Case studies

North Downs Tunnel, Kent
The 3.2 km North Downs Tunnel forms part of the Channel Tunnel Rail Link running from Folkestone, Kent to St. Pancras in London. The primary tunnel lining was made up of sprayed concrete. 1 kg of Ignis PP monofilament fibres were added to the 60 N/mm^2 concrete secondary lining. The lining was constructed insitu, forming a sacrificial layer.

T5, Heathrow Airport
Ignis has been added to Grade C60 concrete on various contracts within this prestigious project. The Ignis enhanced concrete has been used on site in sprayed concrete applications and it has also been added to precast ring segments at a purpose built factory in Ridham Docks.

De Westerschelde Tunnel, the Netherlands
The client Maafroute BV instructed the precast contractors to add 1 kg of Ignis to the C40 concrete. The fibre was included in the concrete sections forming the security exits, safety barriers and connection tunnels.

Dublin Port Tunnel, Ireland
This 4 lane underground highway is designed to take heavy vehicle traffic off the streets of Dublin. A 275 mm thick lining over the tunnels arch is a non-load bearing sacrificial concrete containing 1-2 kg of Ignis.

North Downs Tunnel, Kent

T5, Heathrow Airport, London

Westerschelde Tunnel, the Netherlands

Dublin Port Tunnel, Ireland

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IGNIS® Monofilament Fibre

PASSIVE FIRE PROTECTION

Avoids explosive spalling in concrete

Ignis®
Monofilament Fibres

Increasing the safety of people and structures

Concrete is the most widely used construction material in tunnels around the globe. Due to several tunnel fires in Europe and the increased threat of terrorism, public attention has been focused on the performance of concrete structures both above and below the ground. Passive fire protection that safeguards structural integrity in the event of a fire is of utmost importance for the safety of tunnels. Without such protection, heavy objects and/or hot spalled concrete can pose a serious threat.

Avoiding explosive spalling

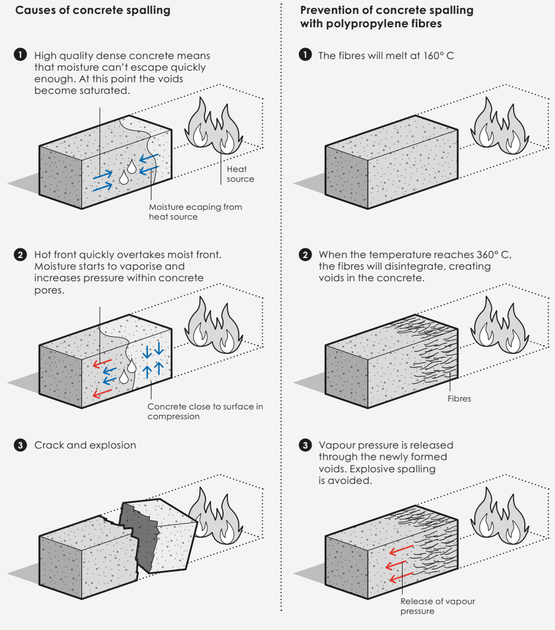
Although concrete is non-combustible and has low thermal diffusivity, it does experience explosive spalling from the build up of pore pressure and internal tensile stresses during a fire. Ignis polypropylene monofilament fibres, when mixed in concrete, increase its permeability during heating thus reducing pore pressure and avoiding the risk of spalling.

Breadth of end-uses

Ignis fibres are applied in a wide range of applications. Examples include sprayed linings, precast segments and pumped concrete behind slip formed shuttering for:

- Road and rail tunnels
- High rise buildings
- Cable tunnels
- Bridges
- Underground/multi storey car parks
- Refractory products

Fig. 1 / **Mechanism of concrete spalling**



Technical details

- Fibre length: 6 mm
- Equivalent diameter: 18 µm
- Shape: Monofilament
- Specific gravity: 0,95 kg/dm^3
- Fibre count: 718 mio.

Functions

- Passive fire protection
- Crack control

Benefits

- Prevention of explosive spalling
- Improved resistance to plastic shrinkage cracks
- Enhanced abrasion and impact resistance

BRE sample without Ignis subjected to European Hydrocarbon Curve showing severe spalling

BRE sample with Ignis subjected to European Hydrocarbon Curve showing no spalling

Testing

Proven perfomance

Extensive testing at independent laboratories such as TNO (NL) and BRE (UK) has proven that Ignis significantly enhances the fire rating of concrete structures.

TNO

Back in 1999 TNO proved that the use of monofilament fibre gave the best results when compared to fibrillated fibres in avoiding explosive spalling. A year later, the institute used the RWS Fire Curve on a number of concrete samples that contained 1.2 and 3 kg/m^3 of Ignis monofilament polypropylene fibre. The samples were loaded to 6.5 N/mm^2. The RWS Fire Curve models a severe hydro-carbon fire and after just 10 minutes the temperature was 1200 °C. The temperature was increased again to 1350 °C resulting in the samples being subject to extreme temperature conditions for two hours. The sample containing no fibre was severely damaged, whereas the panel with 3 kg of Ignis fibre showed virtually no damage at all.

BRE

Samples containing granite aggregates and Ignis monofilament polypropylene fibres were exposed to a severe hydrocarbon fire curve that rises rapidly to 800 °C in three minutes and peaks at 1100 °C. The samples were subject to compressive forces during the test; equivalent to the design loadings predicted in the tunnel lining of the Channel Tunnel Rail Link project. The plain control sample suffered extensive explosive spalling up to a depth of 120 mm. The sample containing Ignis fibres showed no evidence of spalling after two hours of testing. Even the mixes containing lightweight aggregate which totally disintegrated during the initial tests, showed no spalling when Ignis fibres were added.

Fig. 3 / **RWS fire curve vs. alternative tests**

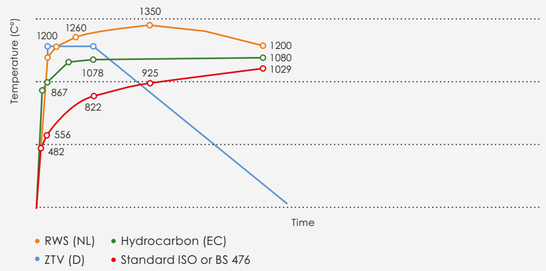


Fig. 2 / **Ignis vs. alternative fibre**

	No. of fibres/kg	Surface area fibres/kg	Spalling depth Max	Avg
Ignis 6 mm	718 Mio	245 m^2	15 mm	6 mm
32 µm (micron) monofilament fibre	110 Mio	133 m^2	60 mm	20 mm

Bridge

Underground car park

High rise building

Road tunnel

Rail tunnel