NYCON® …helping you build smarter and better.

Position Paper

All Synthetic Fibers Are Not Equal

In assessing the value of synthetic fibers as concrete reinforcement, it is of paramount importance to recognize that all fibers are not equal. The view that nylon is nylon or polypropylene is polypropylene or fibers are fibers is a generality that fails to address the essential fiber properties that benefit concrete as a reinforcement. These properties include:

- **Material Properties**

  There are a variety of resins used to produce both nylon and polypropylene fibers. Each has multiple properties that are best suited to specific applications; for example, homopolymer polypropylene resins are extrudable into fibers, whereas copolymer polypropylene resins are used to produce moldable products. (Source: "Chemical Handbook for Fibers")

  There are many ways of extruding resins into various fibers that are marketed as reinforcement for concrete or other applications. However, there are very few synthetic fibers that are specifically manufactured for concrete reinforcement.

  All of Nycon's reinforcing fibers are manufactured specifically for use as concrete reinforcement.

- **Physical Properties**

  The physical properties of synthetic fibers that enhance concrete's performance are:

  1. Tenacity, which reflects fiber strength based on the draw ratio, and…
  2. Elongation, which indicates the length stability of the fiber under load.

  A quick test to determine a fiber's tensile and elongation properties is to put a fiber between the thumb and forefinger of each hand and pull. If the fiber breaks, it has a low tensile strength. If the fiber stretches rather than breaks, it is easy to conclude it has high elongation. A fiber with low tensile strength will never hold concrete together after it cracks.

  All of Nycon's fibers are produced to meet the specific physical properties to insure maximum performance in concrete.

- **Fiber Sizing and Concrete Finish**

  Quality of the concrete finish is another consideration when evaluating synthetic reinforcing fibers. The finish directly relates to the properties of the fibers, as well as the liquid coating applied to the surface of the fibers to facilitate production and—in the case of synthetic fiber reinforcement—to improve fiber distribution within the concrete matrix.

  There are a variety of fiber coatings used in the extrusion process, hydrophilic being the most suited for concrete reinforcing fibers. The hydrophilic coating helps the fibers mix with the mortar in the matrix, a key factor in fiber bond within the concrete. Not all fibers are specifically manufactured as a concrete reinforcement; and those which are not may be inferior in dispersing and bonding within the mix.

One major productivity concern is the surface finish of the concrete slab. NyconRC and MultiMesh fibers are made from nylon and yield a superior finish when compared to other synthetic fibers on the market. In field testing, NyconRC and MultiMesh reinforced slabs finished easier with as smooth a surface as the plain concrete slabs.

- **Fiber Reinforcement Applications**

Two types of reinforcement applications appropriate for synthetic fibers at the typical dosage rate of one to one-and-a-half pounds per cubic yard are plastic shrinkage and hardened concrete secondary reinforcement.

1. Plastic shrinkage reinforcement works within the first eight hours after concrete is placed.

2. Secondary/temperature-shrinkage reinforcement initiates when concrete has hardened and then performs throughout its useful life.

Secondary reinforcement includes welded-wire fabric (WWF), or wire mesh, which is considered a first-generation material. WWF's performance is predicated on where it is placed within the cross-section of the concrete. Unfortunately, it is typically found laying on the subgrade, rather than up in the concrete, where it has little or no benefit.

- **Enhancing the Properties of Fiber-Reinforced Concrete (FRC)**

Most synthetic fibers available on the market perform adequately as plastic shrinkage reinforcement. However, most do not improve concrete's durability—in terms of superior surface abrasion resistance, impact resistance, reduced permeability, fatigue strength and, most importantly, modified micro-macro cracking.

The factors known to enhance the performance of FRC are fiber count, fiber quality, and fiber uniformity. Fiber count relates directly to fiber spacing, which modifies micro-macro cracking of concrete—the number one culprit in diminished durability. The closer together the fibers are the greater, the control of micro-macro cracking. NyconRC has the highest fiber count per unit weight of all synthetic fibers currently marketed as concrete reinforcement. Nycon's other fiber products—MultiMesh, ProConF and ProConM—have a fiber count equal to or exceeding other synthetic fiber products. There is a considerable discussion of this subject in Chapter 4 of ACI 544.1R, "State-of-the-Art Report on Fiber-Reinforced Concrete".

- **Summary**

Nycon's primary line of products is reinforcing fibers for the concrete and asphalt industry. Our nylon and polypropylene products—NyconRC, MultiMesh, NyconG, NyconLC, NyconXL, ProConF and ProConM—are engineered specifically for use as reinforcement. For these reasons Nycon fibers meet the highest performance requirements for secondary reinforcement found in ICC Acceptance Criteria 32.

The full-line of quality fibers Nycon offers—nylon, polypropylene, as well as AR glass, steel, and synthetic/steel blends—combined with Nycon's technical support services tailored to the needs of each customer, demonstrate that all synthetic fibers are not created equal.

NYCON®

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