



Bekaert Underground



With over four decades of experience in the world's most challenging ground support applications in metro, highway, rail, water, and mining, Bekaert Underground Solutions not only has the in-depth expertise and know-how to ensure the safety of these projects, but we also offer fiber concrete reinforcement solutions which guarantee a cost-effective, more durable, and more sustainable shotcrete structure when compared to conventional form-and-pour structures. Replacing conventional rebar and mesh with fibers is our expertise.

We have a wide portfolio of fiber concrete reinforcement solutions and offer a high-quality fiber for reinforcing wet-mix or dry-mix shotcrete applications. With our global expertise, we provide state-of-the-art, fiber-reinforced shotcrete solutions for ground support in mining and in primary and final sprayed concrete linings in civil tunnels, shafts, and caverns. Our fiber-reinforced shotcrete solutions have been used in numerous tunnels and mines around the world. Bekaert is the modern-day pioneer in the development of Dramix® steel fibers in the 1970s. Now, our newest lines of high-performance fibers have proven themselves just as revolutionary in enabling structural shotcrete single-shell linings of tunnels and underground stations. Saving time, saving material, and providing a low carbon solution at a significant cost savings is in the mix!

At Bekaert, we continuously strive to minimize our environmental impact by integrating sustainability at every level of our business. The Bekaert R&D team, together with universities, continues to investigate recyclability. In January 2023, Dramix® manufactured at our USA production plant was granted an Environmental Product Declaration (EPD) Stee certificate.

MINING APPLICATIONS

The role of a thin shotcrete lining is not to support the original ground pressures. The role of the shotcrete is to stabilize the deformations required to mobilize the ground's inherent strength. Most underground excavations do not have a smooth, uniform rock surface. Wire mesh reinforcement cannot conform to the uneven excavation surface, but steel-fiber reinforced shotcrete can easily adapt to nearly any surface profile.

PRACTICAL BENEFITS OF STEEL-FIBER REINFORCED SHOTCRETE

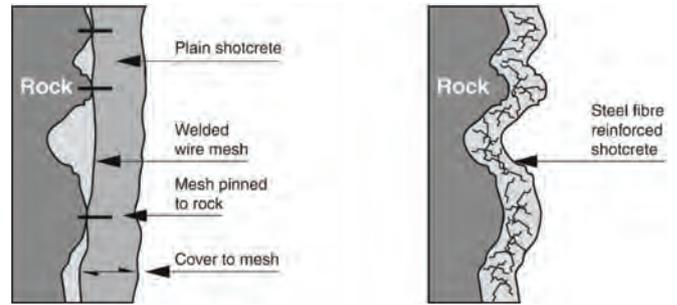


Figure 1: Rebar vs. SFRC Reinforcement.

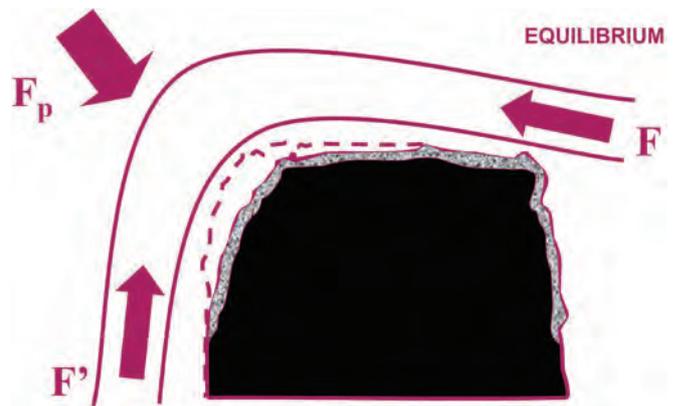


Figure 2: Tunnelling Stresses.

CIVIL APPLICATIONS FOR STEEL-FIBER REINFORCED SHOTCRETE

- Fast and efficient method of tunnel lining (wet-mix).
- Replaces wire mesh in most cases.
- Increases safety.
- Sprayed manually or with a remotely manipulated nozzle (robotic).
- Available for use on either wet-mix or dry-mix shotcrete.
- Suitable for repairs and small works in dry-mix.

Traditionally, conventional excavated tunnels consist of a “double shell” type lining. The initial shell is a FRSC (Fiber-Reinforced Sprayed Concrete) “temporary” lining that stabilizes the opening after excavation and contains short- to medium-term loads. Following installation of a waterproofing

membrane, a traditionally reinforced final cast in-place concrete lining is installed to contain long-term loads and provide durability. Thanks to advancements in shotcrete and steel fiber technology, a SFRPSCL (Steel Fiber-Reinforced Permanent Spray Concrete Lining) system that is a “single shell” of sprayed concrete is attainable.

“You can count on Bekaert for support along each step of your project – from concept design to on-site quality support.”

The advantages expected from the development of SFRPSCL as a permanent lining are many:

- Environmental Impact: Reduction of CO₂ by reducing the steel weight vs. rebar.
- Reduction of CO₂: A thinner lining uses less concrete; plus a more durable lining means a longer service life.
- Cost Reduction / Performance: Reduction in weight of steel required plus no separate installation cost.
- No Formwork Required: Less labor, less forming materials, and a quicker build time.
- Quality and Safety: Achieved using the right product for the right use, specifying clear performance requirements and appropriate testing methods.

You can count on Bekaert for support along each step of your project—from concept design to on-site quality support. Our services include recommendations on design, construction detailing, concrete optimization, and automatic total quality control procedures. We are also happy to share our knowledge with you and your team. Feel free to request a workshop or training on the topic of steel fiber reinforcement for your offices.

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Fig. 3: Edouard Montpetit (EMP) Station Cavern. Photo courtesy of AECOM.

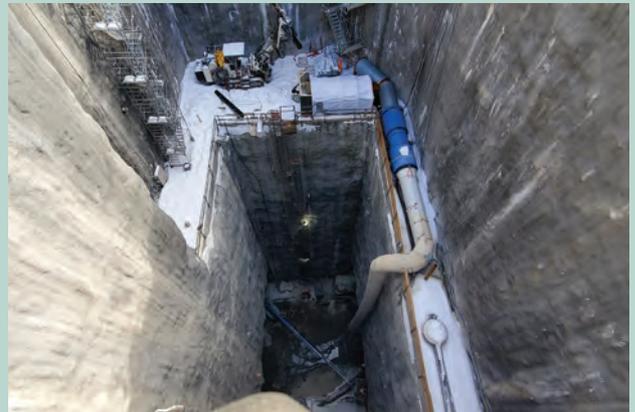


Fig. 4: Edouard Montpetit (EMP) Station. Photo courtesy of AECOM.

PROJECT PROFILE: ÉDOUARD-MONTPETIT STATION (EMP) – MONTREAL, QC, CANADA

Once completed at the end of 2024, the Réseau Express Métropolitain (REM) will be the 4th largest automated transportation system in the world! The project includes 3 underground stations in downtown Montreal. One of the underground stations, Edouard Montpetit (EMP) Station, will be the deepest station in Canada when complete. The EMP Station is built within the existing double track Mont Royal Tunnel (MRT). The side platforms are built by enlarging the existing tunnel. Using the NATM method of excavation, the EMP Station utilizes permanent rock bolts and shotcrete reinforced with steel fibers for both the initial and the final linings of the station structures (tunnels, shafts, caverns, etc.). First, a 2 in. (50 mm) layer of steel-fiber shotcrete is applied as initial support and safety; then, rock bolts are installed, followed by a sprayed-applied waterproofing membrane, and then another 2 in. (50 mm) of steel-fiber-reinforced shotcrete is applied. The liner is designed for a 125-year service life.