



## The “Lilac” Line Forges Ahead

The new underground railway line is just a part of the expansion project for Milan’s large infrastructure network ahead of the upcoming Expo 2015

# M5

BIGNAMI

Ponale

Bicocca

Ca' Granda

Istria

Marche

Zara

2007

2013

Milan's M5 underground railway line is a prestigious "work in progress", and is forging ahead in order to be complete and ready for Expo 2015. This part of the project, with Mapei as always right there in the front line, is divided into two lots: the stretch from Bignami to Garibaldi (at the time of going to press running as far as Zara) and the stretch from Garibaldi to the San Siro Stadium (currently at the executive stage). When it eventually operates at full regime, the M5 alone will lead to a reduction of 5 million private car journeys per year.

### Underground Works

After already taking part in work on the M1 red line, the M2 green line and the M3 yellow line, it is now the lilac line's turn to benefit from the collaboration of Mapei. The new line will have 19 stations along a 12.6 km stretch. It will be a light railway line, that is, completely automated with no conductor or fixed operators, with just a few floating operators.

### Cutting-edge Solutions

The tunnels have been constructed using two different techniques. Part of it has been excavated using a 9.4 metre diameter Lovat Tbm (Tunnel Boring Machine), and then lined with prefabricated blocks. The other part has been excavated using traditional techniques and the lining (primary support) includes the installation of hundreds of metal ribs and a layer of shotcrete, followed by an inverted arch finishing layer and protective lining. Numerous Mapei products have been used on

this important site. To condition the soil during the mechanical excavation work, POLY-FOAMER FP foaming agent and the polymer MAPEDRILL M3 were used. To repair the prefabricated concrete stones forming the ceiling of the tunnel, MAPEGROUT T60 and MAPEGROUT LM2K were used after protecting the steel reinforcing bars with MAPEFER 1K, while to smoothing the concrete, the choice went to MONOFINISH mortar.

### Mobile Works

Over the last few years, the technology of concrete has reached such innovative quality and performance levels that dedicated mix-designs can now be formulated to not only help solve the problems of complying with UNI-EN standards, but also and above all as a support to specific design requirements regarding the execution of complex constructions, such as viaducts, bridges, tunnels and large buildings. And all this with one aim: to extend the service life of reinforced cement constructions. The jewel in the crown of the technical assistance provided by Mapei, which goes much further than simply supplying products, is their fleet of mobile laboratories. The dedicated technical support, with their well-equipped vans, is able to carry out a multitude of wet tests directly on site, including sampling, various test methods to measure consistency, the preparation of samples, evaluating air and water content and density. And all this according to the most recent specific UNI-EN standards. This safe, reliable technical consultancy service is available to manufacturers of concrete to enable



### IN THE SPOTLIGHT MAPEPLAN TU S

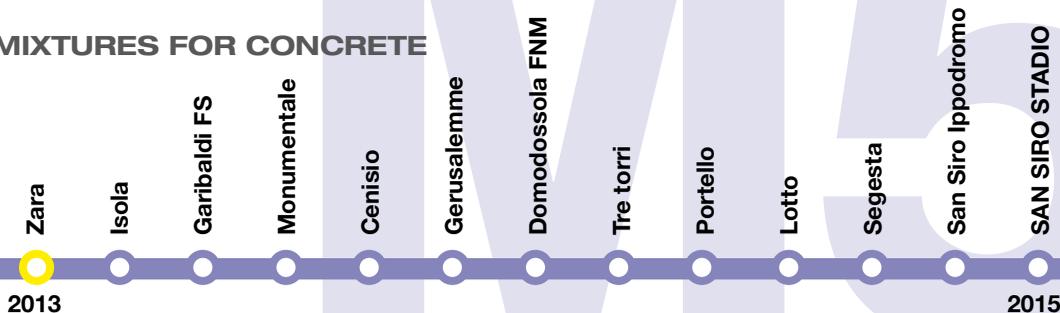
It belongs to the range of synthetic PVC-P waterproofing membranes that, thanks to the use of exclusive "multi-extrusion coating" technology, offer high performance characteristics and durability. It is used particularly in drill and blast tunnel, open cut tunnel and underground structure. This and numerous other high-tech products are marketed by Mapei as part of our UTT category, which stands for "Underground Technology Team". For further information see the website [www.utt-mapei.com](http://www.utt-mapei.com)

**FACING PAGE.** The purple logo of the Milan underground M5 line outside the entrance of a station along Viale Fulvio Testi.

**ON THIS PAGE.** Two phases of the construction of the tunnels (photos courtesy of M5 S.p.A.).



# M5



them to mix cementitious conglomerates that provide an efficient response in terms of final use, transport and application times and the logistics for mounting formwork and handling all the steelwork required. The Mapei team has provided support for their clients during every single phase of the execution of this project, from the design of the concrete mixes, to the qualification of materials on site, right up to quality control of the concrete mixes once they have been applied. A highly professional service, with technicians experienced in managing sites of this dimension.

## The Admixtures

To mix the concrete, two families of high concentration, polymer-based super-plasticising admixtures have been used, depending on specific design requirements and/or the raw materials available: DYNAMON SX (SX 32 and SX 34) and DYNAMON SR (SR1 and SR 912/914). They are all based on DPP (Designed Performance Polymer) technology, a new chemical process which, through total monomer design (know-how exclusive to Mapei), allows the characteristics of the admix to be modulated according to the specific performance requirements of the concrete employed. Because of its high workability, concrete made with this type of admixture is easy to apply while fresh and offers high mechanical performance when hardened. The products from the Dynamon family are also part of the Real (Robustness Enhancing Admixture

Line) category of admixtures for concrete: lower water/cement ratio, higher mechanical strength, extended maintenance of workability, easily pumped with no segregation or bleeding.

## UTT Line

Large underground works, and tunnels in particular, offer specific challenges due to their considerable complexity during both the design phase and the executive phase. This type of work is often carried out in extreme conditions and requires the skill of specialised technicians who, thanks to their vast experience, have the ability to handle unforeseen problems and guarantee that work progress quickly and according to specification. Technicians that have the backing of a range of high-tech products produced and marketed by Mapei under the UTT category, which stands for "Underground Technology Team". MAPEPLAN TU S is also part of this family, a range of synthetic PVC-P waterproofing membranes that, thanks to the use of exclusive "multi-extrusion coating" technology, offer high performance characteristics and durability. One of the fundamental characteristics of this product, which has been used here to waterproof the tunnels and stations, is its excellent workability and weldability. Hot welding in particular causes the molecular chains to melt and fuse together to form a bond that is resistant to the pressure of water and mechanical stresses.

**ON THIS PAGE.** Now work on the stretch between Bignami and Zara has been completed, headway is being made on M5 line from Zara to the San Siro Stadium. Work should be completed in time for Expo 2015.

## Technical data

### M5 Underground Railway Line, Milan

**Period of Construction:** ongoing since 2007 (work scheduled to be completed in 2015)

**Period of Intervention:** ongoing since 2007

**Intervention by Mapei:** supply of admixtures for concrete, waterproofing products from the UTT division and on-site technical assistance with our fleet of mobile laboratories

**Client:** Milan City Hall

**Concession:** M5

**Milan City Council Director:** Francesco Tarricone

**Works Manager:** Stefano Perotti (Ingegneria SPM, Milan)

**Safety Coordinator (Design phase and Executive phase):** Gabriella Ablondi (Ingegneria SPM, Milan)

**Consortium Contractors:** Astaldi SpA (Consortium Lead), Alstom Ferroviaria SpA, AnsaldoBreda SpA, Ansaldo Trasporti Sistemi Ferroviari SpA and Azienda Trasporti Milanesi SpA

**Mapei Co-ordinators:** Gianluca Bianchin, Alessandro Boscano, Pietro Lattarulo and Massimo Seregini, Mapei SpA

## Mapei products

### Admixtures for concrete:

Dynamon SX 32, Dynamon SX 34, Dynamon SR1, Dynamon SR914, Dynamon SR912

**Ground conditioning:** Mapedrill M3, Polyfoamer FP

### Restoration and smoothing of concrete:

Mapegrout T60, Mapegrout LM2K, Mapefer 1K, Monofinish

### Waterproofing:

Mapeplan TU S

**For further information see the websites [www.mapei.com](http://www.mapei.com) and [www.utt-mapei.com](http://www.utt-mapei.com)**

