MULTIMESH

Test Data: Effectiveness of Nycon MultiMesh Fibers as Reinforcement in Hardened Concrete

Overview

In December 1997, a testing program was undertaken to determine the compliance of Nycon MultiMesh (MM) 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 #97-17520, was conducted at Stork Twin City Testing Corporation in St.Paul, Minnesota. The test results demonstrated the effectiveness of Nycon MultiMesh fibers as secondary temperature-shrinkage reinforcement in hardened concrete.

Material Description

0.75" (19mm) Multifilament Virgin Nylon Fiber

Standard Dosage Rate

1.0 pound/cubic yard (0.60 kg/cubic meter) of concrete

ICC Test Procedure	Plain Concrete	MM-Reinforced Concrete	Control %	ICC Specs
Compressive Strength	33.85 MPa (4,910 psi)	36.40 MPa (5,280 psi)	107.5%	≥ Plain Concrete
Flexural Strength	5.17 MPa (750 psi)	5.65 MPa (820 psi)	109.3%	≥ Plain Concrete
Freeze/Thaw Durability	92.1%	94.6%	102.7%	≥ Plain Concrete
Bond Strength	87,240 N (19,610 lbs)	87,310 N (19,630 lbs)	100.1%	≥ Plain Concrete
Plastic Shrinkage Cracking		76.0% Reduction		Minimum Reduction 40%
Impact Resistance 7 Days 28 Days	 6 blows 7 blows	 13 blows 13 blows	 217% 186%	 200% Minimum 150% Minimum

Compatibility with Concrete	4 Weeks	8 Weeks	16 Weeks	32 Weeks	52 Weeks	
% Unaged Residual Strength	100.0	97.4	95.4	92.3	102.0	≥ Plain Concrete

Above results reflect the minimum performance value at tested dosage rate.

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.

Discussion of Performance Criteria

- **Compressive, Flexural, Freeze/Thaw, 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, freeze/thaw, and bond strength test results for the Nycon MM specimens exceeded the performance of plain concrete. The data prove that Nycon MM 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.

- **Plastic Shrinkage**

  This test is required to show that Nycon MM 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 76% when compared to the plain concrete, exceeding the 40% minimum reduction specified. The value of Nycon MM's benefit can best be stated as a durability enhancement: If there are fewer cracks created during the plastic and initial hardening phases and the crack widths are less, 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 fibers hold 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 MM fibers exceeded both the 7- and 28-day requirements. Impact resistance data show the superior ability of Nycon MM 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 the fibers' ability to yield benefits beyond performing as secondary reinforcement. The most prominent application of this attribute would be 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 used to evaluate 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 64 weeks of accelerated aging. Data generated must be equal to or greater than 85% of the unaged data.

Test Results

The data for compatibility with concrete at all specimen ages show MultiMesh fibers exceeded the minimum required residual strength value of 85%. In fact, the residual strength of the 52-week-aged specimens was 102% of the unaged. These results, coupled with the program's other test results, demonstrate the superior bonding properties of MultiMesh fibers.

Conclusions

The results of this testing program validate the benefits of Nycon MultiMesh fibers in concrete and demonstrate that MultiMesh-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.

XXXX

NYCON®

Helping you build smarter and better.™

Nycon, Inc.
101 Cross Street
Westerly, RI 02891 USA
Phones: 800 456 9266, 401 596 3955 Fax: 401 596 4242
Web-site: www.nycon.com E-mail: nycon@nycon.com