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FIBER REINFORCED CONCRETE

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Concrete is the most used material in the construction, over two billion tons produced annually. Concrete has many advantages except tensile strength and ductility. Although the steel rebar can provide tensile strength, the wide use of steel leads to a susceptibility to corrosion, leading to concrete failure. Additionally, concrete carries flaws and micro-cracks both even before an external load is applied, these emanate from excess water, bleeding, plastic settlement, thermal and shrinkage strains and stress concentrations imposed by external restraints. One possible solution is fiber reinforced concrete [1; 3].

Fiber Reinforced Concrete (FRC) can be defined as a composite material consisting of mixtures of cement, mortar or concrete and discontinuous, discrete, uniformly dispersed suitable fibers [2].

When fibers are added in a mixture, the fibers are able to reduce plastic shrinkage by blocking any crack paths by reinforcing the concrete together and reducing the water from escaping through any openings. Polymer fibers are also known to make the concrete impact resistant which is the ability to consume energy. [3] When a crack in concrete occurs, the load from the matrix can be transferred to the fibers. In the hardened state, when fibers are properly bonded, they interact with the matrix at the level of micro-cracks and effectively bridge these cracks thereby providing stress transfer media that delays their coalescence and unstable growth. If the fiber volume fraction is sufficiently high, this may result in an increase in the tensile strength of the matrix [3].

Fiber is a small piece of reinforcing material possessing certain characteristics properties [2]. The character and performance of FRC changes with varying concrete binder formulation as well as the fiber material type, fiber geometry, fiber distribution, fiber orientation and fiber concentration.

Fiber parameters that relate to fiber geometry can be used in evaluating fiber effectiveness. Specifically, the number of fibers within a unit volume of concrete, the surface area of fibers in a unit volume of concrete, and the cross-sectional area of fibers across a given plane of an FRC volume, appear to be the most relevant. Individual fibers are produced in an almost limitless variety of geometric forms including prismatic [4].

Fiber concentration determines the choice of FRC production technology. For high performance fiber reinforced composites, with a high fiber dosage, benefits of fiber reinforcement are noted in an increased tensile strength, strain-hardening response before localization and enhanced toughness beyond crack localization. While in FRCs with low to medium volume fraction of fibers, fibers do not enhance the tensile flexural strength of the composite and benefits of fiber reinforcement are limited to energy absorption or toughness enhancement in the post-cracking regime only.

The low range of fiber addition is well suited for batch mix preparation using conventional mixing equipment and drop placement. Higher fiber concentrations often require special mixing or placing techniques [3; 4].

One of the differences between conventional reinforcement and fiber reinforcement is that in conventional reinforcement, bars are oriented in the direction desired while fibers are randomly oriented. Certainly, the fibers aligned parallel to the applied load offer more tensile strength and toughness than randomly distribute or perpendicular fibers [2]. A number of authors have proposed factors to determining the effective cross-section of fibers when considering orientation effects. One such recommendation is 54 %, that means the individual fiber cross-sectional area is only 54 % effective given random orientation in comparison with the most favorable alignment [4].

Another important factor which influences the properties and behavior of the composite is the *aspect ratio* of the fiber/ In other words, this is a measure of the slenderness of individual fibers. It is computed as fiber length divided by the equivalent fiber diameter for an individual fiber. Fibers for FRC can have an aspect ratio varying from approximately 40 to 1000 but typically less than 300. This parameter is also a measure of fiber stiffness and will affect mixing and placing [4].

Longer fibers are ideal for flexural testing because the long fibers are able to link together, creating a stronger bond and preventing additional bending.

Many fibers are straight in shape, but it is common to see metals fibers that have hooks at the ends because this helps them lock into the concrete [1].

Provided there is ample fiber strength and ductility, FRC performance is generally enhanced by pressure forming production processes thus confirming ideas of increased fiber efficiency through enhanced fiber-to-matrix bonding [4].

For efficient stress transfer the modulus of elasticity of matrix must be much lower than that of fiber. Low modulus of fiber such as nylons and polypropylene are, therefore, unlikely to give strength improvement. High modulus fibers such as steel, glass and carbon impart strength and stiffness to the composite. Interfacial bond between the matrix and the fiber also determine the effectiveness of stress transfer, from the matrix to the fiber [2].

It can be concluded that the benefits of the addition of fibers in concrete vary based on the type of fiber. Among the types of fibers available, steel, polymer, and glass are the most commonly used.

Steel fibers. The use of steel fibers in concrete has potential in many structural applications because of the high yield strength of steel. However, the steel fibers were unable to withstand heat and caused the samples to deteriorate from the inside out. Thus the caution should be used in areas that are prone to fire because the fibers can cause the concrete to experience explosive behavior [1].

Polymer fibers could be beneficial in locations that are prone to corrosive materials because of the high corrosion resistance. Additionally, the polymer fibers could be ideal for pillars that are submerged in water such as bridges and dams [1].

Glass fibers can be used when a higher flexural strength is desired. For example, large slabs and thin-shelled concrete are less resistant to bending because they can have a smaller thickness so fibers can help increase the strength [1].

Thus, we lead to a ***conclusion*** that adding fiber is capable to make the reinforce concrete stronger, lighter, and possibly less expensive due to preventing micro-cracks and increasing of ductility. Fiber from many materials can be used, each type has its advantages and disadvantages, it is recommended to choose fiber considering its properties.

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