

<b>CONTRolPCM</b>	<p><b>Test Data:</b>  <b>Effectiveness of Nycon ConTrolPCM</b>  <b>as Concrete Reinforcement</b></p>
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**Overview** In March 2000, a testing program was undertaken to determine the compliance of Nycon ConTrolPCM fibers with ICC Engineering Services, Inc. (ES), acceptance criteria (AC) for concrete reinforced with synthetic fibers. A joint committee of ICC ES personnel and synthetic fiber industry representatives established acceptance criteria to evaluate the performance of synthetic fibers as temperature-shrinkage reinforcement in concrete, i.e., AC 32, Section 4.1.2. The testing program, Project #00-030026, was conducted at Stork Twin City Testing Corporation in St. Paul, Minnesota. The test results demonstrated the effectiveness of Nycon ConTrolPCM fibers as secondary temperature-shrinkage reinforcement in hardened concrete.

**Material Description** 0.75" (19mm) Monofilament Virgin Polypropylene Fiber

**Matrix Dosage Rate** 1.0 pounds/cubic yard (0.60 kg/cubic meter) of concrete

ICC Test Procedure	Plain Concrete	ConTrolPCM Reinforced Concrete	% of Plain Concrete	ICC Specs	
Compressive Strength	34.4 MPa (4,990 psi)	34.80 MPa (5,050 psi)	101.2%	Plain Concrete	
Flexural Strength	3.8 MPa (550 psi)	3.8 MPa (550 psi)	100.0%	Plain Concrete	
Freeze/Thaw Durability	Testing in progress				
Bond Strength	62.5 kN (14,040 lbs)	62.7 kN * (14,090 lbs)	100.4%	Plain Concrete	
Plastic Shrinkage Cracking		85.1% reduction		40% Minimum	
Impact Resistance 7 Days 28 Days	4 blows 5 blows	9 blows 10 blows	225% 200%	200% Minimum 150% Minimum	
Compatibility with Concrete	4 Weeks Testing in Progress	8 Weeks Testing in Progress	16 Weeks Testing in Progress	32 Weeks Testing in Progress	52 Weeks Testing in Progress

\*These data are for vertically cast specimens of both plain and ConTrolPCM modified concrete.

## Standard Test Methods Used In Program

Compressive Strength	ASTM C39
Flexural Strength	ASTM C78
Freeze/Thaw Durability	ASTM C666 Method A
Bond Strength	ASTM C234
Plastic Shrinkage	ICC ES AC 32 Appendix B
Impact Resistance	ICC ES AC 32 Appendix C-2
Compatibility with Concrete	ICC ES AC 32 Annex B-2

## Specimens Per Test Set

- Three test specimens were used per test set for compressive, flexural, freeze/thaw, bond strength, plastic shrinkage and compatibility with concrete.
- Five test specimens used per test set for impact strength.

## Performance Criteria

- **Compressive, Flexural, and Bond Strength**

These tests insure that the synthetic fibers do not compromise the performance of reinforced concrete when compared to plain concrete.

### Test Results

Compression, flexural, and bond strength test results for the Nycon ConTrolPCM specimens exceeded the performance of plain concrete. These data confirm that Nycon ConTrolPCM fibers enhance the soundness of the concrete matrix, and their three-dimensional distribution in the matrix provides for the distribution of load over a greater volume of concrete.

- **Freeze-Thaw**

This test insures that the synthetic fibers do not compromise the performance of reinforced concrete when compared to plain concrete.

### Test Results

Testing in progress.

- **Plastic Shrinkage**

This test is required to validate that Nycon ConTrolPCM fibers do, in fact, provide a reduction in measurable crack formation and growth. A minimum reduction in measurable shrinkage of 40% is required.

### Test Results

The plastic shrinkage test results show a major reduction in measurable cracks of 85.1% when compared to the plain concrete, exceeding the 40% minimum reduction specified. The value of ConTrolPCM can best be stated as a durability enhancement: If there are fewer cracks created during the plastic and initial hardening phases and crack widths are smaller, then the concrete will be less permeable. This translates into greater resistance to freeze/thaw, which is doubly proven by the testing; it also translates into improved fatigue strength.

- **Impact Resistance**

This test is required to show that the synthetic fiber holds concrete together after it cracks, which is the sole performance requirement of temperature-shrinkage reinforcement. Again, a minimum performance level is required. For tests comparing number of blows to total failure when synthetic fiber specimens have been aged for seven days, the minimum improvement compared to plain concrete at the same age is 200%. When specimens are 28 days old, the improvement is 150%.

### **Test Results**

Nycon ConTrolPCM fibers exceeded both the 7- and 28-day requirements. Impact resistance data show the superior ability of ConTrolPCM to bond with concrete, thus providing resistance to the cracked concrete's propensity to separate or push apart. Test results illustrate the ability of the fibers to hold concrete together after it cracks, demonstrating their ability to yield benefits beyond secondary reinforcement, the most prominent of which would be in seismic-resistant structures.

- **Compatibility with Concrete**

This is an accelerated aging test used to show whether the synthetic fiber chemically reacts with the mortar matrix and/or loses strength. ASTM C1609 is the test method for evaluating performance, specifically residual strength; this is a calculated number for the toughness index generated by the test results. Beams are tested at 4, 8, 16, 32 and 52 weeks of accelerated aging. Data generated must be equal to or greater than 85% of the unaged data.

### **Test Results**

Accelerated aging testing for compatibility with concrete is in progress. Nevertheless, polypropylene fibers have been used successfully in concrete since the early 70's with no evidence of lost strength or chemical incompatibility, thus demonstrating their value-add in concrete.

## **Conclusions**

This testing program validates the benefits of Nycon ConTrolPCM fibers in concrete and confirms that ConTrolPCM reinforced concrete meets or exceeds the performance criteria of ICC ES AC 32, Section 4.1.2, Synthetic Fibers as Temperature-Shrinkage Reinforcement in Concrete.



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