

Line 3 of Metro Bulgarian Capital City Sofia Water Sealed, Waterproofed and Repaired

PROJECT

Sofia Metro

LOCATION

Sofia, Bulgaria

CUSTOMER

Metropolitan

CUSTOMER CHALLENGES

- Prevent leakage in joints of helical segments of tunnel construction and waterproof area between helical segments of tunnel construction and soil
- Reinforcement of a cracking retaining wall that supports the soil of the stations

SOLUTIONS

Injection resins (60.000 kg in total):

PC® Leakinject 2K Flex 6811 LV
 PC® Leakinject Uni 6816 E & EVL
 PC® 509 Rubber Acryl

CFRP (400 m):

PC® Carbocomp Plus
 PC® 5800 BL

Work joints (20.000 m):

PC® Elastoswell 20x10mm
 PC® Injectra



Increasing population and related citizen traffic imposed the Bulgarian capital city Sofia to realize an extensive metro system. In 2016, the construction works started on Line 3, the final phase, connecting Botevgradsko shosse with Ovcha Kupel 1 neighbourhood in south-western. When completed, line 3 is expected to expand to a total 16 km in length, with 19 stations, bringing the network to 56 km of lines and 53 stations by 2020, able to carry around 1,2 million passengers daily. This places it among the top 30 of the most extensive European metro systems.

The construction of the metro tunnels has its own specific challenges as Sofia is a city with more than 2.000 years of history, with several archaeological layers and diverse geological and tectonic conditions. There are also two main ground water levels, and tunnel 3 is built beneath the already existing Line 1 and under the Perlovska river. The tunnel was therefore constructed with TBM machines by the Turkish company Dogush. During the construction of the tunnels and stations, water leakage and seepage appeared which needed to be blocked, and the expansion and construction joints were to be sealed. This was indispensable as any leakages may prevent the further development and use of the tunnels and stations. Bulgarian Metropolitan-Sofia JSC, a company owned by Sofia Municipality and the operator of the entire metro system, engaged a trusted contractor for the water sealing, waterproofing and injection works in the stations and the tunnels connecting the stations.



PC® Elastoswell

CONTRACTOR QUOTE

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“The quality of Tradecc’s products is outstanding. Add this to their chemical and technical support and knowledge, and you understand why we have been working with their chemical construction products for more than 10 years. It was only logical to use them for the structural repair, the water sealing and waterproofing of the Sofia Metro”

Holding back the water

After construction of the helical tunnel segments there was strong water seepage (30 liters per minute) coming through the joints of the helical segments that needed to be blocked. The contractor used several injection resins to resolve this problem. First, the water seepage was stopped with

PC® Leakinject UNI 6816 (E and EVL), a low viscosity single component water reactive polyurethane injection resin. Because of the low viscosity, this PU foam penetrated deep into the cracks of the tunnel segments. Thanks to the quick and high expansion ratio it sealed all water penetration.

To obtain the optimal water sealing properties of the construction, this product was combined with **PC® Leakinject 2K Flex 6811 LV**, a two-component polyurethane injection resin that also has very low viscosity. It is perfect to seal very fine cracks, has excellent adhesion properties to concrete, is elastic/flexible, does not swell in contact with water and does not dry out.

Finally, the contractor applied **PC® 509 Rubber Acryl**, an elastic five-component acrylate injection resin, between the tubing elements of the tunnel and the retaining walls of the stations. With this product, the initiator is dissolved in a strengthening polymer blend, leading to excellent physical properties of the gel. The product was chosen because of its outstanding cohesion upon swelling, good stability, high water retention capacity, superior tear strength and outstanding behavior through wet-dry cycles.

The contractor also performed waterproofing work in the Sofia metro. In the middle of the construction joints of the stations, they applied around 20.000 meters of **PC® Elastoswell**. This swell strip was selected because of its exceptional elastomeric

properties that are maintained in a maximum swelling state. It keeps its shape without splitting or cracking, has outstanding re-swelling performance in wet-dry cycles and good swelling capacities in highly alkaline and salty environments.

Simultaneously the contractor equipped the construction joints with around 20.000 meters of **PC® Injectra**. The injection hose PC® Injectra has a porous structure with cells that are mutually connected and open under pressure of the injected resin, providing a very effective sealing of the joint. The water-repelling coating prevents the penetration of concrete milk coming from outside. The injection hose and pressure hose are connected with an easy push-and-pull 90° hook connection.

Holding back the soil

The contractor was also engaged for the structural repair of a small part of the metro. After construction of the tunnel, small cracks were detected in a retaining wall that supports the soil. To repair the cracks and to reinforce the structure the contractor applied 400 meters of Tradeccs **PC® Carbocomp Plus**, according to the design prescriptions. This patented epoxy multidirectional carbon fibre laminate was anchored with bolts in the concrete to increase the load bearing capacity. The laminates have high tensile strength and stiffness, a low weight and creep, are flexible in use and large lengths can be installed easily. Because of the excellent corrosion, acid and alkali resistance the laminates have a very high durability, which is ideal for use in the metro tunnel of Sofia. To glue the laminates to the concrete **PC® 5800/BL**, a two-component solvent-free epoxy glue, was used.

Thanks to the chemical construction products of Tradecc the passengers that will take the metro line will be safe and dry in the years to come.