

BEBO Arch Precast Elements with MasterFiber[®] M 100

To Meet Explosive Spalling Requirement



BEBO[®] Arch Systems are reinforced precast concrete arch structures that are covered with a membrane and overfilled with earth to form a bridge, tunnel or other hollow structure. The Southwest Calgary Ring Road (SWCRR) highway tunnel, located in Calgary, Alberta, Canada, will be the longest BEBO structure in Canada, measuring 1 655.5 m (543 ft).

Armtec, now AP Infrastructure Solutions LP, was selected as the concrete contractor and the precast concrete producer for the BEBO elements and was required to provide a solution for explosive spalling in the event of a fire inside the SWCRR BEBO structure, in accordance with criteria set by Alberta Transportation Ministry. Explosive spalling of concrete will occur when free water in concrete is changed to steam during a fire and there is no path for release of the steam, leading to pressure buildup within the concrete. In addition to degradation of the concrete matrix due to a fire, explosive spalling will harm the integrity of a structure and lessen its durability. Because explosive spalling is not a common design consideration in concrete structures, there was limited specification information available. Looking for a proven solution for the precast arch elements, Armtec, now AP Infrastructure Solutions LP, contacted Master Builders Solutions, which had a solution for explosive spalling of concrete that had been utilized in Europe. The solution required the use of a shorter 6-mm length version of Master Builders Solutions' MasterFiber M 100 monofilament microfiber at a minimum dosage of 2 kg/m³ (3.4 lb/yd³). Composed of a homopolymer polypropylene, the microfiber will melt during a fire and leave fine fissures in the concrete that would allow for the safe release of steam, thus preventing a pressure buildup within the concrete matrix.

Project:

Southwest Calgary Ring Road
BEBO Arch

Location:

Calgary, Alberta, Canada

Owner/s:

Government of Alberta, Canada

General Contractor:

KGL

Concrete Producer:

AP Infrastructure Solutions LP
(formerly Armtec)

Products Used:

MasterFiber M 100
monofilament microfiber

Market Sector:

Precast Concrete

Award:

2018 Innovative Fiber Project of the
Year, Synthetic 1st Place, by Fiber
Reinforced Concrete Association

Solution Profile

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Photos courtesy of Mark Sokolowski

The Challenge

Typically, MasterFiber M 100 monofilament microfiber is used at a dosage of 0.3 kg/m³ (0.5 lb/yd³) to minimize or prevent cracking due to plastic shrinkage. However, in this explosive spall prevention application, the microfiber dosage is over six times the typical dosage. Consequently, the total surface area of fiber that had to be coated with paste to ensure adequate workability and finishability of the concrete mixture was significantly increased. The challenge therefore was to proportion a new concrete mixture with enough paste content without impacting other properties such as early-age strength.

Engineering Requirements

In addition to strength, durability of the BEBO arch structure with respect to explosive spalling in the event of a fire was also required.

Results

The Master Builders Solutions sales team were able to provide pertinent research data in addition to developing a concrete mixture that included the custom length 6-mm MasterFiber M 100 monofilament microfiber needed to get the solution approved by the Alberta Transportation Ministry. Development work on the new concrete mixture began in December, 2017, and Master Builders Solutions provided valuable assistance with this effort.

The SWCRR project required 182 precast segments to form the BEBO structure. Precast production started in April, 2018, and was finished in July, 2018. The precast segments exceeded the expectations with fit on the install and the structure is expected to open to traffic in 2021.

This project was awarded Synthetic 1st Place, 2018 Innovative Fiber Project of the Year, by the Fiber Reinforced Concrete Association (FRCA).

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