



ADFIL

TUNNELLING SOLUTIONS

High performance construction fibres

Durus®

Macro synthetic fibre for economical and sustainable concrete reinforcement

Thanks to a unique fibre shape and extrusion technology applied in its manufacture, this fibre is outperforming alternative products.



Whether it be for primary shotcrete linings, cast in situ or permanent precast segmental linings, Durus macro synthetic fibres provide safety of application, durability and sustainability, adding value to assets and return on investment for clients, as well as time and cost savings to contractors.

Each product has been tested and approved by independent laboratories. Round Panel and EFNARC Tests (ASTM 1550 / EN 14488-5) for example have shown that Durus fibres significantly increase the flexural toughness of shotcrete.

Specific fibre reinforced concrete mixtures can be tested at the state-of-the-art Adfil concrete laboratory.

Environmentally sustainable reinforcement? Only with macro synthetic fibres. As confirmed by the International Tunneling and Space Association, macro synthetic fibres are by far the most environmentally sustainable solution for the reinforcement of precast concrete segments for tunnel linings when compared directly to steel fibres and steel mesh alternatives.

Function

- Concrete reinforcement

Application areas

- Shotcreting
- Precast tunnel segments

Benefits

- Increased flexural toughness of the concrete
- Enhanced impact resistance
- Extended service life
- Increased ductility

Advantages

- Easy to transport, store and handle
- Improved safety on site
- Increased speed of construction
- High alkali, acid and salt resistance
- Chemically inert and stable
- Easy to finish
- Substantially reduced carbon footprint

Embodied carbon dioxide for different forms of reinforcement

Material	Embodied CO ₂ (kg CO ₂ /tonne)	Dosage used in segment production (kg/m ²)	Embodied CO ₂ of concrete (kg/m ²)
Conventional steel reinforcement	1,932 ¹	60 - 160	116 - 309
Steel wire fibres	2,425 ²	25 - 40	61 - 97
Polypropylene synthetic fibres	260 ³	8 - 10	2 - 2.6

ITAtech (2016), Guidance for Precast Fibre Reinforced Concrete Segments, Vol. 1: Design Aspects, p. 24

Sources:

- (1) "Embodied carbon dioxide (ECO₂) and construction materials" (V1.1, 2008) Concrete Centre (UK)
- (2) Correspondence from steel fibre manufactures, 2014
- (3) Correspondence from sythetic manufactures, 2014



Round Panel Test, WTCB Belgium

Ignis®

Micro synthetic fibre for reliable passive fire protection

Ignis fibres have been used in tunnels right around the world for over 20 years: For the safety of people and the safety of structures.



Due to several tunnel fires in Europe and the increased threat of terrorism, public attention has been focused on the performance of structures both above and below the ground.

Nothing is more simple when it comes to protecting tunnel linings from explosive spalling than our tried and tested Ignis monofilament fibres. Many have followed our lead, but nobody can offer the quality and support provided by our Technical Sales Managers, Concrete Technologists and Engineers. Why take the risk of inferior performance on site and in a real fire, when the best of proven performance fibres are available?

Ignis micro synthetic fibres have been tested according to the RWS fire curve developed by Rijkswaterstraat, the Dutch Ministry of Transport, Public Works and Water

Management. It models a hydrocarbon fire with a temperature of 1,200°C after just 10 minutes. The temperature is increased again to 1,350°C and the samples subjected to the temperature for a period of two hours. The test confirmed that Ignis provides reliable passive fire protection. Concrete panels containing no fibres were severely destroyed whereas the samples containing Ignis showed virtually no damage at all.

Reference projects

- **Kentish Town Cable Tunnel**, London (UK)
- **Schlossberg Tunnel**, Graz (Austria)
- **North Downs Tunnel**, CTRL 410, Kent (UK)
- **Airside Tunnel**, Heathrow Airport, Terminal 5, London (UK)
- **Stratford Tunnel**, CTRL 220/240, London (UK)

Technical details

- Fibre length: 6 mm
- Equivalent diameter: 18 µm
- Shape: Monofilament
- Specific gravity: 0,95 kg/dm³
- Fibre count: 718 mio.

Functions

- Passive fire protection
- Crack control

Application areas

- Shotcreting
- Precast tunnel segments

Benefits

- Significant reduction in explosive spalling
- Improved resistance to plastic shrinkage cracks
- Improved abrasion and impact resistance

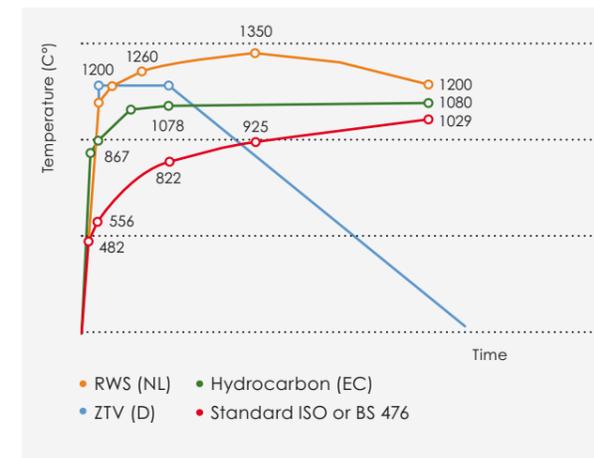
Advantages

- Easy to transport, store and handle
- Improved safety on site
- Faster construction
- Reduced labour costs
- Chemically inert and stable
- Easy to finish

- **SWOT-Tunnel**, Heathrow Airport, London (UK)
- **Swancombe Dock Tunnel**, CTRL 320 (UK)
- **Bindermichel Tunnel**, Linz (Austria)
- **St. Johns to Elstree Cable Tunnel**, London (UK)
- **De Westerschelde Tunnel** (Holland)
- **Pistentunnel**, Flughafen (Austria)
- **Channel Tunnel Rail Link**, Contract 103 (UK)
- **Dublin Port Tunnel** (Ireland)
- **U2 / U5 Tunnel**, Vienna (Austria)
- **Dartford Cable Tunnel**, (UK)

- **Penchala Tunnel**, Kuala Lumpur (Malaysia)
- **Weehawken Tunnel**, New York (USA)
- **Rannersdorf S1 Straßentunnel**, Vienna (Austria)
- **Mersey Kingsway Cross Passages**, Liverpool (UK)
- **Umfahrung Enns**, HL. (Austria)
- **Lainzer Tunnel**, LT22 / LT24, Vienna (Austria)
- **Malmo City Tunnel** (Sweden)
- **Hallandsas Tunnel**, (Sweden)
- **Petelinje Tunnel** (Blagovica)
- **Ostrava Tunnel** (Poland)
- **Lower Lea Valley** (UK)

RWS fire curve vs. alternative tests



Enkadrain® | Enka®-Tex

Geosynthetics for drainage, protection and more

With Enka Solutions high-performance geosynthetics unsurpassed performance lays ahead for your next project.



Backed by extensive geosynthetics expertise, Enkadrain drainage and protection mats developed to meet the specific needs of the tunnelling industry have been launched about four decades ago. Ever since they have become an integral part of several approved sealing systems and been the preferred choice of tunnelling engineers and contractors around the globe. Examples of projects successfully completed with Enkadrain include the Gotthard Base Tunnel – the world's longest and deepest tunnel.

In addition, the Enka Solutions product portfolio for underground traffic infrastructure encompasses Enkadrain vibration damping mats.

If you are looking for economic, yet reliable flame retardant nonwovens for protection, separation or filtration, you will find the right product in the extensive Enka-Tex range.

The Enka Solutions product range consists of a wide range of geosynthetics and geotextiles designed to comply with the specific requirements of the most diverse tunnel construction challenges.

Please visit the Enka Solutions website at www.enka-solutions.com for technical details of selected products or contact your local Enka Solutions representative.

Functions

- Drainage
- Protection
- Vibration damping
- Separation
- Filtration

Application areas

- Bored tunnels
- Cut and cover tunnels

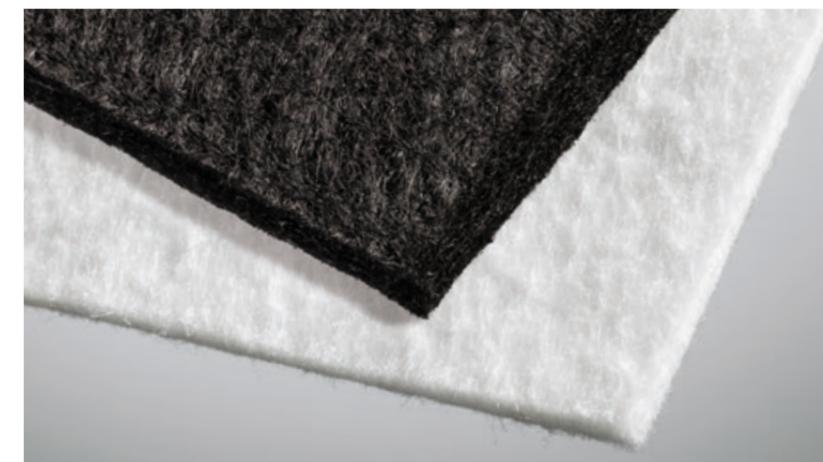
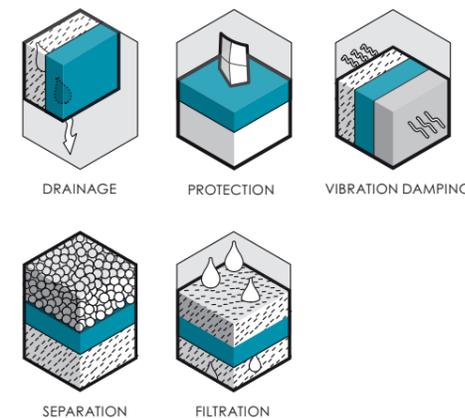
Advantages Enkadrain

- Combines the functions drainage, protection and filtration in one product
- High compressive strength, yet very flexible
- Certified durability and long-term performance
- Ease of handling and installation

Advantages Enka-Tex

- Excellent compression resistance
- High elongation at break
- Outstanding chemical resistance
- Thermal and mechanical bonding ensures superior performance at low weight

Product functions





Adfil construction fibres as well as Enka Solutions geosynthetics and geotextiles are manufactured by Low & Bonar. The Group is a global leader in high performance materials selling in more than 60 countries worldwide and manufacturing in Europe, North America and China. Low & Bonar designs and produces components which add value to, and improve the performance of its customers' products by engineering a wide range of polymers using in-house manufacturing technologies to create yarn, fibres, geosynthetics, industrial and coated fabrics and composite materials.

These materials contribute to a more sustainable world and higher quality of life.

The quality systems of Low & Bonar facilities have been approved to the ISO 9001 Quality Management System Standard. The Belgian plants where Adfil fibres as well as Enka-Tex are being produced are also ISO 14001 certified (Environmental Management).

Low & Bonar is listed on the London Stock Exchange.

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