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JEPCO NEWS

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SPRING by ED PENNYPACKER 2008

STRUCTURAL FIBERS

Anyone who knows anything about concrete, knows that a four inch thick skating rink, measuring 68 feet by 187 feet in an oval shape, cannot be poured without steel and saw cuts to control curling and shrinkage. Wrong! There is one in Marrietta, GA and it is four years old. Just concrete and 7.5 lbs of macrofibers per yard. No steel, no expansion joints, no saw cuts and NO CRACKS. Do structural fibers in high doses stop the slab from shrinking? Stop curling? No, but the reinforcement offered by the fibers is enough to prevent cracking.

January 30, 2008 A & R concrete, Newburgh, NY, tested several inlet boxes to show how effective fiber reinforcement can be. Boxes measure 48 inches tall, with 6 inch walls except at knock-outs where the thickness is only two inches. Some of the 30 x 48 boxes were made with conventional re-bar and mesh reinforcement. Others were made with only 5.0 lbs of macrofibers per yard as the sole reinforcement.

Ready for testing. The label indicates that this inlet box was made on November 12, 2007 with structural fiber reinforcement instead of steel.

Ron Thornton, of Delta Engineers, calculated that a load of 13.5 inches Hg would be equivalent to AASHTO H-20 loading. Never before has anyone ever tried to test structural fibers to this standard. Each inlet box passed with not even a slight crack. There was no apparent damage at all from the loading.

Then, to simulate an accident during back-fill, the inlet was turned on its side, and a 30 lb. test cylinder was dropped from 5 feet onto the two inch thick knock-out. The cylinder merely bounced off.

ConSeal on wet concrete seals without sticking.

Five different macrofiber reinforced boxes were tested. In each case the results were the same. No damage at all from the 13.5 inches of Hg.

Ron Thornton, Delta Engineers, Binghamton, checks for damage and deflection while the inlet endures H-20 load.

These inlets are suitable for use in traffic locations where H-20 loading is anticipated. Some state and local agencies have not approved structural fiber reinforcement yet, but they should.

13.5 in Hg. (equivalent to AASHTO H-20 loading.

Are All Fibers Created Equal?

There are three types of fibers used in concrete. TYPE 1 fibers are the ones you remember from thirty years ago. Used in low doses of .75 to 1.5 lbs per yard, these lighter, shorter fibers slow the passage of bleed water as concrete sets and they provide very minimal reinforcement. These include the monofilament "fuzzy" fibers and recently, a new "invisible" cellulose product. They are inexpensive, but have no use as a replacement for wire mesh.

TYPE 2 fibers are typically fibrillated polymer fibers that anchor better in the hardened concrete. In addition to slowing bleed water, they offer some improvement in reinforcement. Usually they are dosed at about 1.5 lbs per yard.

TYPE 3 fibers are used in much higher doses. From 3 lbs to 10 or more lbs per yard. These longer fibers are deformed to better bond in concrete. We call them "structural" fibers because in high doses they add a structural element to concrete. They not only replace wire mesh, they can replace re-bar.

There is no engineering data that correlates a certain fiber dosage with a known steel reinforcement pattern. What we do now is a "proof of design", which means that the stated fiber dose is actually tested in the finished precast structure to a load that exceeds an anticipated load by a reasonable safety factor. Tests prove that, higher fiber dosage yields better performance. Is there an upper limit? There must be, but we have not found it yet. The "magic number" is 7.5 lbs of macrofiber per yard in flat work. Precast seems to need about 5.0 lb per yard, although many have had impressive results at 4.0 lb dosage. Grace Strux and Euclid Tuf Strand require about 15 -25% higher dosage to achieve the same result. This is verified by every test we have done lately. Doses of 3.0, 5.0, and 7.5 lbs per yard of each were tested head-to-head. (South Dakota School of Mines, May 2007) This is probably due to better mixing for the macrofibers, and the unique design of the individual fibers.

How About Costs?

The break-even dosage is about 5.0 lb per yard. Taking into account the cost of the steel, labor to bend and place it, compared to the direct cost of the fiber.

Type	Type I	Type II	Type III
Dosage	.5 - 1.5lb	1.5 -3.0 lb	3.0 - 7.5 lb
ARS	0 - 50	50 - 125	125 - 300
Function	Shrinkage	Shrinkage / WWF	Structural
Material	Monofilament	Fibrillated	Macro

This does not include cutting waste and aggravation. How do we put a price on flat tires from wire pieces, cuts and scrapes, and rusty shadows on the precast? Fiber needs no chairs and no spacers.

There is no hassle when a customer has to punch through a knock-out and no hassle coring when a boot is installed. Fiber is definitely easier to work with.

ARS is Average Residual Strength- A measure of "post-crack"reinforcement. Higher dosages yield higher ARS.

Macrofiber at 5.0 lbs per yard is the only reinforcement for this manhole section. Performed for DOT approvals, similar structures made with either conventional steel reinforcement or Grace STRUX fibers were put to the same test. Macrofiber was equal or better than steel in every test.

9.2 inches of Hg with 7.5 lbs per yard of macrofiber!