MASTER® BUILDERS SOLUTIONS

Project:
2nd Avenue Subway with MasterFiber products

Location:
New York, NY

Owner/s:
Metropolitan Transportation Authority

Design Engineer:
DMJM Harris / Arup JV

Contractor:
S3 Tunnel Constuctors

Ready-Mixed Concrete Producer:
Ferrara Brothers

Requirements:
A fiber-reinforced concrete solution

Products Used*:
MasterFiber® FF 3 steel fiber

MasterFiber M 100 microsynthetic fiber

MasterGlenium® 7500 high-range water-reducing admixture

MasterSet® DELVO hydration control admixture

Market Sector:
Ready-mixed concrete

Project Profile

Fiber-Reinforced Concrete

2nd Avenue Subway

The Background

While several subway lines service Manhattan's west side, only the Lexington line services the east side. Because of strong residential development in this area, the Lexington line now carries as many as 1.5 million passengers per day, exceeding the total combined volume of the Chicago, Boston, and Washington, D.C. subway systems. The 2nd Avenue line is now being built to alleviate this overcrowding.

When completed in 2020, the twin tunnel line with 16 new stations will stretch 8.5 miles under Manhattan's 2nd Avenue, from 125th Street to the financial district. The estimated final cost of $17 billion will make it the nation's largest public works project since the "Big Dig" in Boston.

BASF
We create chemistry

2nd Avenue Subway

The Challenge

The engineer provided the option of using either reinforcing steel or steel fibers for the concrete used for the final tunnel lining in this project. Moving reinforcing steel into the tunnel and then placing and tying it prior to placing the forms would be labor-intensive. Eliminating the need for conventional reinforcing steel in the tunnel would result in substantial labor savings.

Steel fiber reinforced concrete has been used in structural applications for many years in Europe, but is a relatively new technology in North America. For this project, a fiber-reinforced concrete with properties meeting the following minimum values was specified: first peak strength of 530 psi (3.7 MPa); splitting tensile strength of 380 psi (2.6 MPa); and, for residual strength, a $f_{150,1.125}$ greater than 300 psi (2.1 MPa).

In addition, the engineer specified microsynthetic fibers for fire protection. The specification required a dosage of 1.75 lb/yd^3 (1 kg/m^3) of polypropylene fibers with a maximum length of 0.5 in. (13 mm) and a diameter not exceeding 32 microns.

The Fiber Solution

Testing was conducted at the Ferrara Bros. Flushing, NY plant and BASF's laboratory in Cleveland, Ohio, to determine the proportions of a fiber-reinforced self-consolidating concrete mixture that met the stringent requirements of the project specifications and the needs of the concrete producer and contractor with respect to workability retention and pumpability. The peak strength and residual strength parameters were evaluated in accordance with ASTM C 1609, "Standard Test Method for Flexural Performance of Fiber-Reinforced Concrete (Using Beam with Third-Point Loading)," and ASTM C 496, "Standard Test Method for Splitting Tensile Strength of Cylindrical Concrete Specimens" was used to determine the splitting tensile strength of the concrete. The laboratory-determined, engineered concrete mixture proportions were used in the project.

With the completion of the first contract, involving construction between 92nd and 63rd Streets, 17,000 yd^3 (13,000 m^3) of concrete containing BASF fibers has been used in this project.

Benefits

This fiber-reinforced concrete solution saved the contractor significant labor, time and money compared to the option of installing reinforcement. Despite the space limitations in the tunnel, the fiber-reinforced concrete solution allowed for more efficient use of crews with less down time and, more importantly, it met the specified performance parameters.

Mixture Proportions

Water-cementitious materials ratio	0.38
Cement content	900 lb/yd^3 (534 kg/m^3)
Class C Fly Ash	140 lb/yd^3 (83 kg/m^3)

Fiber dosage

MasterFiber FF 3:	30 lb/yd^3 (18 kg/m^3)
MasterFiber M 100:	1.75 lb/yd^3 (1 kg/m^3)

Properties of Concrete

- Air content: 5%
- Concrete temperature: 70 °F (21 °C)
- Slump flow: 24 in. (610 mm)
- 7-day compressive strength: 6,600 psi (45.5 MPa)

More Information

The Master Builders Solutions brand brings all of BASF's expertise together to create chemical solutions for new construction, maintenance, repair and renovation of structures. Master Builders Solutions is built on the experience gained from more than a century in the construction industry.

The know-how and experience of a global community of BASF construction experts form the core of Master Builders Solutions. We combine the right elements from our portfolio to solve your specific construction challenges. We collaborate across areas of expertise and regions and draw on the experience gained from countless construction projects worldwide. We leverage global BASF technologies, as well as our in-depth knowledge of local building needs, to develop innovations that help make you more successful and drive sustainable construction.

The comprehensive portfolio under the Master Builders Solutions brand encompasses concrete admixtures, cement additives, chemical solutions for underground construction, waterproofing solutions, sealants, concrete repair & protection solutions, performance grouts, performance flooring solutions.

*Effective January 1, 2014, the names of BASF's Master Builders Solutions brand products have changed:
Glenium 7500 became MasterGlenium 7500
Delvo Stabilizer became MasterSet DELVO

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