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Research Paper Review: An Experimental Study on Fiber Reinforced Concrete

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ABSTRACT- The helfulness of fiber reinforced concrete (FRC) in various civil engineering applications is indisputable. Fiber Reinforced Concrete (FRC) is gaining consideration as an effective way to improve the performance of concrete. Fibers are currently being specified in tunneling, bridge decks, pavements, docks, thin unbounded overlays, concrete pads, and concretes slabs. These applications of fiber reinforced concrete are becoming increasingly popular and are exhibiting excellent performance. Fiber-reinforced concrete (FRC) is concrete containing fibrous material which growths its structural integrity. It contains short discrete fibers that are evenly distributed and randomly oriented. Fibers contain steel fibers, glass fibers, synthetic fibers and natural fibers. This study presents thoughtful strength of fiber reinforced concrete. Mechanical properties and durability of fiber reinforced concrete.

Keywords- Steel fiber Reinforced Concrete, tensile strength, compressive strength

1. INTRODUCTION

Fiber-reinforced concrete (FRC) is concrete containing fibrous material which increases its structural integrity. It contains short discrete fibers that are uniformly distributed and randomly oriented.

Fibers include steel fibers, glass fibers, synthetic fibers and natural fibers – each of which lend varying properties to the concrete. In addition, the character of fiber-reinforced concrete changes with varying concretes, fiber materials, geometries, distribution, orientation, and densities.

The concept of using fibers as reinforcement is not new. Fibers have been used as reinforcement since ancient times. Historically, horsehair was used in mortar and straw in mud bricks. In the 1900s, asbestos fibers were used in concrete.

In the 1950s, the concept of composite materials came into being and fiber-reinforced concrete was one of the topics of interest. Once the health risks associated with asbestos were discovered, there was a need to find a replacement for the substance in concrete and other building materials. By the 1960s, steel, glass (GFRC), and synthetic (such as polypropylene) fibers were used in concrete. Research into new fiber-reinforced concretes continues today.

2. Literature Review

- Kishore Kumar et al studied the effects of glass fiber on strength and durability properties of Geopolymer concrete. Sodium silicate and sodium hydroxide were used as alkali activators and its ratio is kept as 2.7. Alkali solution to fly ash ratio as 0.35 and glass fibers was added with the variation of 0.005% to 0.035% by volume of concrete. A 12M molarity of sodium silicate and sodium hydroxide was used as alkali activator.
- G. Ramkumar et al studied the load carrying capacity and deflections at peak load and service loads in Steel Fiber Reinforced Geopolymer Concrete. Three GPC mixes of fly ash (50%) and GGBS (50%) in the binder

stage were considered. 0.75% Stainless steel fiber and 0.75% mild steel fibers were added in the concrete. Ratio between Na2SiO3/NaOH used in the production of alkaline activator was 2.2.

- Tadepalli Naga Srinu et al studied the Mechanical Properties of Steel Fiber Reinforced Geopolymer Concrete incorporated with Fly-Ash & GGBS. Steel fibers are added maximum up to 2% taken by weight of binder of diameter 0.5mm.
- Meor Ahmad Faris et al studied the Performance of steel wool fiber reinforced geopolymer concrete and were tested in terms of density, workability, and compression. Steel wool fiber of high quality, low carbon steel were added into the geopolymer concrete as reinforcement with different weight percentage vary from 0 % – 5 %. Ratio between Na2SiO3/NaOH used in the production of alkaline activator was 2.5. The ratio of fly ash to alkaline activator that has been used in this research was 2.0. The molarity of the solution used in this research is 12M.

2.1 What is fiber reinforced concrete?

Fiber reinforced concrete (FRC) is a new structural material which is gaining increasing importance. Addition of fiber reinforcement in discrete form improves many engineering properties of concrete.

It increases the tensile strength of the concrete. It reduce the air voids and water voids the inherent porosity of gel. It increases the durability of the concrete. Fibres such as graphite and glass have excellent resistance to creep, while the same is not true for most resins.

Fiber-reinforced concrete is concrete mixed with suitable fiber which increases its toughness. Fiber acts as micro reinforcement which increases the structural reliability of concrete. Concrete is weak in tension. The tensile strength of concrete is only one-tenth of the compressive strength of concrete.

2.2 History of Reinforced Concrete :

- Fibers have been used for concrete reinforcement since prehistoric times though technology has improved significantly, as is applicable for other fields. In the early age, straw and mortar were used for producing mud bricks, and horsehair was for their reinforcement. As the fiber technology developed, cement was reinforced by asbestos fibers in the early twentieth century.
- During the middle of the twentieth century, extensive research was in progress for the use of composite materials for concrete reinforcement. Later, the use of asbestos for concrete reinforcement was discouraged due to the detection of health risks.
- New materials like steel, glass, and synthetic fibers replaced asbestos for reinforcement. Active research is still in progress on this important technology. Fiber Reinforced
- Concrete is considered to be one of the greatest advancements in the construction engineering during the twentieth century.
- The amount of fibers added to a concrete mix is expressed as a percentage of the total volume of the composite (concrete and fibers), termed "volume fraction" (Vf). Vf typically ranges from 0.1 to 3%. The aspect ratio (l/d) is calculated by dividing fiber length (l) by its diameter (d).
- Fibers with a non-circular cross section use an equivalent diameter for the calculation of aspect ratio. If the fiber's modulus of elasticity is higher than the matrix (concrete or mortar binder), they help to carry the load by increasing the tensile strength of the material.
- Increasing the aspect ratio of the fiber usually segments the flexural strength and toughness of the matrix. Longer length results in better matrix inside the concrete and finer diameter increases the count of fibers.
- To ensure that each fiber strand is effective, it is recommended to use fibers longer than maximum size of aggregate. Normal concrete contains 19 mm equivalent diameter aggregate which is 35-45% of concrete, fibers longer than 20mm are more effective. However, fibers that are too long and not properly treated at time of processing tend to "ball" in the mix and create work-ability problems.

2.3 APPICATION OF FRC :

1. It is used on account of the advantages of increased static and dynamic tensile strength and better fatigue strength.
2. It has been tried on overlays of air-field, road pavements, industrial footings, bridge decks, canal lining, explosive resistant structures, refractory linings,etc.
3. Used for the fabrication of precast products like pipes, boats, beams, stair case steps, wall panels, roof panels, manhole covers etc.
4. It is also being tried for the manufacture of prefabricated formwork moulds of "U" shape for casting lintels and small beams.

2.4 Fiber reinforced concrete is used for :

i. Industrial flooring
ii. Sprayed concrete
iii. Slender structures (usually in precast plants)
iv. Fire resistant structures
v. mortar applications (rehabilitation)

3. . EXPERIMENTAL STUDY

3.1 Types of Fiber Reinforced Concrete :

i. Steel Fiber-Reinforced Concrete :

- Steel fiber-reinforced concrete is basically a cheaper and easier to use form of rebar reinforced concrete. Rebar reinforced concrete uses steel bars that are laid within the liquid cement, which requires a great deal of prep work but make for a much stronger concrete.
- Steel fiber-reinforced concrete uses thin steel wires mixed in with the cement.
- This imparts the concrete with greater structural strength, reduces cracking and helps protect against extreme cold. Steel fiber is often used in conjunction with rebar or one of the other fiber types.
- Tensile strength: 560 to 980 N/mm^2
- High flexural strength than Portland cement paste
- For unimportant Fiber concrete organic Fiber like coir, jute, cane splits, are used.

Fig.no.1

ii. Glass Fiber Reinforced Concrete

- Glass fiber-reinforced concrete uses fiberglass, much like you would find in Fiber glass insulation, to reinforce the concrete. The glass fiber helps insulate the concrete in addition to making it stronger.
- Glass fiber also helps prevent the concrete from cracking over time due to mechanical or thermal stress.
- In addition, the glass fiber does not interfere with radio signals like the steel fiber reinforcement does.
- Because we are mixing aggregate and cement and glass fiber, it gets damaged due to the up reason and impact forces of the aggregate. Therefore, we have to add it in a much more controlled condition.

Fig.no.2

iii. Synthetic Fibers

- Synthetic fiber-reinforced concrete uses plastic and nylon fibers to improve the concrete's strength. In addition, the synthetic fibers have a number of benefits over the other fibers.
- While they are not as strong as steel, they do help improve the cement pumpability by keeping it from sticking in the pipes.
- The synthetic fibers do not expand in heat or contract in the cold which helps prevent cracking.
- Finally synthetic fibers help keep the concrete from spalling during impacts or
- fires.

Fig.no.3

iv. Natural Fiber Reinforced Concrete

Historically, fiber-reinforced concrete have used natural fibers, such as hay or hair.While these fibers help the concrete's strength they can also make it weaker if too much is used. In addition if the natural fibers are rotting when they are mixed in then the rot can continue while in the concrete. This eventually leads to the concrete crumbling from the inside, which is why natural fibers are no longer used in construction.

Fig.no.4

v. Asbestos Fiber Reinforced Concrete

- Mineral fiber, most successful of all as it can be mixed with portland cement.
- Tensile strength of asbestos varies between 560 to 980 N/mm2.
- Asbestos cement paste has considerably higher flexural strength than portland cement paste.
- For unimportant concrete work, organic fibers like coir, jute and canesplits are also used.

Fig.no.5

vi. Carbon Fiber Reinforced Concrete

- Posses very high tensile strength 2110 to 2815 N/mm2 and Young's modulus.
- Cement composite consisting of carbon fibers show very high modulus of elasticity and flexural strength.
- Used for cladding, panels and shells.

Fig.no.6

3.2 Factors affecting properties of Fiber Reinforced Concrete

- Transfer of stress between matrix and fiber.
- Type of fiber.
- Fiber geometry.
- Fiber content.
- Orientation and distribution of fibers
- Mixing and compaction technique of concrete.
- Size and shape of aggregates.

I. Relative Fiber Matrix Stiffness

1. Modulus of elasticity of matrix must be much lower than that of fiber for efficient stress transfer.
2. Nylon and propylene fiber impart greater degree of toughness and resistance to impact.
3. Steel, glass and carbon impart strength and stiffness to the composite.
4. Interfacial bonds also determine the degree of stress transfer.
5. Bonds can be improved by larger area of contact, improving frictional properties and degree of gripping and by treating steel fibers with sodium hydroxide or acetone.

II. Volume Of Fiber

1. Strength largely depends upon the quantity of fibers used.
2. Tensile strength and toughness of the composite linearly increase with increase in volume of fibers.
3. Higher percentage of fibers is likely to cause segregation and harshness of concrete and mortar.

III. Aspect Ratio Of Fiber

1. One of the important factor affecting the properties and behavior of composite.
2. Increase in aspect ratio upto 75, increase the ultimate strength of concrete linearly.
3. Beyond 75 relative strength and toughness is reduced.

IV. Orientation Of FiberS

1. One of the major difference in conventional reinforcement and fiber reinforcement.
2. Specimens with 0.5% volume of fiber were tested and it showed that when fibers were aligned parallel to the load applied, more tensile strength toughness was seen as compared to randomly distributed and perpendicular fibers.

V. Workability and Compaction of Concrete

1. Use of steel fibers decrease the workability.
2. External vibration fails to compact the concrete.
3. Poor workability is also result of non uniform distribution of fibers.
4. Fiber volume at which this situation is reached depends on the length and diameter of fiber used.
5. Workability and compaction standard can be improved with help of water reducing admixture.

VI. Size Of Coarse Aggregates

1. Maximum size of aggregates should be restricted to 10 mm.
2. Fibers also act as aggregate.
3. The interparticle friction and between fibers and between fibers and aggregates controls the orientation and distribution of fibers which affect the properties of composite.
4. Friction reducing admixtures and admixtures improving the cohesiveness can significantly improve the mix.

VII. Mixing

1. Mixing is important to avoid balling of aggregates, segregation and to obtain uniform composite.
2. Increase in aspect ration, volume percentage, size and quantity of aggregates intensify the balling tendencies.

3. A steel fiber content in excess of 2% by volume and an aspect ratio of more than 100 are difficult to mix.
4. Addition of fibers before addition of water is important to get uniform dispersion of fibers in concrete mix.

3.3 Benefits

Polypropylene and Nylon fibers can:

- Improve mix cohesion, improving pumpability over long distances
- Improve freeze-thaw resistance
- Improve resistance to explosive spelling in case of a severe fire
- Improve impact resistance
- Increase resistance to plastic shrinkage during curing

Steel fibers can:

- Improve structural strength
- Reduce steel reinforcement requirements
- Improve ductility
- Reduce crack widths and control the crack widths tightly, thus improving durability
- Improve impact– and abrasion–resistance
- Improve freeze-thaw resistance

3.4 Effects of fiber reinforced concretes:

- Improved durability of the structure
- Increased tensile and flexural strengths
- Higher resistance to later cracking
- Improved crack distribution
- Reduced shrinkage of early age concrete
- Increased fire resistance of concrete
- Negative influence on workability
- Improved homogeneity of fresh concrete

3.5 Current development in FRC:-

- High fibre volume micro-fibre system.
- Slurry infiltrated fibre concrete(SIFCON).
- Compact reinforced composites.

CONCLUSION :

1. The efficient utilisation of fibrous concrete involves improved static and dynamic properties like tensile strength, energy absorbing characteristics, Impact strength and fatigue strength. Also provides a isotropic strength properties not common in the conventional concrete.

2. It will ,however be wrong to say that fibrous concrete will provide a universal solution to the problems associated with plain concrete. Hence it is not likely to replace the conventional structural concrete in total Superior crack resistance and greater ductility with distinct post cracking behavior are some of the important static properties of FRC.

3. The enormous increase in impact resistance and fatigue resistance allow the new material to be used in some specified applications where conventional concrete is at a disadvantage.
4. A new approach in design and in the utilization of this material, to account for both increase in performance and economics is therefore ,needed.

References ;

i. www.google.com
ii. www.wikipedia.com