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Utilization of Fiber Reinforced Concrete in Future: A Review

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***Abstract*—Fiber reinforced concrete (FRC) is concrete containing cement and some fibrous materials disturbed randomly. The fiber used are steel, nylon, polythene and also natural fibers such as flax, bamboo, sisal, jute and wood fibers are put to use. FRC is generally made with high cement content & low water cement ratio. Fiber reinforced concrete sustains considerable loads even at deflection as compared to plain cement concrete that fails once the ultimate flexural strength is exceeded. FRC has excellent properties like as ductility, flexural-tensile strength, resistance to spitting and crack, excellent permeability and frost resistance can be successfully used in the construction of slabs, architectural panels, precast products, offshore structures, crash barriers, footings, hydraulic structures, repairs of structures, structures in seismic regions and many other applications.**

***Index Terms*— Fiber reinforced concrete, Structural properties, strength, Glass**

I. Introduction

Concrete is most widely used as a construction material. Concrete has several desirable and reliable mechanical and durability properties under usual environmental factors. The plain concrete fails suddenly when the deflection corresponding to the ultimate flexural strength is increase, fiber-reinforced concrete continue to sustain considerable loads even at deflections considerably in excess of the fracture deflection of the plain concrete. This weakness in tension can be excluded by the provision of reinforcement along with the concrete, to some extent by the mixing of sufficient amount of certain fibers. Due to the property that toughness of concrete, FRC is widely used for structural purposes.

In India, domestic waste plastics are causing considerable damage to the environment effect and whether they can be successfully used in concrete to improve some of the mechanical properties as in the case of the steel fibers [1].

It has been reported that fibers are effective in many ways, such as:

- Fiber reinforcement has been shown to improve the ductility, toughness, flexural strength and shear strength of cementitious materials.
- Fibers transfer load and connects the cracks during load and also resist the growth of cracks and acts as energy absorber [3].
- The fibers reduce the shrinkage, cracking and permeability of concrete.
- The fibers enhance fatigue and impact resistance and hence ensure the transfer of the loads.
- The fibers take up internal stresses through their tension and exists between the fibers and the hardened cement matrix.

II. Types of FRC

They are classified as;

a) Steel fibre reinforced concrete
b) Glass fibre reinforced concrete
c) Polymer fiber reinforced concrete
d) Natural fibre reinforced concrete
e) Synthetic fibre reinforced concrete

A. Steel Fiber Reinforced Concrete

Steel fibers are those consisting of cement concrete mix and steel as fibers. This mix, have large number of volume fractions, geometries, orientations and material properties. Steel fibre increases properties like ductility, energy absorption, shear resistance and stiffness. The steel fibers can be straight, crimped, twisted, hooked, ringed and paddled end. Diameter can range from 0.25 to 0.76 mm [5].

Fig. 1. Steel fibers

B. Glass Fibre Reinforced Concrete

Glass fibre-reinforced concrete is (GFRC) concrete composition which is composed of material like cement, sand, water, and admixtures, in which short length discrete glass fibers are dispersed [2]. The flexure strength of glass fibre can be increase to 130% when compare with ordinary plan concrete [4].

Fig. 2. Glass fibers

C. Polymer Fiber Reinforced Concrete

The homogeneity of the concrete matrix is much improved by the uniformity distributed fibers throughout the concrete. The toughness and tensile strength are increased, the cracking and deformation are improved by the use of polymer fibers [2]. But this method adds another layer, which is prone to degradation when exposed to marine environment due to surface blistering. As a result, the adhesive bond strength is reduced.

Fig. 3. Polymer fibre

D. Natural Fiber Reinforced Concrete

In addition to industrial fibers, natural organic and mineral fibers have been also investigated in reinforced concrete. Wood, sisal, jute, bamboo, coconut, asbestos and rock-wool, are examples that have been used and investigated. Natural fibers have relatively, high strength, high stiffness and low density. Because natural fibers are easily available materials, they are not uniformly in diameter and length. Typical values of diameter for natural fibers vary from 0.004 to 0.03 in. (0.10 to 0.75 mm).

Fig. 4. Natural fibers

E. Synthetic fibre

Synthetic fibers are not suitable for primary reinforcement in concrete because they add small or no strength. The synthetic fibers are often chosen as secondary gradient by the contractors as these gives benefit while the concrete is in still plastic state as compared to the plain reinforced concrete. They also enhance some of the properties of hardened [2].

Fig. 5. Synthetic fibers

III. Mechanical Properties of Fibre Reinforced Concrete

1. *Compressive Strength:* The failure mode of cylinders may alter with the presence of fibers, but the compressive strength value (0 to 15 percent) will not be much effected.
2. *Impact Resistance:* The impact strength for fibrous concrete is generally 5 to 10 times that of plain concrete depending on the volume of fiber [5].
3. *Corrosion of Steel Fibers:* A 1O-year exposure of steel fibrous mortar weathering in an industrial atmosphere showed no adverse effect on the strength properties. Corrosion was found to be confined only to fibers actually exposed on the surface. Steel fibrous mortar exhibited a 15 percent loss compared to 40 percent strength decrease of plain mortar.

IV. Structural Behavior of Fibre Reinforced Concrete

Fibers with reinforcing bars in structural members will be widely used in the future. The following are some of the structural behaviour:

- *Flexure:* The use of fibers in reinforced concrete increases ductility, tensile strength, moment capacity, and stiffness. The fibers improve crack control and preserve cracking for structural integrity of members.
- *Torsion:* The use of fibers eliminate the sudden failure characteristic of plain concrete beams. It increases stiffness, torsional strength, ductility, rotational capacity, and the number of cracks with less crack width.
- *Shear:* Use of fibers increases shear capacity of reinforced concrete beams up to 100percent. Addition of distributed fibers increases shear-friction strength, strength of first crack, and ultimate strength.
- *Column:* The increase of fiber content small increases the ductility of axially loaded specimen. The use of fibers helps

in reducing large amount of failure for columns.

- *High Strength Concrete:* Fibers increases the ductility property of high strength concrete. The use of high strength concrete and steel makes slender members. Fiber uses will help in controlling cracks and deflections.

V. Advantages and Disadvantages of FRC

A. Advantage

- Better durability
- Limitations contraction cracks
- Improvement of ductility
- Improvement tensile strength
- Better fire resistance

B. Disadvantage

- Exacting of production technology
- Higher price (per cubic meter concrete)
- Higher specific gravity
- Corrosion of steel fibers

VI. Current Applications of FRC

1. It is important to recognize that in general, fiber reinforcement is not uses for conventional reinforcement.
2. Fibers and steel bars have different uses to play in modern concrete technology, and there are many applications in which both fibers and continuous reinforcing bars should be used together.
3. Components which must withstand high loads or deformations, such as blast resistant structures, or precast piles which must be hammered into the ground.
4. Overlays of air area, road pavements, industrial floorings and bridges decks etc.
5. Canal and refractory linings.

Fig. 6. Precast concrete railroad track slabs for high-speed trains. Source: Brite-Euram (2002)

- Steel-FRC in addition with traditional reinforcement to significantly reduce crack width and/ or the required amount of reinforcement increase to durability improvement.
- A decrement of reinforcing bar up to 50% is possible while keeping crack width constant.

Fig. 7. Segmental tunnel lining using steel-FRC

Fig. 8. Precast concrete sewer pipes. Reinforcing precast concrete pipes using only steel fiber is economically advantageous for pipe diameters up to 36 in. (900 mm)

VII. Future Trends of FRC Application

FRC materials has been developed, the so-called ‘high performance’ FRC, which exhibit multiple cracking and strain hardening beyond the point of first cracking, with a concomitant increase in energy absorption capacity.

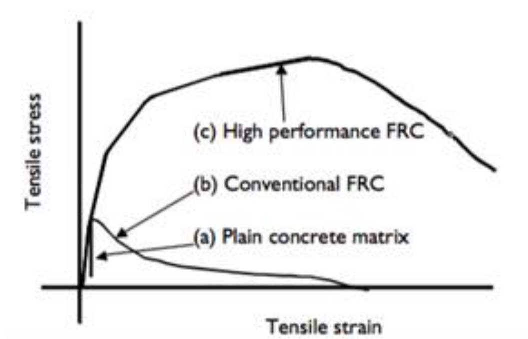

Fig. 9. Stress–strain curves for conventional and high performance FRC

VIII. Conclusion

Addition of fibers to concrete improves the mechanical and durability properties. The use of hooked fibers than straight fibers has much improved the mechanical properties of FRC. The control in cracking and deformation under impact load results better in FRC than in plain concrete. Natural fibers can be used for FRC along with the waste materials followed with their pretreatments.

References

[1] R. Kandasamy and R. Murugesan: “Fiber reinforced concrete using domestic waste plastics as fibers” Vol. 6, No. 3, March 2011. Pp. 75-82.

[2] Amit Rai and Y.P. Joshi: "Applications and properties of fiber reinforced concrete", Vol.-4, Issue 5 (version1), May2014, PP 123-131.

[3] Bensaid Boulekbache, Mostefa Hamrat, Mohamed Sofiane Amziane: "Flow-ability of fiber reinforced concrete and its effect on the mechanical properties of material" PP 1664-1671.

[4] Komal Chawal and Bharti Tekwani: "Studies of glass fiber reinforced concrete composites"- ISSN: 2319-6009, Vol. 2, No. 3, August 2013. PP 176-182.

[5] Faisal Fouadwafa: "Properties and application of fibre reinforced concrete." pp. 49-62.