Fiber Reinforced Concrete

By Craig E. Barnes, P.E., SECB

Twenty-five years ago was my first experience with the use of small fibers in concrete construction. We had designed 40,000 square feet of slab on grade for a commercial project. As I think back on that project, the contractor made a convincing argument to the project owner that it would be more to his benefit (reduce cost) to use this new technology of fibers in place of welded wire reinforcement. Although we had no experience with the use of the fibers, I cannot say I was ambivalent. Every concrete job using welded wire fabric, either on grade or in an elevated slab that we had investigated because of crack problems, revealed the welded wire fabric was either directly on the metal deck or on the soil in the slab-on-grade situations. I recall attempting to defend myself by putting into the record a letter attempting to place the burden for whatever would go wrong on the contractor. I cannot say things went all that well with my first experience.

The contractor, as it turned out, who had no experience himself, was simply relying on manufacturer's hype. We were all surprised that some of the bags of fiber did not entirely break up with the on-site mixing and ended up sliding down the chute like wool balls. The inexperience of the contractor was also reflected in the finished surface which, in a humorous way, looked a little bit like a mohair rug shortly after finishing. Inexperience won the day again.

The contractor and the consultant, not understanding that the hairs would wear off very quickly, had the contractor cross back and forth over the surface with a Hawk heater, singeing the hairs like Grandma used to do with the Thanksgiving turkey.

After our first encounter with fibers in concrete, it was on to the even more interesting use of steel fibers, which left tiny rust spots on the concrete surface. It seems as though pricing and handling issues have decided the battle of the fiber wars, as it has been a number of years since we have used steel fibers on a job. Even during our internal experimenting process, after one experience, we stopped using steel fibers in parking garages as it was too difficult explaining the rusting.

Today, with a comfort level and a lot more experience, we will often replace welded wire fabric altogether. With one exception, the increase in fiber usage is not exclusively due to improvements in fiber technology, but the combination of improvement in technology and contractor awareness regarding proper quality control for concrete slab placement. Twenty-five years ago, all we heard of on the construction side of the equation was checkerboard slab placements to mitigate concrete shrinkage. "Checkerboarding" usually followed column spacing and was frequently found anywhere from 25 feet to 40 feet. Strip casting of 25 feet wide by lengths of over 100 feet are now commonplace. Water-reducing admixtures in concrete, mechanized placement and finishing, and the use of fibers have been responsible for that change.

Manufacturers have toned-down the promotional hype to a point where even younger engineers are no longer convinced that fiber can be a replacement for structural reinforcement.

In our part of the country, the Northeast, polypropylene fibers have come into their own. They are used with great frequency in concrete placements that often don't receive the respect that the contractors should provide. For instance, thin toppings on precast plank and just about all placements of concrete on metal deck, whether composite or non-composite, are subject to contractor inattention. Now that the Steel Deck Institute has accepted fibers as an alternative to welded wire fabric for shrinkage control, there will be more pressure on the American Concrete Institute to accept fiber as a material acceptable to deal with shrinkage control within the body of ACI 318. Why not? Do you think ACI was simply looking for something to do before an ACI 318 subcommittee took an interest in Post Installation Anchors, contained now in ACI 318-Appendix D? ACI Committee 544 has been researching and collecting data on fiber reinforced concrete for years. It won't be long before engineers can go directly to an ACI 318 reference rather, than taking the back door approach of ACI 318-1.04.

Individual fiber is already a welcome, low-cost compliment for slab placements that use

steel reinforcement as the primary shrinkage control medium. Fiber technology has a long way to go, in my opinion, before the industry will see the general acceptance of individual fibers for flexural reinforcement, but I think it will come, just as fiber-reinforced polymers (FRP) have become acceptable for certain types of flexural reinforcement.

In this age of chemicals, we can't neglect that component of the industry; even as fibers reach a common acceptance. We have long recognized the characteristic of concrete to self-heal microcracks up to approximately 0.02 inches. Thinking back 30 years, I recall certain chemical additives boasting that they could enhance the self-healing characteristics of concrete. Now, with chemists tinkering with the molecular component of crystals, we are exposed to additives whose very purpose is to heal microcracks in that range. With the correct application of crystal chemistry, fiber technology, concrete densification, and *good* construction practice, we may be seeing the death of concrete coatings used for waterproofing purposes.

Your thoughts are always welcome on this topic.▪

Craig E. Barnes, P.E., SECB is principal and founder of CBI Consulting Inc. As an engineer registered in both the civil and structural fields, Mr. Barnes has over 40 years experience designing, coordinating, and managing structural and civil engineering projects throughout New England. Craig can be reached via email at ***cbarnes@cbiconsultinginc.com****.*