



**KRAMPE HAREX®**

KNOW WHY.

## References

TUNNEL  
CONSTRUCTION

KNOW WHY  
**OUR FIBRES MAKE  
TUNNELS SAFER.**

AN  
UNBEATABLE  
COMBINATION:  
SAVE **TIME**  
& **REINFORCE**  
RELIABLY.

**40** years  
of steel fibre expertise

**5 – 10,000** tons  
any delivery quantity possible

Whether tunneling sequentially or using a TBM, KrampeHarex® supports tunnel builders with in-depth knowledge, technical solutions and services relating to all aspects of the reinforcement work – and all from a single source. **Our specialty:** a huge range of fibres for all project-specific concrete performance requirements. If desired, we can assist you with quality management of the shotcrete, in situ concrete or tubbings, too.

The specific addition of steel or polypropylene fibres can optimally enhance both fire protection and reinforcement properties. Based on structural and fire protection analyses, we can determine the safest and most cost-effective fibre content for your requirements. KrampeHarex® is your partner of choice for optimized fibre-reinforced concrete and rapid construction progress.

Because we know why.

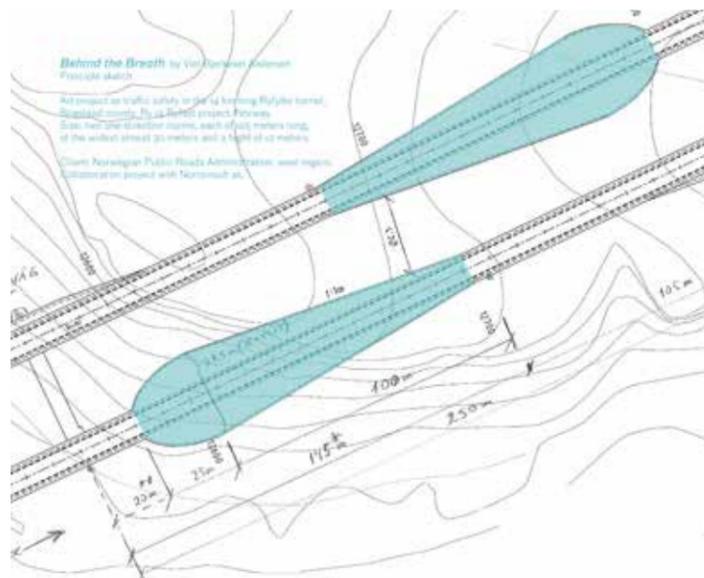
# IN SITU/SHOTCRETE FOR THE MOST EXTREME STRESSES.

When constructing a tunnel, shotcrete is often the most economical solution. Fibres from KrampeHarex® open up new possibilities for safe, long-lasting, time- and cost-saving tunnel construction. As the fibres are applied together with the shotcrete, there's no additional reinforcement work necessary. Fibre reinforced concrete is more robust, more crack-resistant and longer-lived than concrete reinforced with rebar.

## REFERENCE RYFYLKE TUNNEL IN NORWAY

**14.3 km long and up to 290 m beneath the sea:** the Ryfylke tunnel is the longest underwater road tunnel in the world. Over 14 kilometers long, cut off from the outside world – a test of the drivers' mental endurance. The visual monotony, the associated loss of orientation, the increasing feeling of confinement and fatigue can be highly stressful for travelers and negatively impact road safety.

The artist Viel Bjerkeset Andersen came up with an unusual idea for combatting tunnel monotony. The project was realized in collaboration with KrampeHarex® and the result is impressive.  
Photo below: ©Viel Bjerkeset Andersen 2020



»Every tunnel represents a new challenge. By providing the ideal solution and the correct fibres for fire protection and the required load-bearing capacity, we make an important contribution to safety.«

Dipl.-Ing. Wilhelm Nell  
Product and Business Development  
Manager, KrampeHarex®

### Blue Symphony of fibre reinforced concrete.

„In order to cope with a long tunnel, we need mental breaks.“ The Norwegian artist Viel Bjerkeset Andersen has contemplated the issue of tunnel anxiety for a long time. And for the Ryfylke tunnel, she came up with a groundbreaking concept: two enormous “breathing spaces” that are illuminated by sea-blue LED light punctuate the confinement of the tunnel halfway along. A welcome refreshing break for the travelers.  
Photo: © Viel Bjerkeset Andersen 2020

Up to **290** m  
beneath the seabed

**30** bar  
pressure

**14.3** km  
in length

# THE LONGEST & DEEPEST UNDERWATER TUNNEL IN THE WORLD.



**Construction project:** Ryfylke Road Tunnel  
**Steel fibre type:** DE 35/0.55 N  
**Concrete:** C 25/30 M40  
**Total volume:** 3,400 t of fibres

# »DEEP TUNNEL STORMWATER SYSTEM« DRAINAGE IN DUBAI SOUTH.

**490** km<sup>2</sup>  
drainage area

**1.3** billion  
total project volume

EXPO 2021 Area, Al Maktoum International Airport and the Smart City: a tunnel system for Dubai protects 40% of the urban area against flooding during the rainy season.

**36** months  
project duration

**40** %  
of the urban area

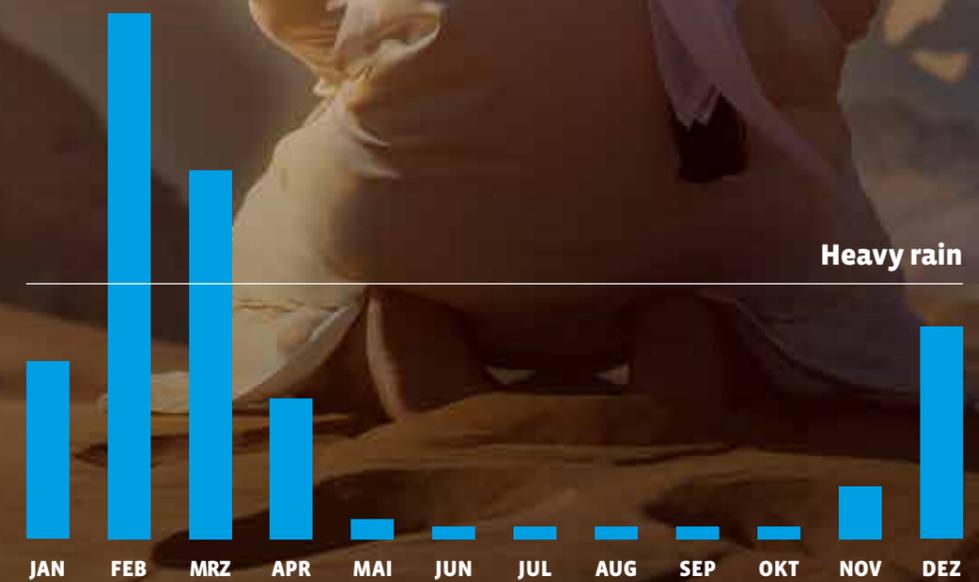
**2,600**  
drainage capacity in swimming pools

## An infrastructure project on a vast scale.

Dubai is renowned for its architectural feats. Now they're blazing a trail with a new superlative: The „Stormwater System“ and the central tunnel being constructed for it are setting new benchmarks below ground for drainage concepts. And: the massive project is scheduled to take just 36 months. To execute the project this quickly, Dubai's city council has recruited leading experts from international companies, including KrampeHarex® as technology partner for the steel fibre reinforced concrete.

The central tunnel is 10.4 km long and is being excavated by TBM. Due to the volume of water to be channeled, the tubbings being used here must be extremely durable. To this end, the concrete elements are being reinforced with steel fibre. A total of 5.000 tons of cold-drawn wire – supplied just in time by KrampeHarex.

In order to keep to the tight schedule, the supply chain and workflow must function flawlessly. So a factory was specially constructed on site to ensure sufficient tubbings are always on hand.



# DEEP TUNNEL: CENTRAL ELEMENT OF THE NEW DRAINAGE SYSTEM IN DUBAI.

**6.5** Mio. m<sup>3</sup>  
drainage capacity per day

**10.4** km  
length of tunnel

**125,000** m<sup>3</sup>  
fibre reinforced concrete

**45** m  
deep drop shafts

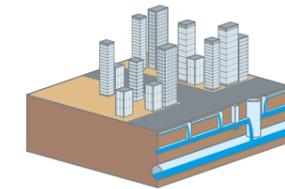
**Construction project:** Deep Tunnel Stormwater System Dubai  
**Concrete:** C55/67  
**Steel fibre type:** Steel fibre type: DE 60/0.9 H  
**Total volume:** 5,000 t of fibres



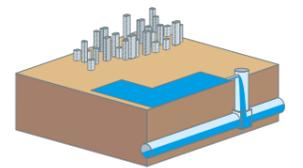
## REFERENCE STORMWATER SYSTEM DUBAI

**Our fibre for Dubai.** KrampeHarex®'s experience and research has shown that a type DE 60/0.9 H cold-drawn steel fibre is best suited for the planned concrete grade C55/67 with expected real 28-day compressive strength of >80 N/mm<sup>2</sup>. The benefits: high tensile strength of 1,900 N/mm<sup>2</sup>, optimal price/performance ratio and excellent workability: It doesn't have a tendency to clump or to float or settle out either.

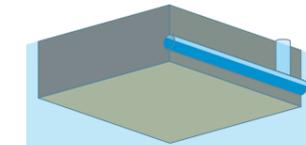
**5** Five elements make up the »Stormwater System«. The core element: the tunnel.



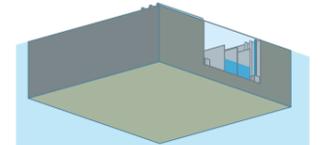
**1. Network of drains**  
The drainage system consists of 4 vertical shafts to the tunnel (each 20 m), 11 collection chambers, several micro tunnels (each 3 m) and numerous drainage channels.



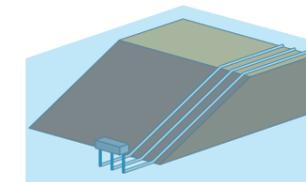
**2. Holding Pond**  
The artificial lake creates additional drainage capacity. Its surface provides space for thousands of solar panels for generating pollution-free power.



**3. Deep Tunnel**  
The 10.4 km long tunnel with a diameter of 11.05 m is being excavated by a tunnel boring machine at a depth of 45 m - while life in the city above continues undisturbed.



**4. Pumping Station**  
The pumping station can move 2,500 m<sup>3</sup> water per minute - about the volume contained in an Olympic swimming pool. The overall capacity of the system is the equivalent of 2600 pools.



**5. Sea Outfall**  
The water is pumped into the sea 1 km off the coast of Dubai. The gradient to the outfall as well as two kinds of pumps ensure that energy consumption is kept to a minimum.

# TUBBINGS GREATER RESILIENCE WITH FIBRES.

The tubbings used in tunnel construction, especially single-shell designs, must meet the highest of quality standards. The dimensional stability of the tubbings is crucial, as it has a significant influence on the stability, impermeability and lifespan of the tunnel, resilience to earth and water pressure and much more besides. Reinforcing the tubbings with fibre improves their quality in every respect.



»The long service life of civil engineering works represents sustainability in the best sense. Our fibres significantly increase the longevity of concrete – and it's something we're proud of.«

**Dipl.-Ing. Wilhelm Nell**  
Product- & Business Development  
Manager, KrampeHarex®

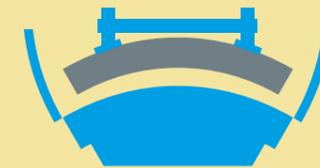
## Small fibres, great advancement.

The project-related demands made of concretes are becoming ever more complex and specific. Every tunnel project presents new material and civil engineering challenges. With its exceptionally broad and diverse spectrum of special fibres, KrampeHarex® can provide you with a reliable and economical solution for practically any requirement.

We regularly customize fibres for a particular use case in order to more exactly meet the engineering requirements. By choosing the material composition, type and size of the fibres specific to the application, we can precisely tune the properties of the final concrete mixture. Our decades of experience are your guarantee of long-lasting, dependable results.

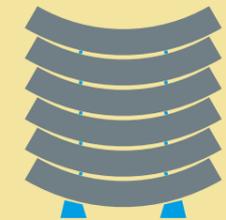
Most construction projects nowadays envisage a service life of 100 – 120 years. By supplying you with the ideal fibres for your tunnel project, we help you meet the strict criteria and conditions that apply.

## ADVANTAGES OF FIBRE REINFORCED TUBBINGS



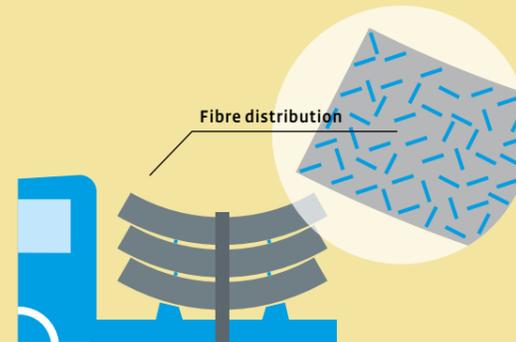
### Immediate load-bearing capacity.

The steel fibres are able to assume the important reinforcing function after just a few hours, thus allowing the tubbings to be lifted/removed from the formwork sooner.



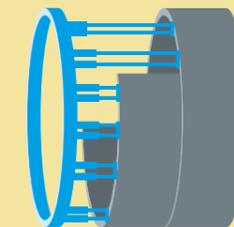
### Safe storage.

The exceptional strength of fibre reinforced concrete pays for itself at an early stage: No cracks and no chipped edges when stacking the tubbings.



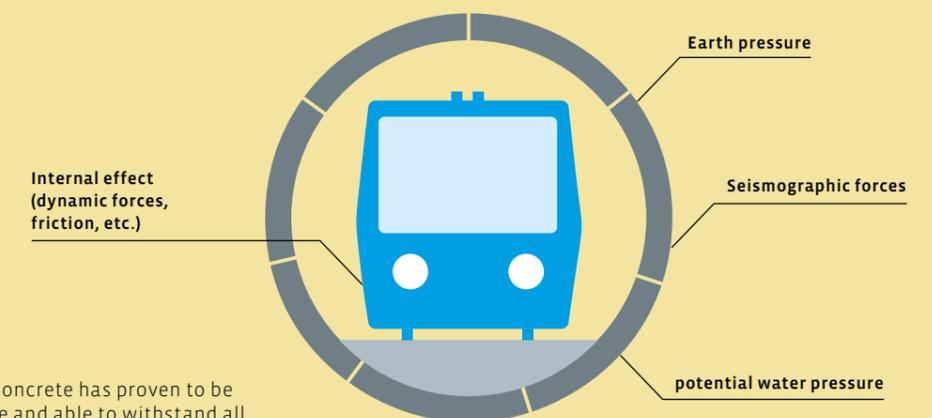
### Less transport damage.

The fibres are homogeneously distributed throughout the element, including in the edges. This makes the tubbings better able to withstand knocks and vibration during loading and transport.



### High strength during installation.

The elements are subjected to large forces during installation with a tunnel boring machine. Here too, the strength of the fibre reinforced concrete is of great benefit.



### Extremely robust.

Fibre reinforced concrete has proven to be extremely durable and able to withstand all the forces that act on it when the tunnel is in use, too. Moreover, the use of synthetic fibres results in passive fire protection.



**1<sup>st</sup>** In situ concrete rail tunnel with polypropylene fibres in Germany

**500** million fibres per m<sup>3</sup> of concrete

**100** % fire protection



Schlüchterner Tunnel



Polypropylene fibres

**Construction project:** Schlüchterner rail tunnel  
**Fibre type:** PM 6/32  
**Concrete:** regarding austrian standard (ÖNORM)  
**Fibres:** 80 t

# FIRE PROTECTION FROM END TO END.



»Systematically specializing in fibre technology has enabled KrampeHarex® to develop groundbreaking products. With them, we can open up new possibilities for our customers when it comes to tunnel construction.«

Dipl.-Ing. Wilhelm Nell  
Product- & Business Development Manager, KrampeHarex®

The addition of synthetic fibres can give rise to concrete with inherent fire retardant properties. KrampeHarex® polypropylene fibres have been optimized through years of development and refinement.

Independent tests\* prove that they reduce or completely prevent explosive spalling in case of fire.

(\*e.g. Gesellschaft für Materialforschung – German Materials Society)

**100** %  
Cost saving

## REFERENCE SCHLÜCHTENER TUNNEL

The first in situ concrete rail tunnel in Germany using polypropylene fibres.

Trains on the high-speed track between Frankfurt am Main and Göttingen travel at up to 280 km/h. The highest of standards when it comes to fire safety must be met here too.

Because of this, Deutsche Bahn decided to use synthetic fibres when renovating the 3575-meter-long Schlüchterner Tunnel. A practice that has long been commonplace in other European countries, and is even mandated in Austria, was a pilot project in Germany: The first in situ concrete rail tunnel in Germany using polypropylene fibres to enhance safety in case of fire.

The standards the fibre material had to meet were correspondingly high: for example, in addition to the type approval, tighter restrictions were imposed with respect to the permissible tolerance of the fibre diameter, as well. Whereas allowable tolerances for a polypropylene micro-fibre according to CE certification is normally +/- 10% for a 32 µm fibre (i.e. 28.2 to 35.2 µm), deviations of just +/- 2 µm (i.e. 30 to 34 µm) were permissible for the renovation of the old Schlüchterner Tunnel. A test certificate had to be submitted for each 500 kg batch.



# FIBRES THE ROOT OF STABILITY.

KrampeHarex® can help you realize your tunnel concept, too. Whether you're planning a local construction project or international mega-project, whether you need 5 or 10,000 tons of fibres: We're your partner of choice for stability and safety.



### Fibres for tubings

DE 60/0,9 H  
DE 60/0,9 M  
DE 60/0,8 M  
DE 60/1,0 H  
DE 60/0,75 N

### Fibres for shotcrete

DE 35/0,55 N  
DE 35/0,55 M  
DE 35/0,60 N  
DE 35/0,70 N  
DE 40/0,55 N  
DE 40/0,55 M



### Fibres for fire protection

PM 3/15  
PM 3/18  
PM 6/15  
PM 6/18  
PM 6/32



»Our fibres have been increasing the stability and durability of concrete for over 35 years. In order to ensure availability of supply at all times, we ourselves manufacture the wire used to make our fibres.

As such, we are not subject to the delivery periods of external vendors and can reliably meet even the most ambitious timings.«

Dipl.-Ing. Ulrich Krampe  
Managing Director,  
KrampeHarex®

# >17,000,000

km of drawn wire / yaer

### Expertise in every fibre.

As a world-renowned specialist and technology leader in the field of fibres, our satisfied customers include companies and property developers in 50 countries around the globe.

Thanks to our world-class expertise and outstanding service, we are earning greater recognition each day.

Our Service+ portfolio includes engineering, support, construction supervision, special solutions and metering unit rental service as well as exemplary quality management.

# 21

wire-drawing machines



100% green power in all processes



Highly efficient cross-sectional technologies



Environmentally friendly production and waste management



**KRAMPE HAREX®**

KNOW WHY.

## OTHER PROJECTS

### Musameer Pumping Station and Outfall Doha / Qatar

**Lenght:** 10 km  
**Fibres:** 1.400 t  
**Fibertype:** DE 60/0,9 H

### Cityringen Sydhavnen Copenhagen / Denmark

**Lenght:** 4,5 km  
**Fibres:** 1.000 t  
**Fibertype:** DE 60/0,8 M

### Highspeed 1 Stratford Tunnel London-Stratford / UK

**Lenght:** 4,7 km  
**Fibres:** 210 t  
**Fibertype:** PM 6/32

### Lysehortunnelen E39 Svegatjorn - Radalen / Norway

**Lenght:** 9,2 km  
**Fibres:** 2.600 t  
**Fibertype:** DE 35/0,55 N

### Cityringen Copenhagen / Denmark

**Lenght:** 15 km  
**Fibres:** 200 t  
**Fibertype:** PM 6/18

### Alter Kaiser- Wilhelm-Tunnel Cochem / Germany

**Lenght:** 4,2 km  
**Fibres:** 100 t  
**Fibertype:** PM 6/32

### Escape Tunnel Schürzeberg B27 Oberrieden / Germany

**Lenght:** 240 m  
**Fibres:** 20 t  
**Fibertype:** DE 30/0,8 N

### Deep Tunnel Sewerage System Singapore

**Lenght:** 12 km  
**Fibres:** 2.500 t  
**Fibertype:** DE 60/0,9 H

### Railway Tunnel Lodz Lodz / Poland

**Lenght:** 4,5 km  
**Fibres:** 135 t  
**Fibertype:** PM 6/18

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