"IMPROVING STRUCTURE INTEGRITY WITH FIBRE REINFORCED CONCRETE"

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Abstract – In conventional concrete, micro-cracks develop before the structure is loaded because of drying shrinkage and other causes of volume change. When the structure is loaded, the microcracks open up and propagate because of the development of such microcracks, results in inelastic deformation in concrete. Fiber reinforced concrete (FRC) is cementing concrete reinforced mixture with more or less randomly distributed small fibers. In the FRC, several small fibers are dispersed and distributed randomly in the concrete at the time of mixing and thus improve concrete properties in all directions. The fiber shell transfer load to the internal microcracks. FRC is a cement based composite material that has been developed in decent years. It has been successfully used in construction with its excellent flexural-tensile strength, resistance to spitting, impact resistance and excellent permeability and frost resistance. It is an effective way to increase toughness, shock resistance and resistance to plastic shrinkage cracking of the mortar. These fibers have many benefits. Steel fibers can improve the structural strength to reduce the heavy steel reinforcement requirement. Freeze the resistance of the concrete is improved. The durability of the concrete is improved to reduce in the crack widths. Polypropylene and Nylon fibers are used to improve the impact resistance. Many developments have been made in the fiber reinforced concert.

1. Introduction

Fibre-reinforced concrete (FRC) is concrete which contains fibrous material and increases its structural integrity. It has short discrete fibre which is uniformly distributed and randomly oriented. Fibres include steel fibres, glass fibres, synthetic fibres and natural fibres – each of them has different properties to the concrete. Also, the character of fibre-reinforced concrete changes with varying concretes, fibre materials, geometries, distribution, orientation, and densities.

1.1 What is Fibre-Reinforced concrete?

Concrete containing a hydraulic cement, water, fine or fine and coarse aggregate and discontinuous discrete fibres is called fibre-reinforced concrete (FRC). It may also contain pozzolans and other admixtures commonly used in conventional concrete. Fibres of various shapes and sizes produced from steel, plastic, glass, and natural materials are being used; however, for most structural and non-structural purposes, steel fibre is the most commonly used of all the fibres. Fibre reinforced concrete (FRC) is a new structural material which is gaining importance. With the Addition of fibres in a discrete form improves many Structural properties of concrete.

1.2 Problem Specification.

The fibres are generally used in concrete to make concrete stronger and to control cracking due to plastic shrinkage and to drying shrinkage. Thus, which helps in reducing the bleeding of water? There are many types of fibres which possess many qualities such as abrasion and shatter resistance in concrete. But Fibres are not responsible for increasing flexural strength of the concrete; thus, we cannot use them as a replacement of steel reinforcement. Some fibres decrease the strength of concrete. The amount of fibres added to a concrete mix is decided as per the percentage of the total volume of the composite (concrete and fibres), termed "volume fraction" typically ranges from 0.1 to 3%. Typical load-deflection curves for plain concrete and fibre-reinforced concrete are shown below concrete fails suddenly once the deflection corresponding to the ultimate flexural strength is exceeded; on the other hand, fibre-reinforced concrete continues to sustain considerable loads even at deflections considerably over the fracture deflection of the plain concrete. The most important contribution of fibre reinforcement in concrete is not to strength but the flexural toughness of the material. When flexural strength is the main consideration, fibre reinforcement of concrete is not a substitute for conventional Fibre-reinforced concrete is generally made with a high cement content and low water/cement ratio. When well compacted and cured, concretes containing steel fibres seem to possess excellent du-rabidity as long, affixers remain protected by cement paste Ordinary glass fibre cannot be used in Portland cement mortars and concretes because of a chemical attack by the alkaline cement paste.

2. Aim and objective of Fiber-Reinforced Concrete.

- Their main purpose is to increase the energy absorption capacity and toughness of the material, but also increase the tensile and flexural strength of concrete.
- For many applications, it is becoming increasingly popular to reinforce the concrete with small, randomly distributed fibres.
- It has been preferred by many engineers due to its accountability on increased static and dynamic tensile strength and increased fatigue strength
- It has been practically used on overlays of the airfield, Road Pavements, Industrial footing, bridge decks, canal lining, Explosive resistant structures, Refractory Linings. Etc.

2.1 Fibre reinforced concrete is used for.

- Industrial flooring
- Sprayed concrete
- Slender structures (usually in precast plants)
  Fire resistant structures
- mortar applications (rehabilitation)

2.2 Types of Fibre-Reinforced Concrete.

- Steel Fibre-Reinforced concrete.
- Glass Fibre-Reinforced concrete.
- Synthetic Fibre-Reinforced concrete.
- Natural Fibre-Reinforced concrete.

(we are work on steel Fibre-Reinforced concrete)

(2.2.1) Steel Fibre-Reinforced Concrete.

Steel fibre-reinforced concrete is normally cheaper and easier than any other fibres to use a form of standard reinforced concrete. Commonly used reinforced concrete utilises steel bars that are placed in the liquid cement, which requires a great potential of preparation work but results in making much durable concrete. Steel fibre-reinforced concrete uses fibres which are thin and similarly uses wires made up of steel to mixed in with the cement. This force the concrete with much greater structural strength reduces cracking, other failures and helps protect against extreme cold.

3. DESIGN METHODOLOGY.

Materials re-required and properties of materials

Materials Used:

- Ordinary Portland Cement
- Ordinary sand
- Fibres
- Coarse Aggregates
- Water

3.1 Ordinary Portland Cement.

A hydraulic cement made by finely pulverising the clinker produced by calcining to incipient fusion a mixture of clay and limestone or similar materials.

3.2 Steel Fibres

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3.3 Ordinary sand

Aggregate contains almost 75-80% of the concrete volume. While in SCGC for self- com action the fine aggregate content should be 40% of the mortar volume. Ordinary sand which passes through 4.75mm IS sieve and having no more than 5% coarser material are included in fine aggregate. River sand is obtained by river mining which is a non-renewable source. Fine aggregate fills the voids and increases the workability of concrete.

3.4 Coarse Aggregates

The aggregate having size more than 4.75mm is termed as coarse aggregate. For FRC Aggregates content needs to be increased to carry the burden of fibres present in it. Aggregate sizes from 10-12 mm are generally used.

3.5 Water

Tapped water from a college campus is used.

4. Strength of Fibre Reinforced concrete

Compressive Strength: Fibres are capable of enhancing their static compressive strength of concrete, with the increment in strength from 0 to 25% is quite appreciable. Even members which contain standard reinforcement on the addition of steel fibres, the fibres leave a little but quite impact able effect on its compressive strength. However, the fibres have shown substantially increment in the energy absorption or post-cracking ductility of the material.

Tensile Strength: Fibres, when aligned together in the direction of the tensile stress, are capable of bringing greater increment indirect tensile strength, unto 133% for 5% of straight and smooth steel fibres. However, randomly distributed fibres show greater increment in strength is much smaller sizes which range from as small as very less amount of increment is seen some instances to a curtained extend say 60%, with various investigations conducted it was concluded that I intermediate values. Splitting-tension test of SFRC show results which are quite similar. Thus, the main purpose of the addition of fibres is mainly to increase the direct tensile strength i. However, as in compression, steel fibres do not intend to lead to a major increment in the behaviour which causes through post cracking or toughness of the composites

Flexural Strength: Steel fibres which are most significantly common to be found and which also possess good flexural strength are likely to get effected by the aggregates of SFRC than on either the compressive or tensile strength, with the increment of more than 100% have already been reported. It becomes sensitive due to increment in flexural strength, but it does not merely applicable to the fibre volume, but also the fibre's aspect ratio, its strength increases due to higher aspect ratio.

Toughness: As we all know that, fibres which are added on the basis that concrete does not possess improvement in strength, but is capable of improving the energy absorption capacity, or toughness. However, the flexural toughness is elaborated based on the area under the complete load-deflection curve in flexure; this is sometimes referred to as the total energy to fracture. Alternatively, the toughness may be defined as the area under the load-deflection curve out to some particular deflection, or out to the point at which the load has fallen back to some fixed percentage of the peak load.

(4.1) Calculation tables

Compressive Strength Table:

Different ratio of fibres	For 1% Steel Fibre-Reinforced Concrete		For 5% Steel Fibre-Reinforced Concrete		For 10% Steel Fibre-Reinforced Concrete	
		AVG		AVG		AVG
50	52.00 51.56 52.44	52.0	53.33 54.67 52.00	53.3	55.56 56.44 56.89	56.3
60	53.33 49.89 48.44	50.3	53.33 52.89 51.56	52.6	53.33 53.57 55.12	54.8
70	50.70 51.60 48.45	50.2	53.34 51.57 50.00	51.42	51.57 53.44 56.11	54.0

Flexural Strength Table:

Different ratio of fibres	For 1% Steel Fibre-Reinforced Concrete		For 5% Steel Fibre-Reinforced Concrete		For 10% Steel Fibre-Reinforced Concrete	
		AVG		AVG		AVG
50	3.11 3.54 3.26	3.40	4.82 3.82 4.15	4.92	5.39 5.25 5.39	5.34
60	2.97 3.40 2.26	3.22	4.96 4.54 4.54	4.68	5.25 5.10 5.39	5.25
70	2.83 2.26 3.40	3.15	4.54 4.96 4.40	4.63	5.82 4.82 5.53	5.20

Tensile Strength Table:

Different ratio of fibres	For 1% Steel Fibre-Reinforced Concrete		For 5% Steel Fibre-Reinforced Concrete		For 10% Steel Fibre-Reinforced Concrete	
		AVG		AVG		AVG
50	9.9 10.2 9.4	9.8	9.8 10.6 11	10.5	11.4 12 11.8	11.5
60	9.4 9.8 9	9.40	9.8 10.2 10.6	10.2	10.6 11 11.4	11
70	9 9 9.8	9.8	9 10 11	10	9.8 11.4 11	10.7

5. Use of Steel Fibre Reinforced Concrete Structurally

When we intend to use in structural applications, steel fibre reinforced concrete which is only intended to be used in a supplementary role to restrain cracking, which helps in improving its resistance to impact or dynamic loading, and to help in resisting material disintegration. Structural members where flexural or tensile loads are most likely to occur the reinforcing steel must be capable of supporting the total tensile load'. Thus, while there are several techniques for predicting the strength of beams reinforced only with steel fibres, there are no predictive equations for large SFRC beams, since these would be expected to contain conventional reinforcing bars as well. An extensive guide to design considerations for SFRC has recently been published by the American Concrete Institute. In this section, the use of SFRC will be discussed primarily in structural members who also contain conventional reinforcement.

For beams which are capable of containing both fibres and continuous reinforcing bars, the situation is quite complex, since the fibres act in two ways:

They gave access to the tensile strength of the SFRC and had the quality to get used in the design, because of the matrix which will no longer have access to its load-carrying capacity at first crack; and

They show great increment in improving the bond between the matrix and the reinforcing bars by inhibiting the growth of cracks emanating from the deformations (lugs) on the bars

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