 days compressive strength of concrete mixes, three concrete cubes for each day were casted and tested in a set itself. The cube specimens were of size 150 mm x 150 mm x 150 mm and were prepared and tested according to IS: 516-1959. The cube compressive strength obtained after testing is as given in table 6:

**Table 6: Compressive ST of FRC**

| Designation | Fibre Type | No of Days | Compressive ST (N/MM^2) |
|---|---|---|---|
| CP1 | Polyester | 3,7,28 | 12.2,18,24.5 |
| CP2 | Polyester | 3,7,28 | 13,19.3,25.2 |
| CP3 | Polyester | 3,7,28 | 13.7,19.9,26 |




## REFERENCES

Gustavo J. Parra-Montesinos, "Shear Strength of Beams with Deformed Steel Fibers", Concrete international / November 2006

Shah Surendra and Rangan(1994),"Effect of Fiber addition on concrete strength", Indian Concrete Journal

Yoon-KeunKwak et al.," Shear strength of steel fiber-reinforced concrete beams without stirrups", ACI structural journal, 2002

Mukesh Shukla, **"**Behavior of Reinforced Concrete Beams with Steel Fibres under Flexural Loading", International Journal of Earth Sciences and Engineering, **4**(6):843-846.

Dr. N. Ganesan & Dr. P.V.Indira, Behaviour of steel fibre reinforced high performance concrete members under flexure,Behaviour of steel fibre reinforced high performance concrete members under flexure May 2007, **88**:20-23.

Nataraja M.C., Dhang N. and Gupta A.P, (1998), "Steel fiber reinforced concrete under compression", The Indian Concrete Journal, **26**(3):353-356.