As the world’s most widely used construction material, concrete offers many advantages to building and civil engineering projects, including versatility, strength, and durability. However, it is known to present problems when exposed to high-temperature fires.

Several major tunnel fires, including the Channel Tunnel (1996), Mont Blanc (1999), Kaprun (2000), and Gotthard (2001), have raised questions about the properties of concrete in fire situations and prompted much research into its behavior at high temperatures. Investigations into fires in concrete structures have determined that a significant loss of cross-sectional area in the tunnel lining can occur due to the explosive spalling of concrete when exposed to very high temperatures.

Explosive spalling occurs when moisture in the concrete is heated faster than it can migrate from the heat due to a rapid temperature rise, as in hydrocarbon-fueled fires. As the heat of the concrete increases, moisture in the concrete pores experiences a phase change to vapor. This vapor causes an increase in pore pressure, which is unable to escape from the concrete mass. As this process continues, vapor pressure rapidly builds up and exceeds the tensile capacity of the concrete, causing explosive spalling.

Fibermesh® Concrete Solutions by Propex has spent many years researching how micro-polypropylene fibers function in concrete when exposed to fire. We have built up a very detailed understanding of the mechanism by which certain types of fiber can provide this valuable function. This research knowledge has been used to develop Fibermesh 150, a quality-assured fiber that provides the highest performance against explosive spalling yet, at the same time, is user-friendly to the concrete producer and contractor.

Unlike several other competitors’ fibers that are offered for this application, Fibermesh 150 has minimal effect on both the workability and air content of the concrete.

Incorporating a relatively small amount of Fibermesh 150 fiber provides a three-dimensional protection system throughout the concrete and ONLY when there is a fire do they create the correct form of permeability that is required to relieve the steam pressure that is created inside the concrete. Despite the claims of some manufacturers, it is not only the number of fibers that determines how much resistance to explosive spalling is provided but also the optimized balance of the best type of fiber and the number of fibers—and that has been built into Fibermesh 150.

The ability of Fibermesh 150 fibers to prevent explosive spalling of concrete has been independently verified at several internationally renowned fire test laboratories, including SP Technical Research Institute (Sweden), Efectis/TNO (the Netherlands), IBS (Austria), Hagerbach Test Gallery (Switzerland), and BRE (United Kingdom).

Fibermesh 150 microsynthetic fibers are manufactured to ISO 9001 Quality Assured Standards from 100% virgin polypropylene containing no reprocessed materials and are engineered specifically for use as concrete reinforcement. Fibermesh 150 microsynthetic fibers are European Standard EN 14889-2:2006 compliant and carry CE marking.

In addition to providing explosive spalling resistance, Fibermesh 150 fibers will provide resistance to early-age shrinkage cracking, improve impact and abrasion resistance, and reduce rebound in sprayed concrete applications.

Explosive spalling in concrete creates three main consequences:
1. A health and safety risk for the emergency services;
2. The structural integrity of the tunnel is placed at risk; and
3. Huge economic damage caused by major disruption and enormous repair costs.
Gotthard Base Tunnel, Switzerland

The Gotthard Base Tunnel, with a length of 35 miles (57 km), will be the longest tunnel in the world upon completion in 2015. Fibermesh 150 fibers were tested and approved for use on this project at the world-renowned Hagerbach Test Gallery in Sargans, Switzerland. Since commencement of the project, Fibermesh 150 fiber at a dosage of 3.4 lb/yd³ (2 kg/m³) has been the preferred fiber of contractors on various sections of this $12.5 billion (11.7 billion Swiss Franc) project.

Melbourne, Australia

In keeping with the focus on safety, tunnel engineers specified the inclusion of Fibermesh 150 fibers at a dosage rate of 3.4 lb/yd³ (2 kg/m³) in both shotcrete and cast-in-place tunnel linings for this twin-bore 1 mile (1.6 km) long road tunnel. Fibermesh 150 fiber was chosen in preference to other fibers because of its certified performance and because it did not adversely affect the workability and air content of the concrete. Joint Venture group—Theiss John Holland were the contractors on this $3.8 billion project.

CTRL, United Kingdom

This $200 million (£130m) project is part of the Channel Tunnel Rail Link (CTRL) high-speed rail link, which runs for 67 miles (108 km) between the Channel Tunnel and central London. The project has over 25 miles (40 km) of 23.5 ft (7.15 m) diameter, precast-concrete-lined bored tunnels—sections that are constructed in water bearing sand. Fibermesh 150 fibers at a dosage of 1.7 lb/yd³ (1 kg/m³) were used in the production of the precast tunnel lining segments, which also included Novocon steel fibers in a total fiber-reinforced solution.

Weehawken Tunnel, New Jersey, USA

Tunnel engineers Parsons Brinkerhoff selected the use of Fibermesh 150 fibers for the tunnel lining on the Weehawken twin-track light-rail project in preference to other fiber products after establishing that they did not adversely affect the level of air entrainment within the specified concrete. Fibermesh 150 fibers were used at a dosage rate of 2.0 lb/yd³ (1.2 kg/m³). Novocon steel fibers were also used to increase the flexural toughness of the tunnel lining.

Vomp Terfens, Austria

This 5 mile (8.4 km) two- and three-track rail tunnel in the Austrian Tyrol forms part of the main Munich to Verona railway line and is the longest NATM tunnel in the Brenner axis upgrade project. Joint Venture group—Zublin AG, Hochtief AG & Strabag Bau-AG selected Fibermesh 150 fiber for the passive fire protection of the final tunnel lining after conducting extensive fire testing and concrete mixture trials. A dosage rate of 3.4 lb/yd³ (2 kg/m³) was specified by the project engineers.