# Mapei's London Underground Bank Station's Capacity Upgrade

*By Enrico Dal Negro, Stefano Anzani, & Steven Price*

Deep in the heart of London's financial centre, work has been continuing to make one of the world's largest stations safer and easier for passengers to use. Finding your way around the existing labyrinth of tunnels, connecting five London underground lines, is a task worthy of the most experienced navigator.

*Fig. 1: Waterproofing System Application*

Banks Station Capacity Upgrade (BSCU) was a project driven by London Underground Limited (LUL) and delivered by Dragados to increase the capacity of the already busy station whilst transforming the experience of commuters and making navigation both safe and easy.

An ambitious and complex project, the Bank Station upgrade has increased the station's capacity by 40%. It includes a new railway tunnel and a wider southbound platform for the Northern line; step-free access to the Northern line for the first time, and improved step-free access to the DLR platforms; new station entrances, interchange routes, moving walkways, lifts, and escalators; and approximately 1400 m (4600 ft) of new tunnels. The installation spanned a tunnel surface of approx. 24,000 m² (260,000 ft²).

The waterproofing system (Fig. 2), which was developed by Mapei UTT in collaboration with Dragados, Dr. Sauer & Partners, and Transport for London, consisted of a low-dust, regulating layer of Mapegrout Gunite FSD and spray-applied Mapelastic TU System. The solution was also used to waterproof reinforced concrete works in areas including shafts.

Mapegrout Gunite FSD (Fig. 3 and Fig. 4) is a fast-setting, ready-to-use fiber-reinforced cementitious mortar developed for concrete, stone, and masonry structures including tunnel linings, shafts, and foundations. It provides

*Fig. 2: Waterproofing System Application*

*Fig. 3: Mapegrout Gunite FSD*

excellent bonding strength and speed of application with low dust emissions. The waterproofing membrane, Mapelastic TU System (Fig. 5), is a one-component, ready-to-use sprayable synthetic membrane developed for tunnels and underground structure waterproofing. Featuring excellent tensile strength and adhesive properties, the membrane creates a flexible, seamless waterproofing barrier and can be used in new tunnels and to replace existing systems. Other Mapei products specified included two fast-drying hydraulic binders: Lamposilex (a water plug) and Topcem for final screeding layers; and two paint finishes: Silexcolor (a silicate-based, vapor-permeable protective paint) and Mapecoat ACT (a mold, virus, and bacteria-resistant cleanable enamel paint).

Tunneling operations commenced in late 2016 and lasted into 2020. One major decision common to all tunnel construction projects is how to control water ingress. There are many papers written that highlight the importance of water management; options range from fully drained

systems to fully watertight systems with pros and cons on both sides of the argument.

Given the required design life for the station, the decision was made to install a system that provides a fully watertight solution; this decision was also made because the design is an integral part of the structure and will provide a maintenance-free service life.

A key consideration for this approach was constructability, as well as the health and safety of the workers. The upgrade project includes shotcrete-lined tunnels with varying profiles. The single point of access prohibited complex scaffolding that would restrict vehicle movements within the tunnel construction. (Fig. 6 & Fig. 7)

*Fig. 4: Preparation of Mapegrout Gunite FSD*

*Fig. 5: Mapelastic TU System Application*


*Fig. 6: Nozzlemen at a tunnel entrance*

*Fig. 7: Tunnel with lift and equipment*

In 2016, an application was made to London Underground for inclusion in their approved product register, and in February 2017, the product was authorized for use in London's deep tunnels network.

Following a detailed technical assessment and review of the system by Dragados and the technical consultant, Dr. Sauer and Partners, a Mapelastic TU System was selected for waterproofing the SCL tunnels at BSCU. A key point for the successful installation was a complete knowledge of the requirements of the system and the application of the product. To achieve this, a training course was developed for both engineers and applicators which consisted of technical theory and practical application.

The first training for the Mapelastic TU System was provided at Mapei's London Specification Center, a purpose-designed space in the heart of London for presenting systems and solutions from the Mapei product line.

The training was then delivered on-site to all workers, with an emphasis on the safety and well-being of the crews as well as the technical performance of the system.

With trained personnel readily available, planning was less challenging, and utilization was tailored to match other construction operations, all of which made an efficient overall program of construction.

Like all systems, the key to a successful application is in the preparation. The SCL surface condition was defined and accepted, the material consumption rates were calculated, and the as-placed sections checked for correct thickness. The system was applied in two layers to ensure complete coverage; additionally, the product was manufactured in 2 contrasting colors: a light bluish-green and a white (Fig. 10).

A unique point of the system was the use of airless spray technology. This provided two distinct advantages:

*Fig. 8: Nozzleman applying Mapegrout Gunite FSD*

*Fig. 9: Application*

*Fig. 10: Nozzleman applying waterproofing layer*

*Fig. 11: Full tunnel view with waterproofing*

firstly, compressed air was readily available on the project and enabled the use of reliable, robust air-driven pumps; secondly, the direct airless placement of the Mapelastic TU System product led to zero rebound and minimal waste.

Zero rebound and the water-based safe formulation were major steps forward for the applicators, and this was a key factor in the decision to use the system. In 2018, Mapelastic TU System design and application in BSCU won the New Civil Engineer (NCE) Tunnelling Award in the Safety category.

As well as safety, spray-applied systems offered other benefits to the project. Complex geometry was easily waterproofed, and the fully bonded monolithic construction allowed a reduction in final lining thickness; this resulted in lower costs on materials and a significant reduction in $CO_2$ emissions. The spray-applied solution was also designed to work with an adjacent, loose-laid PVC waterproofing system thanks to a special transition element. In this way, a hybrid waterproofing system was designed in the newly constructed or rehabilitated tunnels to exploit the different characteristics and performances of both systems.

BSCU has taken many innovative ideas and put these into practice by paving the way for better tunnel construction; waterproofing is just one small part, but it will change the future.

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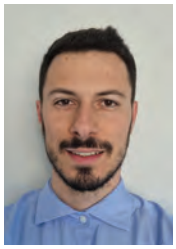

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