TUNNEL AND UNDERGROUND WATERPROOFING WITH MAPEPLAN SYSTEM

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KURORTNYY PROSPEKT, TUNNEL N° 5
Sochi - Russia

HONG KONG MTRC822

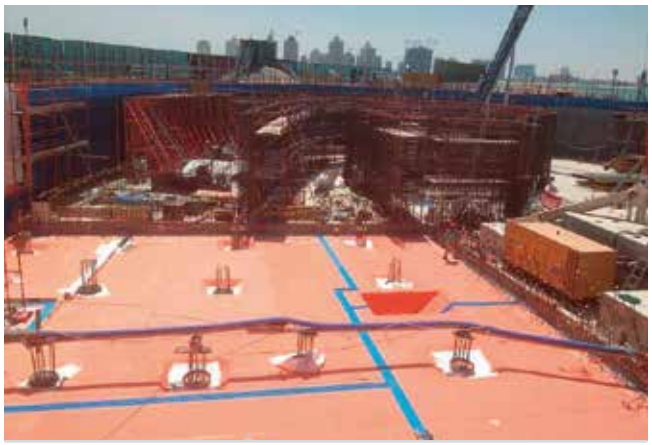
PEDEMONTATNA VENETA
Brogliano - Vicenza (Italy)

LILLIAN TOWER FOUNDATION
Dubai - UAE

INDEX

1. APPLICATION AREAS

APPLICATION FIELDS	DESTINATION USE	
DRILL AND BLAST TUNNELS	ROAD TUNNELS	WATER TUNNELS
CUT AND COVER TUNNELS	METRO TUNNELS	FOUNDATIONS
UNDERGROUND STRUCTURES	RAIL TUNNELS	METRO STATIONS



Foundation (Pearl Maison - Doha - Qatar)

Metro Station (Riyad Metro Line 3)

Road Tunnel (Turecky Tunnel - Slovakia)

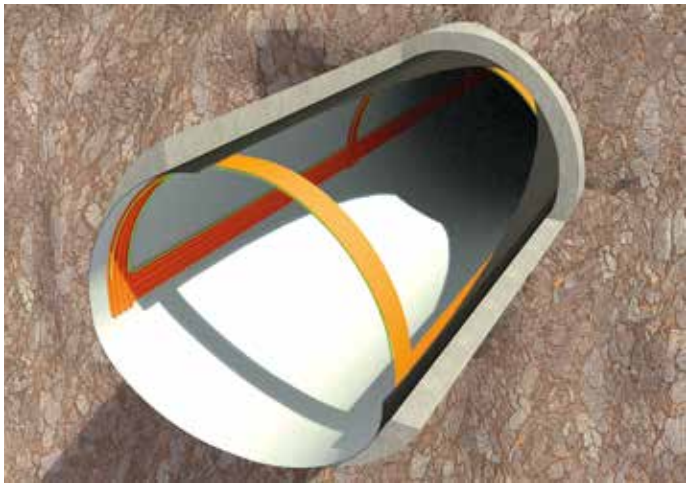
Metro Tunnel (Farringdon station - Crossrail project - London (UK)

2. CONSTRUCTION TYPOLOGIES

DRAINED TUNNELS (UMBRELLA SYSTEM)

- Permanent drainage concept
- Standard waterproofing system

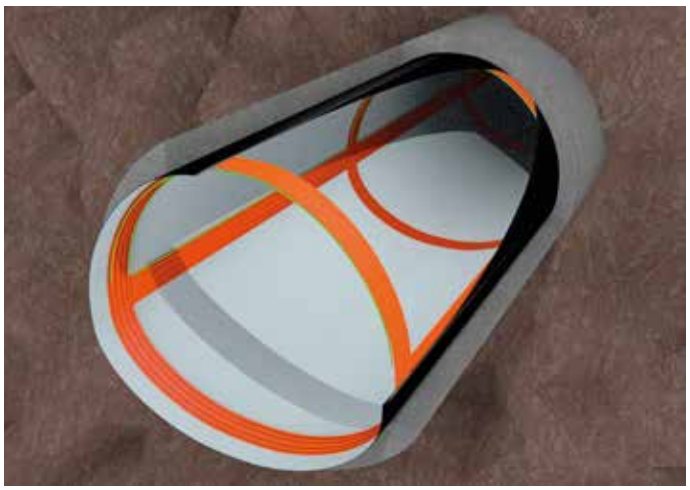
TUNNEL AUTOPISTA LLANO,
Bogotá - Villavicencio, Colombia



UNDRAINED TUNNEL (FULL ROUND SYSTEM)

- Top level of waterproofing system
- Environmentally friendly
- No influence of water table after construction

FARRINGDON STATION, Crossrail project
London (UK)



3. WATERPROOFING SYSTEM

3.1. PRE-INJECTION SYSTEM IN PRESENCE OF WATER

In presence of high water table pre-injection operations are required to prevent the water inflow and allow the installation of waterproofing membrane.
The choice of products is carried out according to the following parameters:

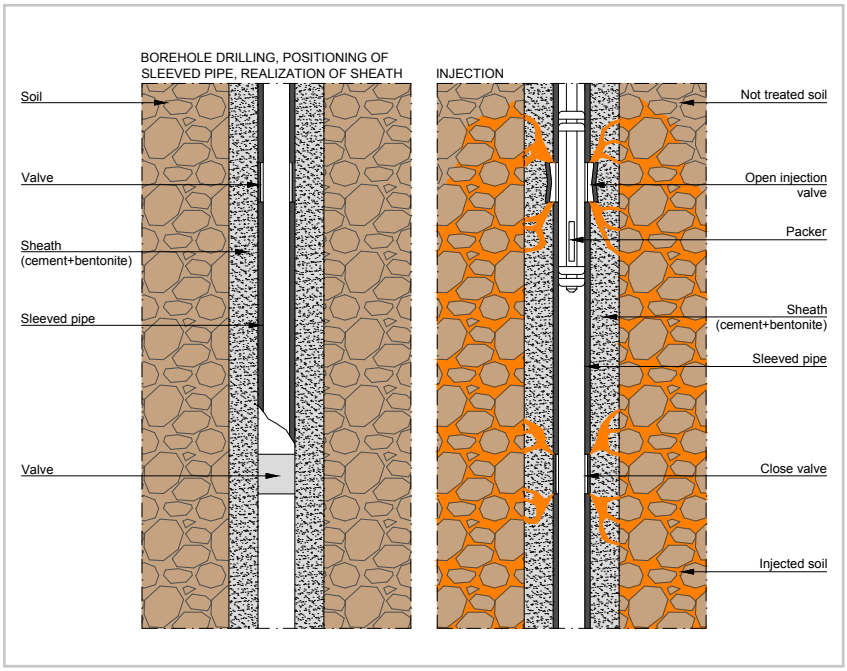
- Soil permeability
- Water content
- Post-injected soil mechanical characteristics required

A fully range of injection products has been developed by Mapei's laboratories in order to match needs and requirements of different jobsites*.

**find all products range and field of application in specific injection synoptic table.*

PRE-INJECTION CONCEPT

Turin subway: bottom slab waterproofing



3.2. SYNTHETIC WATERPROOFING MEMBRANE

3.2.1. RAW MATERIALS

- PVC-P (polyvinyl chloride)
- FPO (flexible polyolefin)

According to the worldwide experiences (> 50 years) the nowdays most used polymer is the PVC-P with a life expectancy higher than 100 years.
Mapei has developed in its own laboratories high performance PVC-P and high flexible FPO membranes.

3.2.2. MAPEPLAN PVC-P AND FPO MEMBRANES: MAIN CHARACTERISTICS

PVC-P	FPO
Signal layer or innovative warning layer	Signal layer
High workability and good welding characteristics	High workability and good welding characteristics
High resistance to root action and microbiological attak	High resistance to root action and microbiological attak
High flexibility at low temperature	High flexibility at low temperature
High resistance to stray currents	High resistance to stray currents
High resistance to ageing	High resistance to ageing
Self-extinguish	Self-extinguish
Suitable contact with both alkaline and acidic water	Suitable contact with both alkaline and acidic water
Radon - proof	Radon - proof
Excellent dimensional stability	Excellent dimensional stability
High mechanical resistance	High mechanical resistance
It can be applied on damp substrates	It can be applied on damp substrates
Formulation without dangerous or harmful substances for human health and the environment	Formulation without dangerous or harmful substances for human health and the environment
High resistance to permanent pressure	Excellent resistance to ageing
Explosion resistance	Formulation without plasticizer

INNOVATIVE WARNING LAYER CONCEPT *

The thinner warning layer concept allows for the easier detection of any damage, even when minimal. Such damage may occur during the installation and/or during all of the subsequent working phases. Thus it helps safeguard the integrity of the whole waterproofing system.

INTRODUCTION AND PURPOSE OF THE STUDY

The purpose of the study was to compare the resistance to abrasion (according to UNI EN ISO 5470-1) of two PVC-P waterproofing membranes. Namely, MAPEPLAN TU 20 (2.0 mm thickness with an orange signal layer of 0.4 mm nominal thickness) and MAPEPLAN TU WL 20 (2.0 mm thickness with warning layer of <0.20 mm nominal thickness). The following equipment was used to highlight the different physical and mechanical properties and performances.

Abrasion test equipment

1. ABRASION TEST, LABORATORY EQUIPMENT

The Taber abrasion equipment used for the test consists of:

- Support,
- Sample holder,
- Circular plate,
- A pair of swinging arms onto which abrasive wheels can be fixed,
- Motor for rotating the sample holder in the plane of its surface,
- Rev counter,
- Device for automatic stopping after a set number of laps (600 revolutions)
- Suction device for removal of the waste.

2. ANALYSIS OF RESULTS

The data analysis shows similar behaviour between the two membranes with respect to mass loss. The membrane MAPEPLAN TU, on average, loses about 0.24 g after 600 revolutions. The membrane MAPEPLAN TU WL, on average, loses about 0.21 g after 600 revolutions. The two different membranes, while showing comparable mass losses near the surface. However, they exhibit a significantly different visual characteristic in the underlying black layer (see Pictures below).

Test results

3. CONCLUSIONS

The resistance to abrasion assessment according to UNI EN ISO 5470-1 of the two membranes MAPEPLAN TU and MAPEPLAN TU WL shows a similar performance (similar mass loss). However, by applying the same mechanical action (600 revolutions) to the MAPEPLAN TU WL it is far easier to detect damage to the membrane surface.

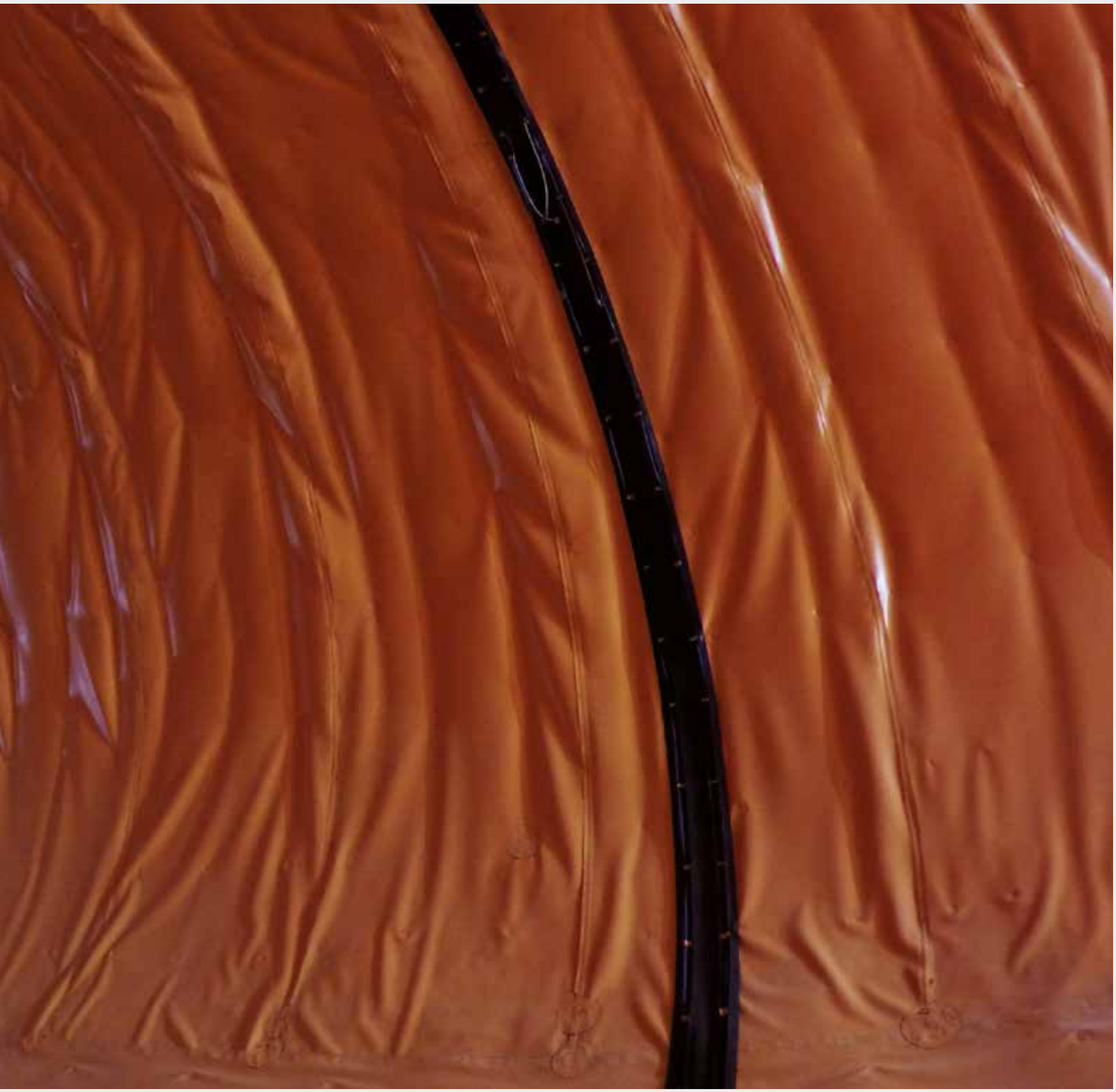
3.2.3. STANDARD AND TESTS

In order to provide CE certification, all MAPEPLAN products for tunnel & underground structures are tested according to EN 13491 and EN 13967 standards: “Geosynthetic barriers – Characteristics required for use as a fluid barrier in the construction of tunnels and underground structures”.

PROPERTY TO BE TESTED		TEST METHODS
Physical Properties	Thickness	EN 1849-2
	Mass per unit area	EN 1849-2
Hydraulic Properties	Water permeability (liquid tightness)	EN 14150
Mechanical Properties	Tensile strength	ISO R 527
	Elongation	ISO R 527
	Static Puncture	EN ISO 12236
	Burst Strength *	EN 14151
	Tear strength *	ISO 34
Thermal Properties	Low temperature behaviour (flexure) *	EN 495-5
	Thermal expansion	ASTM D 696-91
Durability and Chemical Resistance	Weathering *	EN 12224
	Micro organisms *	EN 12225
	Oxidation	EN ISO 13438
	Environmental stress cracking	ASTM D 5397-99
	Chemical resistance *	EN 14414
	Root penetration *	CEN/TS 14416
	Reaction to fire	EN ISO 11925-2

*relevant to specific conditions of use

CROSSRAIL PROJECT - Farringdon Station - London (UK)



3.2.4. SYNTHETIC WATERPROOFING MEMBRANES SYSTEMS

MAIN WATERPROOFING SYSTEMS

SYSTEM	CONSTRUCTION TYPOLOGIES		
	DRAINED TUNNEL (UMBRELLA SYSTEM)	UNDRAINED TUNNEL (FULL ROUND SYSTEM)	FOUNDATION
1L WS SYSTEM	☐		☐
1LP WS SYSTEM	☐	☐	☐
2LP WS SYSTEM		☐	☐

Intermediate solutions are available and can be developed by MAPEI technical supervisors in order to supply all technical requirements of a specific project.

1L WS - 1 LAYER / WATERSTOP
1L Single layer waterproofing membrane
WS Waterstop
Re-injectable hoses

1LP WS – 1 LAYER / PROTECTION / WATERSTOP
1L Single layer waterproofing membrane
P Protection layer
WS Waterstop
Injection valve / Injection hose

2LP WS - 2 LAYER / PROTECTION / WATERSTOP (VACUUM SYSTEM)
2L Double layer waterproofing membrane
P Protection layer
WS Waterstop
Injection valve / Injection hose

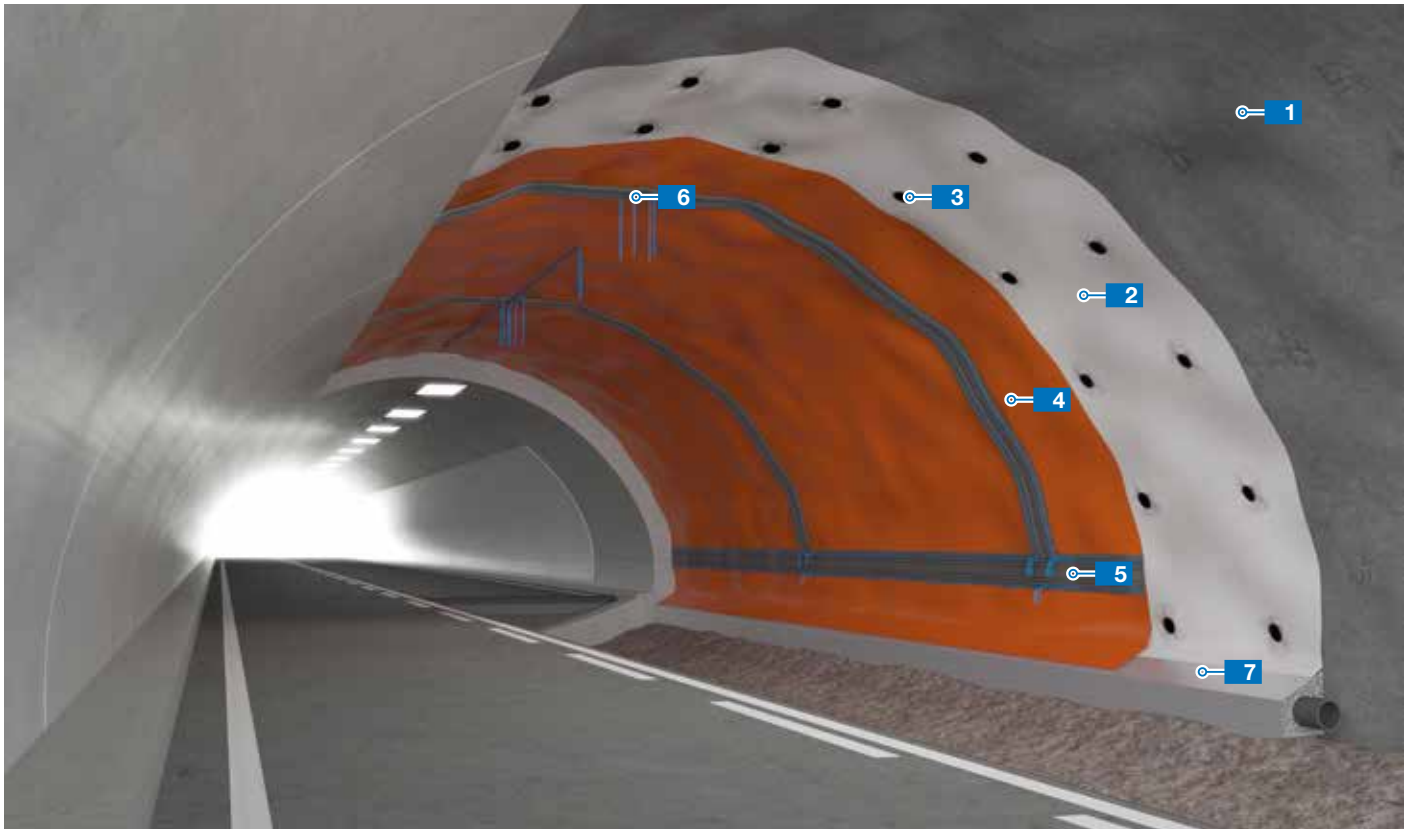
1L WS - 1 LAYER / WATERSTOP

ADVANTAGE:

- Primary compartmentalization

STRATIGRAPHY:

1. Substrate
2. Regularization layer - POLYDREN PP
3. Fixing disk- MAPEPLAN DISK
4. Waterproofing membrane - MAPEPLAN
5. Rebend connection - WATERSTOP
6. Back-up injection system (re-injectable hoses + end box) - IDROSTOP MULTI + MAPEPLAN END BOX
7. MAPEPLAN drainage profile



1LP WS – 1 LAYER / PROTECTION / WATERSTOP

ADVANTAGES:

- Primary compartmentalization
- Injectable compartmentalization

STRATIGRAPHY:

1. Substrate
2. Regularization layer - POLYDREN PP
3. Fixing disk - MAPEPLAN DISK
4. Waterproofing membrane - MAPEPLAN
5. Protection layer (confinement of injection) - MAPEPLAN PROTECTION
6. Injection valve + injectable hoses - MAPEPLAN INJECTION VALVLE
7. Colleting - MAPEPLAN END BOX
8. Rebend connection - MAPEPLAN WATERSTOP

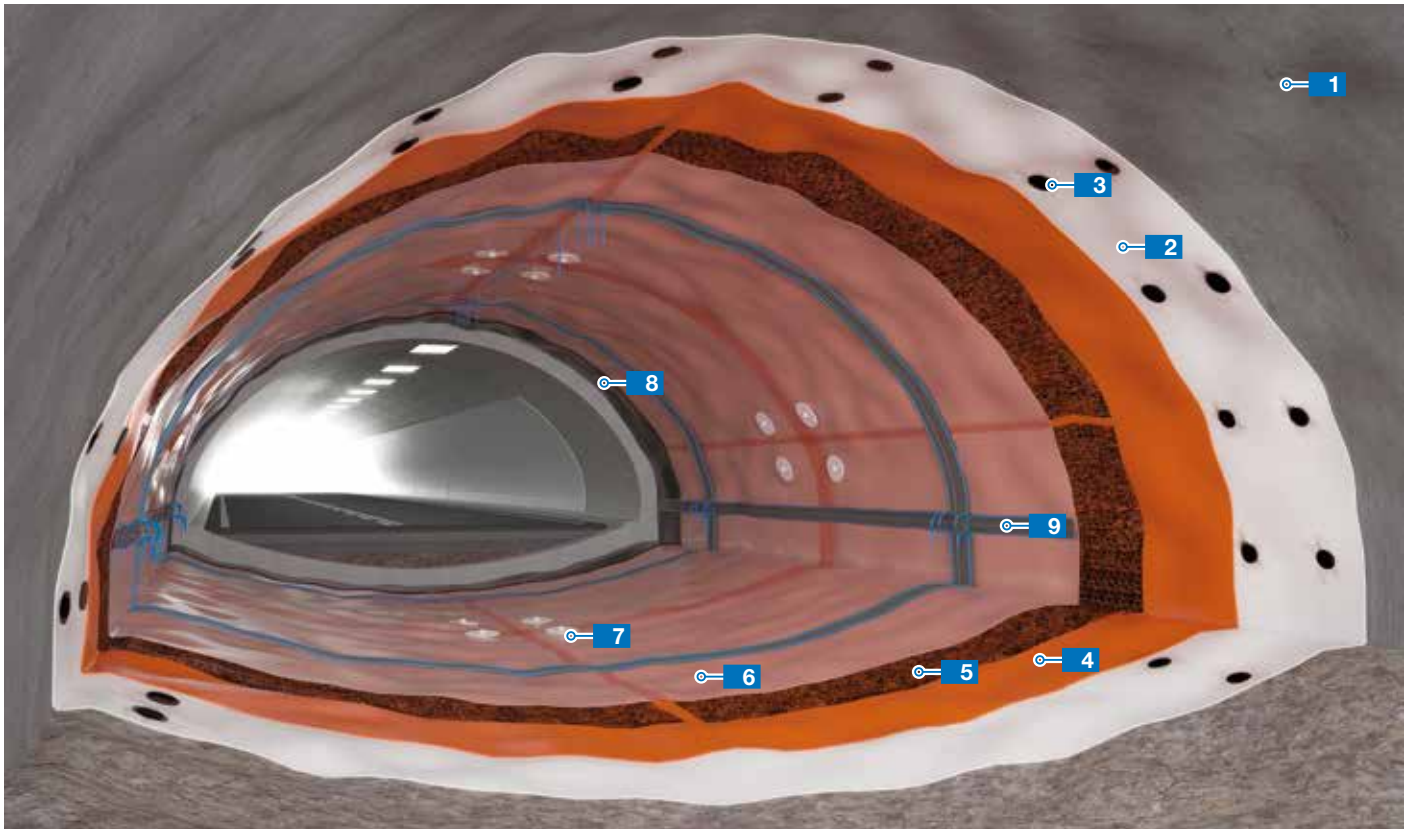
2LP WS - 2 LAYER / PROTECTION / WATERSTOP (VACUUM SYSTEM *)

ADVANTAGES:

- Primary compartmentalization
- Injectable compartmentalization
- Testable before and after the realization of final lining (vacuum system)

STRATIGRAPHY:

1. Substrate
2. Regularization layer - POLYDREN PP
3. Fixing disk - MAPEPLAN DISK
4. Waterproofing membrane - MAPEPLAN
5. Separation layer – MAPEPLAN SEPARATION LAYER (or MAPEPLAN TU ST embossed membrane)
6. Waterproofing membrane (confinement of injection) - MAPEPLAN
7. Injection valve + injectable hoses + end box - MAPEPLAN INJECTION VALVE
8. Protection layer- MAPEPLAN PROTECTION
9. Rebend connection - MAPEPLAN WATERSTOP



VACUUM SYSTEM

COMPARTMENTALISATION / SECTORISATION

By using a double-layered system of PVC-P, in combination with waterstop, injection valves, hoses, a tunnel waterproofing system can be divided and compartmentalised into small independent watertight sections. The tunnel/ structure is therefore divided into manageable sections that can be treated as individual entities.

This system allows us to test for water-tightness at locations suspected of accidental damage, or in the case of leakage. Furthermore, the water infiltrations would be limited to the single damaged section/compartment. Any damage/leakage would remain localised, thus rendering easy rectification, and thereby mitigating one of the major concerns with traditional PVC-P applications. This compartmentalization forms this watertight control by utilising the gap between the two waterproofing membrane layers. This gap can be exploited to monitor the waterproofing system sealing and allows for simple future repairs by resin injection.

VACUUM TESTING

The MAPEPLAN Vacuum waterproofing system allows us to objectively test each section by removal of air between the two PVC-P layers (vacuum). This testing can be performed several times during various critical stages of construction:

- After installation of the waterproofing system.

- After installation of protection screed (horizontal surfaces).

- After installation of rebar (vertical surfaces)

- After the final concrete is cast.

Through the injection valves, it is always possible to access to the gap between the two waterproofing membrane layers. Therefore vacuum testing can be performed at any time, even many years after the construction has been completed.

The opportunity to test the watertightness of the system during the different construction steps is the best guarantee you could wish for the waterproofing system. This type of test allows the contractor to easily detect the critical construction phases. Consequently more attention can be paid to these phases to ensure there are no repercussions.

MAPEPLAN TU S – MAPEPLAN
SEPARATION LAYER – MAPEPLAN TT

FUTURE REPAIRS

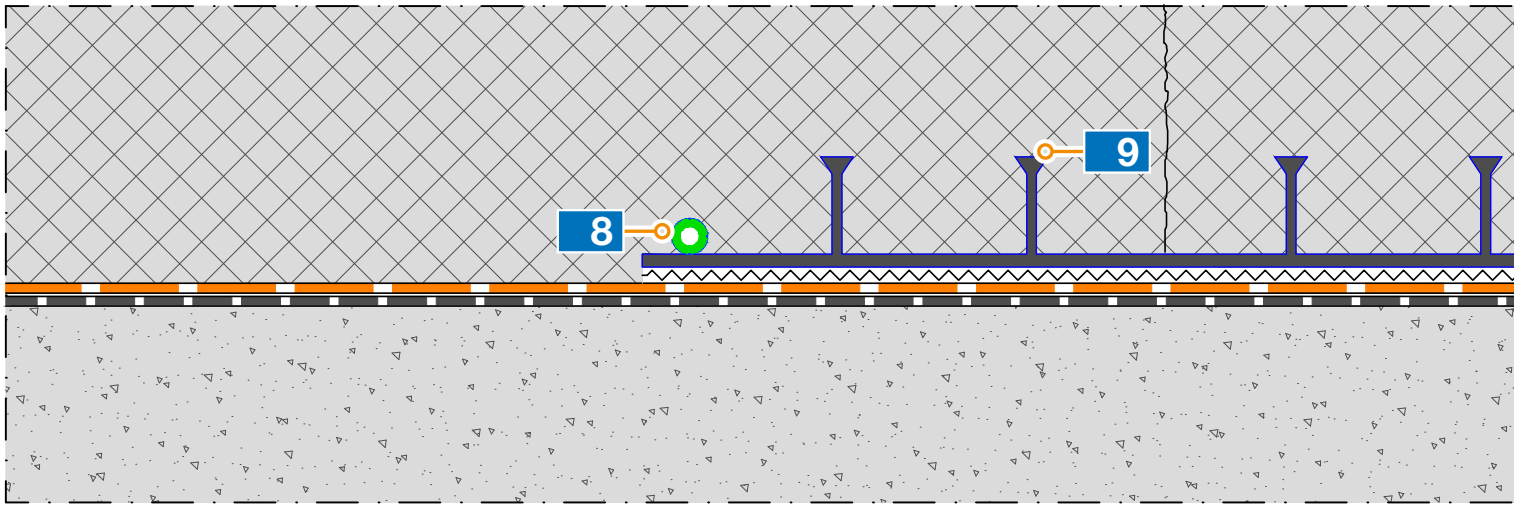
Through the control and injection valves, it is possible, once the leak has been identified, to repair the waterproofing system. This is possible even where the repair is inaccessible (slab / foundation walls). Reparation of the waterproofing is carried out by injecting a low viscosity resin into the space between the PVC-P layers sealing any damage that may have occurred during the construction phases. This type of intervention, through “injection,” is minimally invasive, and guarantees limited and rapid intervention times, thereby avoiding significant interruptions to underground operations.

CATANIA SUBWAY - Italy

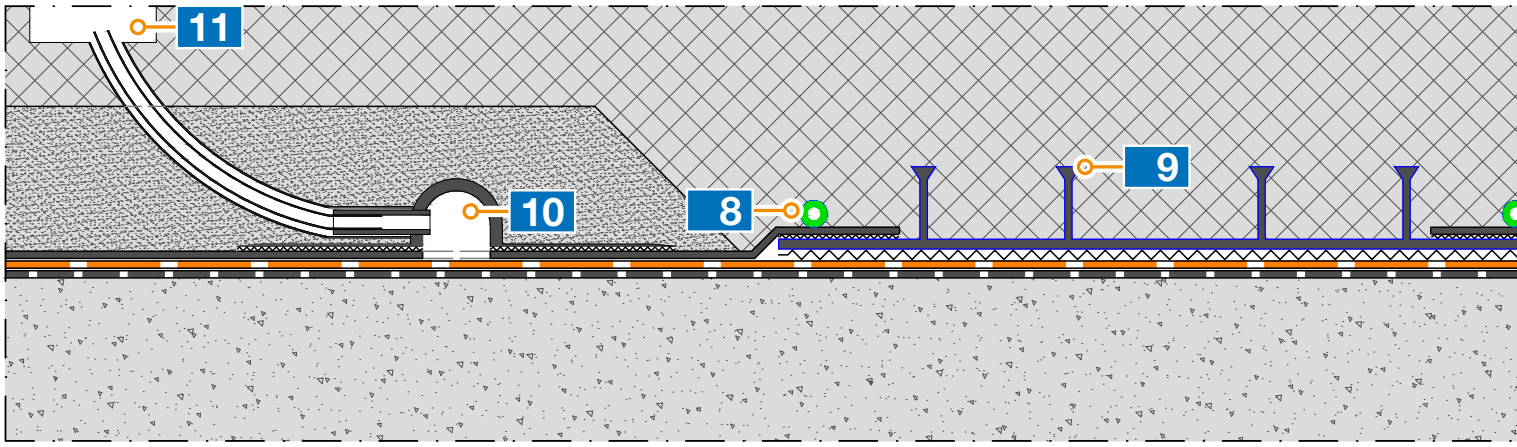
LAGONEGRO TUNNEL - Highway A3 Salerno-Reggio Calabria - Italy

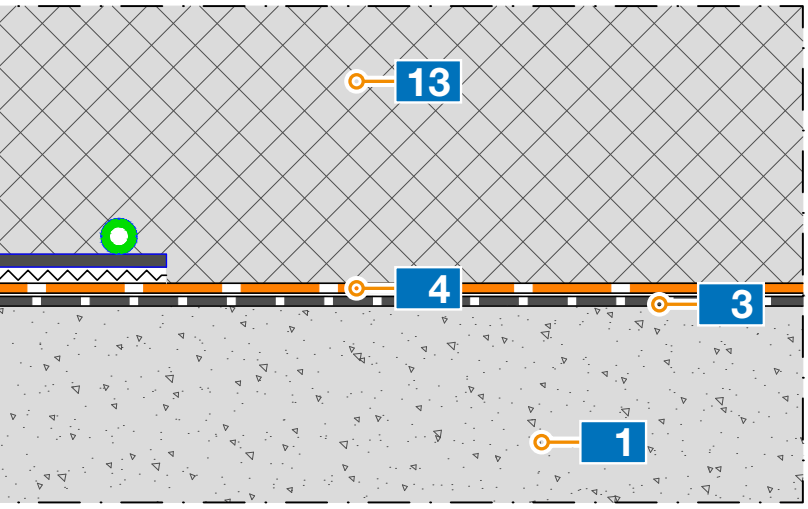
3.2.5 TECHNICAL DRAWINGS

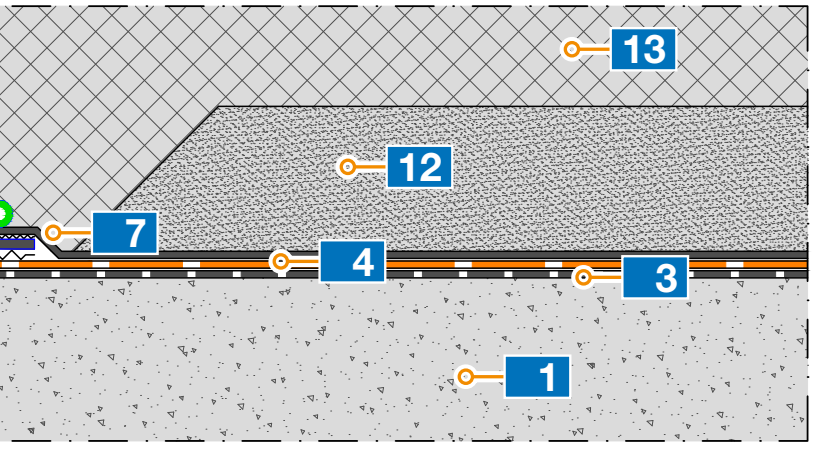
1L WS - 1 LAYER / WATERSTOP



1LP WS – 1 LAYER / PROTECTION / WATERSTOP







1 Substrate (shotcrete)

2 Drainage layer
POLYFOND KIT

3 Regularization layer
POLYDREN PP

4 1st Synthetic waterproofing membrane
MAPEPLAN / ***MAPEPLAN ST***

5 Separation layer
MAPEPLAN SEPARATION LAYER (compartment)

6 2nd Synthetic waterproofing membrane
MAPEPLAN

7 Protection layer
MAPEPLAN PROTECTION

8 Re-injectable hoses
IDROSTOP MULTI

9 Waterbar
MAPEPLAN WATERSTOP

10 Injection valve
MAPEPLAN INJECTION VALVE

11 Hoses collecting box
MAPEPLAN END BOX

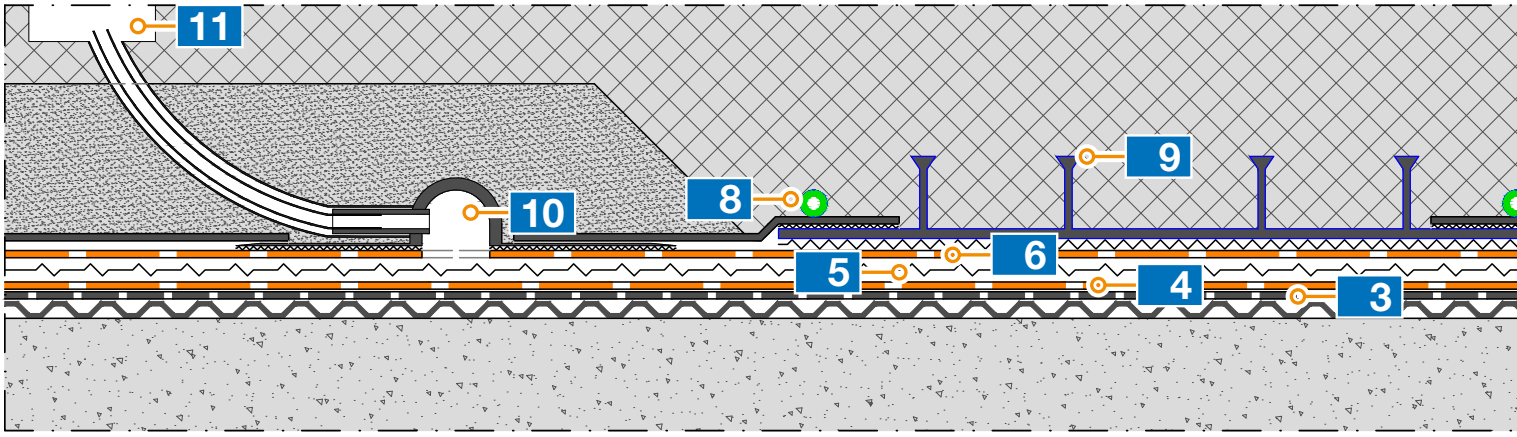
12 Protection screed

13 Final lining

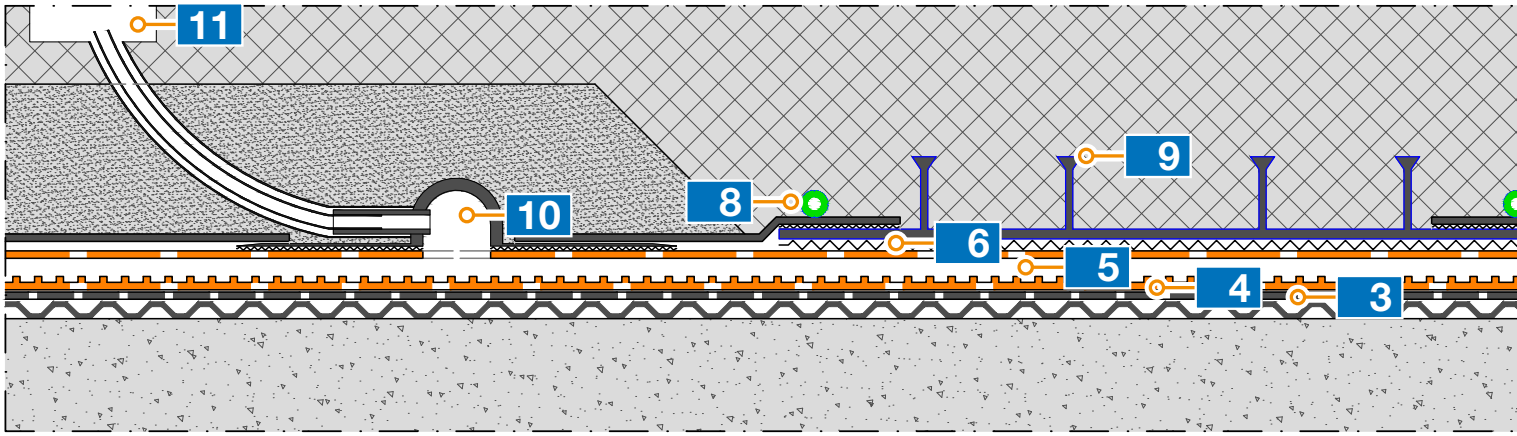
14 Compartment overlap detail

Welding

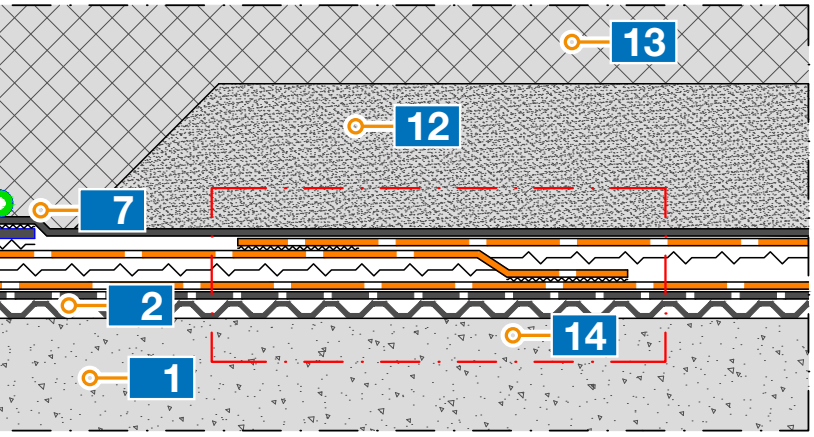
2LP WS - 2 LAYER / PROTECTION / WATERSTOP (VACUUM SYSTEM) + DRAINAGE LAYER*

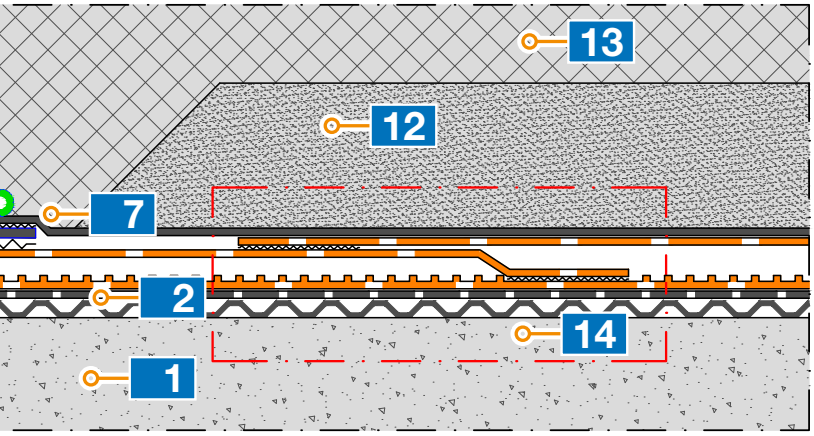


2LP WS - 2 LAYER / PROTECTION / WATERSTOP (VACUUM SYSTEM) + DRAINAGE LAYER*



** to apply the waterproofing system in presence of water inflow*





1 Substrate (shotcrete)

2 Drainage layer
POLYFOND KIT

3 Regularization layer
POLYDREN PP

4 1st Synthetic waterproofing membrane
MAPEPLAN / ***MAPEPLAN ST***

5 Separation layer
MAPEPLAN SEPARATION LAYER (compartment)

6 2nd Synthetic waterproofing membrane
MAPEPLAN

7 Protection layer
MAPEPLAN PROTECTION

8 Re-injectable hoses
IDROSTOP MULTI

9 Waterbar
MAPEPLAN WATERSTOP

10 Injection valve
MAPEPLAN INJECTION VALVE

11 Hoses collecting box
MAPEPLAN END BOX

12 Protection screed

13 Final lining

14 Compartment overlap detail

Welding

HIGH SPEED RALWAY MILAN-GENOA BASE TUNNEL - Italy

3.2.6 MAPEPLAN ACCESSORIES*

MAPEPLAN DRAINAGE PROFILE

MAPEPLAN DRAINAGE PROFILE
Rigid PVC drainage profile to easy connect the drainage system with waterproofing membrane.

DRAINAGE BOARD
POLYFOND KIT

POLYFOND KIT
Embossed HDPE membrane to drainage water allowing the correct waterproofing system application.

GEOTEXTILE *
POLYDREN PP HT

**Different weights per square meters available upon request*

POLYDREN PP
Non-woven geotextile to be used as compensation, levelling, protection and filter layer.

FIXING DISK
MAPEPLAN DISK

MAPEPLAN DISK
PVC fixing element to apply the waterproofing membrane and provide a temporary support.

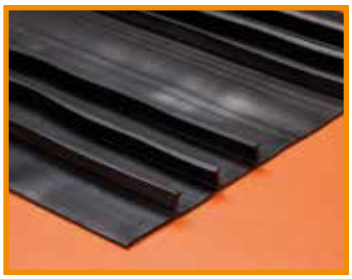
** TPO version available for all ancillary products*

WATERSTOP *

MAPEPLAN WATERSTOPS

type 4/20 width 320 mm
type 4/20 width 320 mm
type 4/30 width 250 mm
type 6/20 width 600 mm
type 6/30 width 500 mm
type 6/30 width 400 mm

**Different waterstop profiles available on request*



MAPEPLAN WATERSTOP
PVC profile designed to waterproof joints and creates compartment.

SEPARATION LAYER

MAPEPLAN SEPARATION LAYER

MAPEPLAN SEPARATION LAYER
Three dimensional extruded polypropylene drainage core of fused, entangled filaments.

PROTECTION

MAPEPLAN LAYER PROTECTION

MAPEPLAN PROTECTION
PVC membrane to protect the MAPEPLAN waterproofing membrane during the construction operations.

RE-INJECTABLE HOSES

IDROSTOP MULTI 11 *

**Accessories available*

IDROSTOP MULTI 11-19
Double jacket re-injectable hoses for multiple injections to seal joints and replacing waterproofing system.

Related products:
Plastic Connectors, Ventilation Hoses, Hot-shrinkage Hoses

INJECTION HOSES

MAPEPLAN INJECTION TUBE
Injectable hoses to inject and seal joints and replacing waterproofing system.

Related products:
Plastic Connectors, Ventilation Hoses, Hot-shrinkage Hoses

INJECTION VALVE and INJECTION TUBE
MAPEPLAN INJECTION VALVE

MAPEPLAN INJETION VALVE
PVC injection valve to inject resin in the compartment.

Related products:
Quick Fitting Connector 8-10 mm, MAPEPLAN Injection Tube 6-8 mm

END BOX
MAPEPLAN END BOX

END BOX
Collecting box for hoses and re-injectable hoses to allow the connection of the pumping equipment with the injection system.

TRUMPET FLANGE
MAPEPLAN MULTICOLLAR

MAPEPLAN CONIC COLLAR
PVC ancillary product to waterproof special detail.

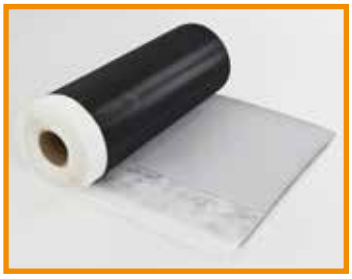
MAPEPLAN CONIC COLLAR

MAPEPLAN COLLAR
PVC ancillary product to waterproof special detail.

MAPEPLAN COLLAR

MAPEPLAN MULTICOLLAR
PVC ancillary product to waterproof special detail.

TAPE
MAPEPLAN TAPE PVC 500



MAPEPLAN TAPE PVC 500 /220
Related product: ADESILEX PG4
Special PVC tape to realize waterproofing membrane termination and connection with different waterproofing system.

METALSHEET and METALPROFILES
MAPEPLAN METALSHEET

MAPEPLAN STRIP and TERMINAL STRIP PROFILE
Steel profiles covered with PVC layer for special termination.

HYDROPHILIC SWELLION PROFILE
IDROSTOP BTN
IDROSTOP CV
IDROSTOP PTZ
IDROSTOP E

Bentonite, acrylic, polyurethane and EPDM based hydrophilic swelling profile.

MTR - Hong Kong

MTRC - Hong Kong

3.2.7 INSTALLATION TOOLS

Hot-air gun (art.A0800)

Nozzle 40 mm (art.A0804)
Nozzle 20 mm (art.A0803)
Nozzle 5 mm (art.A0805)

Double welding machines
(not included in delivery program)

Eletric engraver
(not included in delivery program)

Brass roller (art.A0815)
Toflon roller (art.A0808)
Rubber roller (art.A0807)

Engraver (art.A0809)

Hook (art.A0810)

Welding jig
(not included in delivery program)

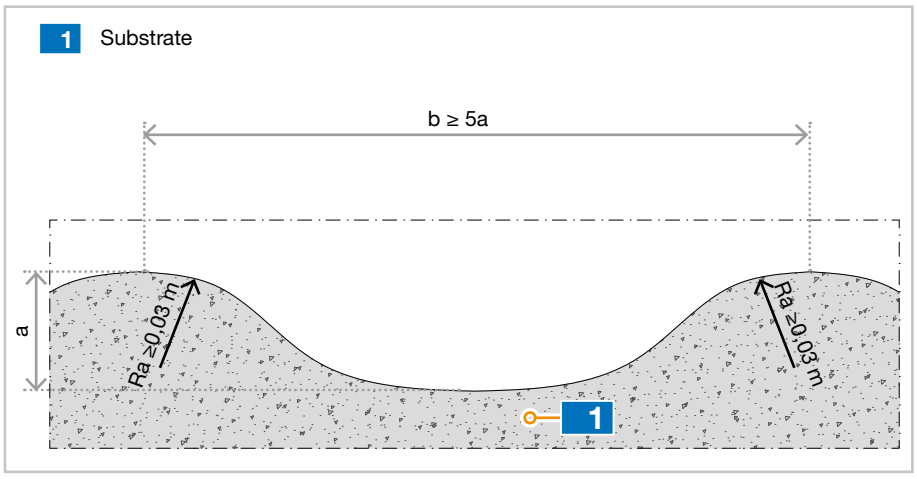
Welding knife
(not included in delivery program)

Vacuum bell
(not included in delivery program)

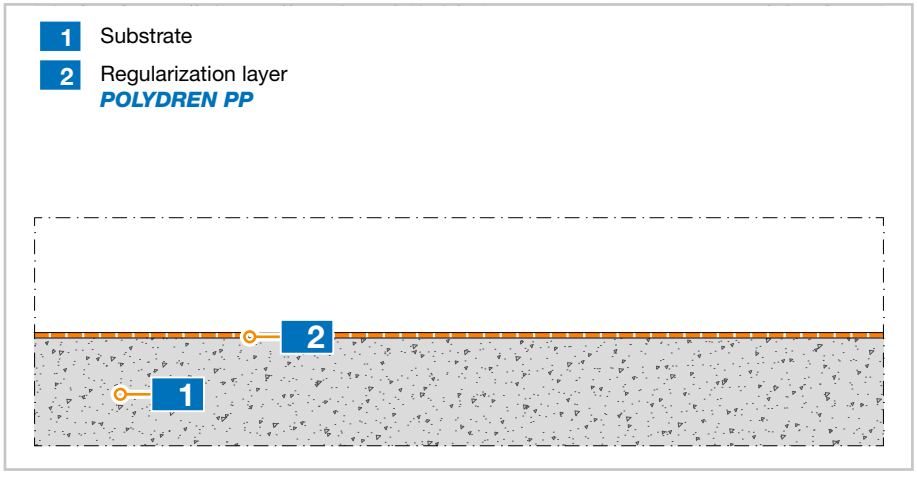
RED LINE METRO STATION - Doha - Qatar

3.2.8 RISK MITIGATION: CHECK LIST FOR WATERPROOFING (INSPECTION, WELDING TESTS)

1. ACCEPTANCE OF SUBSTRATE
   - Verify the compatibility of membrane flexibility with shotcrete evenness
   - Substrate smooth, clean as specified

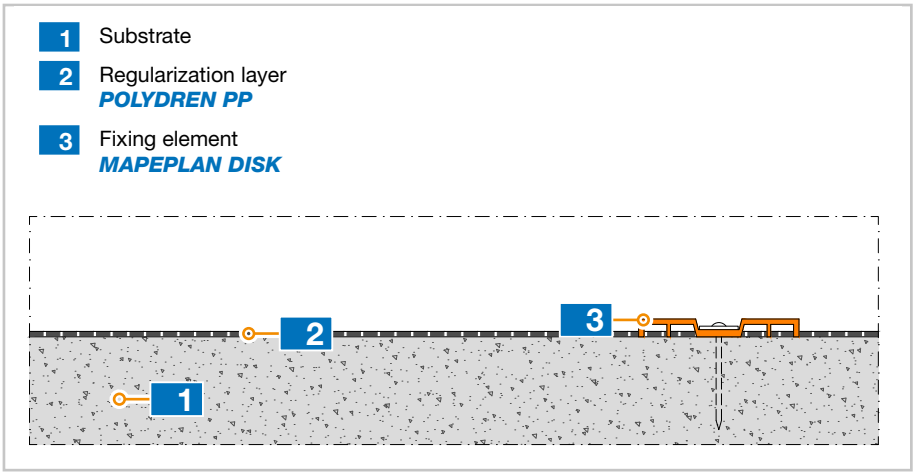


2. LEVELLING LAYER
   - Verify type (PP) and quality (≥500 g/mq) of the layer (according to the substrate)
   - Verify that lapped are correct



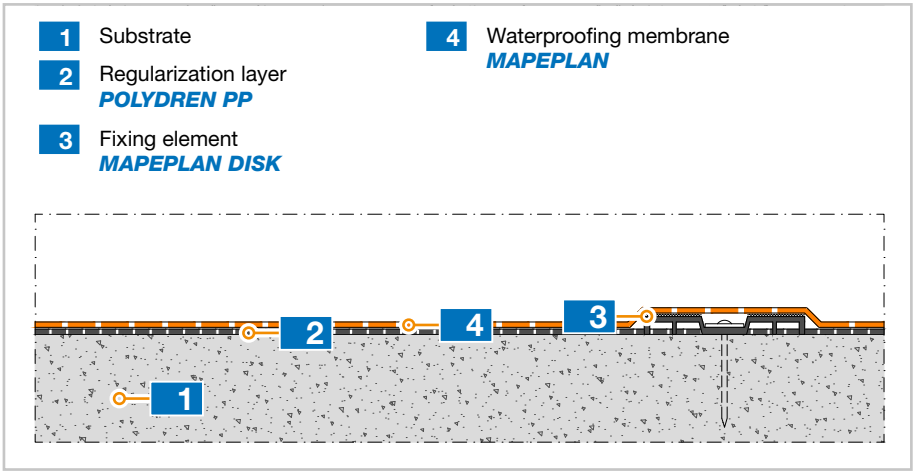
3. FIXING ELEMENTS

- Use an appropriate fixing element (preventive failure of the disk prevent any possible laceration of the membrane)
- Verify number and position of the disk



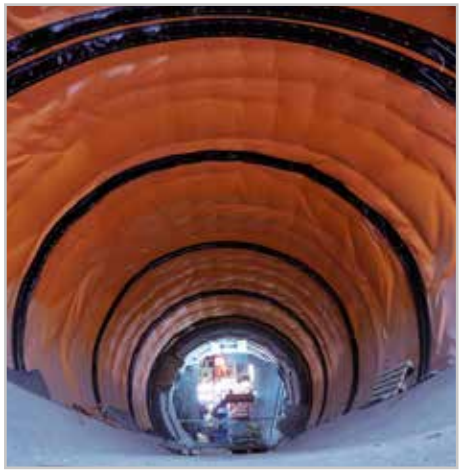
4. WATERPROOFING MEMBRANE

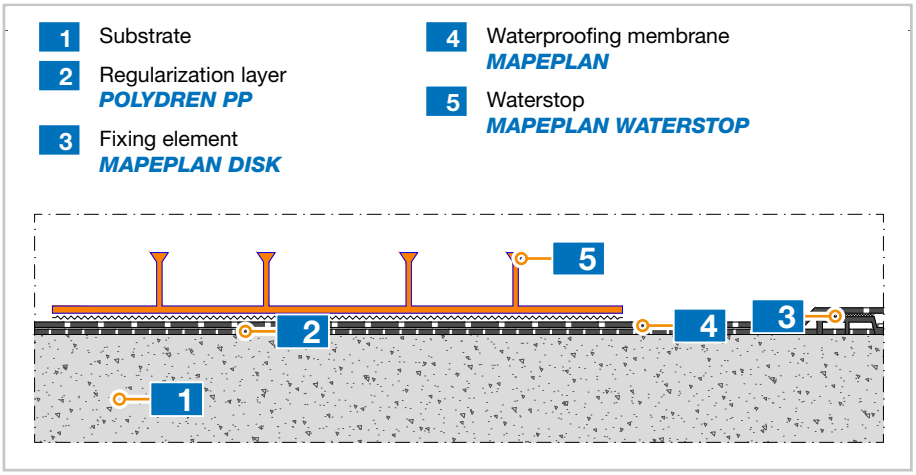
- Verify type (PVC-P), quality, length and mechanical characteristics of the membrane
- Verify that lapped are correct(overlap 10-12 cm)
- Verify that membrane between fixing elements is not in tension



5. WATERSTOP

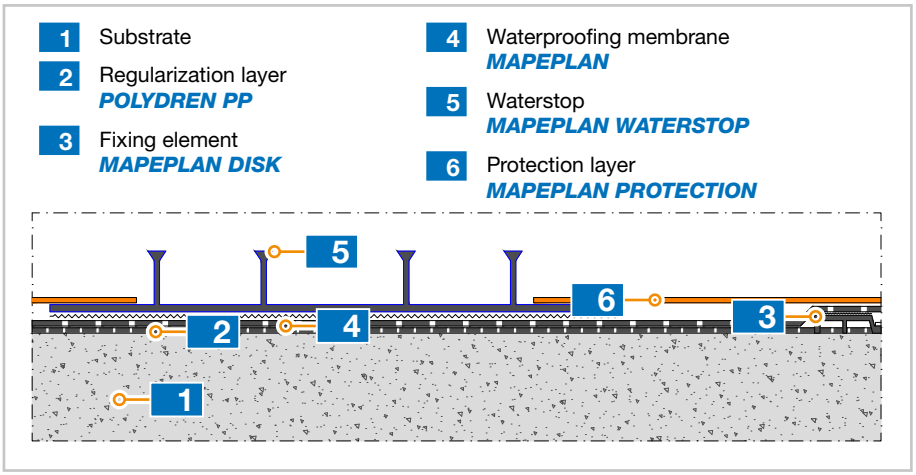
- Verify Waterstops position
- Verify that Waterstops are clean and free of residue
- Verify welds with a hook





6. PROTECTION LAYER

- Verify typologies, quality and thickness of the membrane



7. WELDING OF THE MEMBRANE

- Verify that heating wedges are clean
- Verify that membrane is clean
- Verify the setup of welding machine: temperature, speed, and pressure
- Verify the correct realization of joints

8. WELDING INSPECTION

PARAMETER	TEST METHOD	FREQUENCY	PASS/FALL CRITERIA
Coverage	Visual	Visual inspection to be carried out continuously while the membrane is applied	100% coverage
Double weld seam joints	According to the supplier guidelines	Every joint	Pressure drop not to be greater than 10% when a 2 bar pressure is applied for 10 minutes
Single weld	According to the supplier guidelines	Every hand weld	Hook test (*)
Single weld	According to the supplier guidelines	Every patch	Hook test and Vacuum bell test (flatness permitting) (**)

I
Visual inspection

II
Manual Test Using a Hook

III
Compressed air test – double welding

IV
Vacuum Bell Test – joints/patch

V
Vacuum Pump Test

I Visual inspection.

After welding, all seams should be visually inspected for good workmanship. Special attention should be paid to T-joints, penetrations and flashings.

II Manual Test Using a Hook.

All hand-welded seams should be mechanically tested once they have completely cooled. For this purpose use a hook (about 5 mm wide, with blunted edges). Apply light pressure to the seam, taking care not scratch the membrane. Mechanical testing is not a test for watertightness; it helps detect seams that are not fully welded.

III Compressed air test - double welding.

The double-wedge machines produce two welded seams simultaneously. At both ends of the double seam the channel between the two welds to be tested is clamped shut and a manometer and needle installed. A foot pump is then connected and the appropriate test pressure developed. The standard test parameters are as follows: Test duration: 10 minutes; test pressure: 2 bars. The seam is considered watertight if the initial pressure in the test channel drops by not more than 10 % during the test period. The pressure values are recorded, specifically the initial and final pressure.

IV Vacuum Bell Test - joints/patch

Test procedure:

- Apply a soap solution over the seam edges within the range of the vacuum bell.
- Press vacuum bell over the area treated with soap solution and build-up the vacuum (0.2 bar).
- Visually check the seams under vacuum (bubbling soap solution shows a leak).
- Remove the vacuum bell and clean the seam with clean rags.
- Any leaks must be rectified with a hand held welding gun and 20 mm Silicon rollers at normal welding temperatures.

IV Vacuum Pump Test.

This test is for testing each compartment prior to casting. To test and control the membrane surfaces and relative welding of each compartment the following procedure must be followed:

- Identify and number the compartment to be tested.
- For each compartment (200 to 250 m^2), 4 to 5 valves need to be installed. To one of these valves must be attached a hose and vacuum pump. The remaining valves must be hermetically sealed (airtight).
- Start the vacuum pump, run until the pressure drop is in the region 0.5-0.6 bar.
- Wait until the reading remains stable (1 minute).
- Record the initial test pressure (about 0.5-0.6 bar). Wait approximately 10 minutes and take note of the final pressure.
- The test passes if the difference between the initial and final pressure is lower than, or equal to 20%.

Through this vacuum test it is possible to check the integrity of the waterproofing work. Also it is possible to identify and rectify defects with minimal time and cost implications.

Hauge Tunnel - Istak Lonevag - Norway

3.3. POST-INJECTION SYSTEM

WHERE TO USE

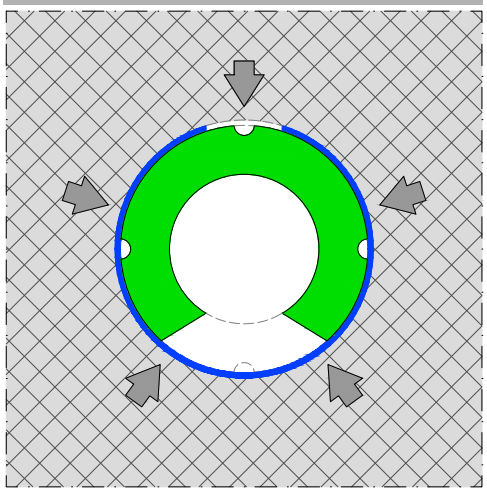
1. Sealing of punctual water inflow
2. Sealing of diffused water inflow
3. Raplacing of waterproofing system - Injection of compartments (1LP / 2LP WS system) and re-injectable hoses (IDROSTOP MULTI)
4. Waterproofing and replacing of concrete cracks and joints

MAPEGEL UTT SYSTEM
Three-component acrylic resin

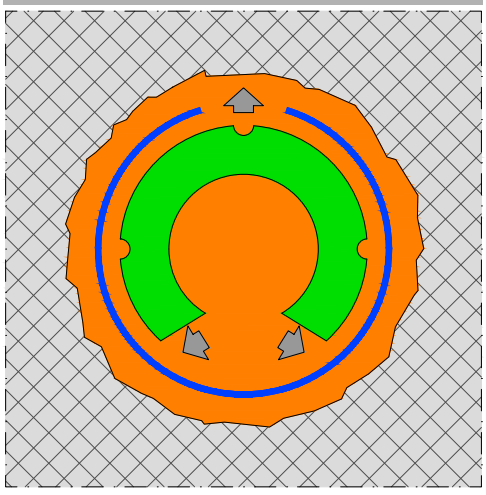
FOAMJET 260 LV
Two-component PU gel

- Low viscosity and high permeation
- Quick and controlled reaction time
- Excellent elasticity
- Excellent chemical resistance

IDROSTOP
embedded in concrete



IDROSTOP
injected with resin



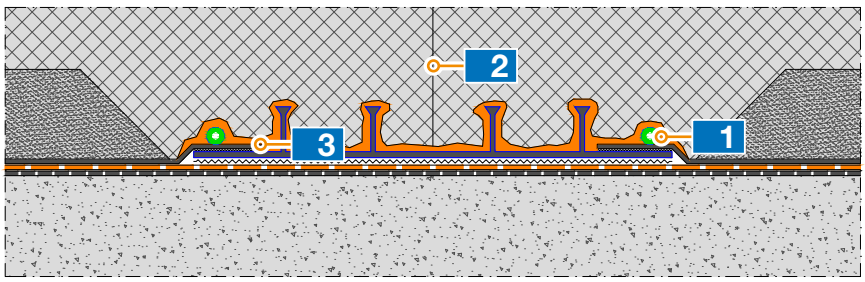
BACK-UP SYSTEM CONCEPT

- Replacing waterstop and sealing joints with acrylic resin injection or low viscosity PU gel (using re-injectable hoses).
- Acrylic or low viscosity PU gel injection with valve inside compartments made with synthetic waterproofing membrane.

1 Re-injectable hoses
IDROSTOP MULTI 11

2 Construction joint

3 Injection of acrylic resin to repair the waterstop and seal the construction joint
MAPEGEL UTT SYSTEM



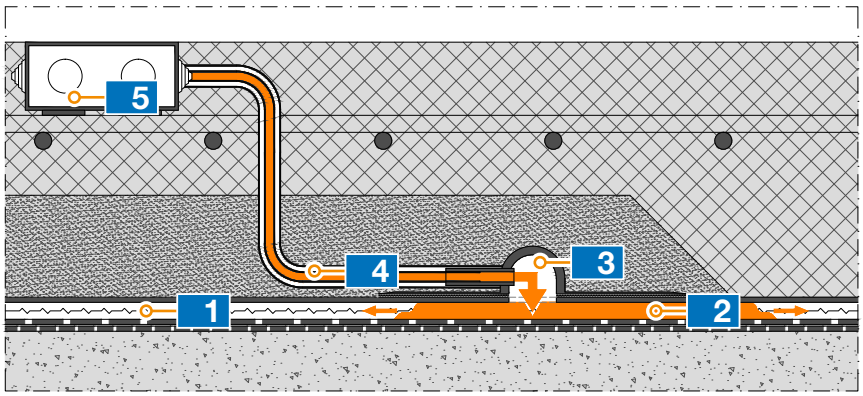
1 Compartment

2 Acrylic resin ti inject the compartment
MAPEGEL UTT SYSTEM

3 Injection valve
MAPEPLAN INJECTION VALVE

4 Injection hoses

5 Collecting hoses box
MAPEPLAN END BOX



3.4. SPRYABLE WATERPROOFING MEMBRANE AND SYNTHETIC WATERPROOFING MEMBRANE

3.4.4. SPRYABLE WATERPROOFING MEMBRANE AND PVC

MAPELASTIC TU SYSTEM is integrated and compatible with PVC waterproofing membrane (MAPEPLAN).
Detail: overlap between PVC membrane (MAPEPLAN) and MAPELASTIC TU SYSTEM.

LÖTSCHBERG TUNNEL - Switzerland

RED LINE METRO STATION - Doha - Quatar

MAPEI UTT
Underground Technology Team

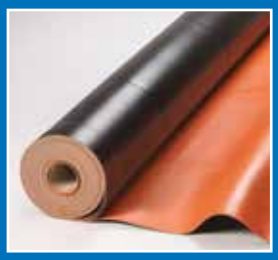
UTT TECHNICAL ASSISTANCE PROVIDES:

- Great technical skills according to deep knowledge of products, production phases and construction systems;
- Assistance during construction and design phases, in order to focus on the correct products and technical solutions;
- Global intervention, 24 hours per day and 365 days per year;
- Production optimization and costs reduction.

THE WORLD OF UTT

- SHOTCRETE TECHNOLOGY
- MECHANIZED TUNNELING PRODUCTS
- DRILLING AND GROUND CONSOLIDATION PRODUCTS
- INJECTION SYSTEMS
- WATERPROOFING SYSTEMS
- PAVEMENT PRODUCTS
- TUNNEL MAINTENANCE, REHEABILITATION AND COATING PRODUCTS

SUPPLIER OF ...

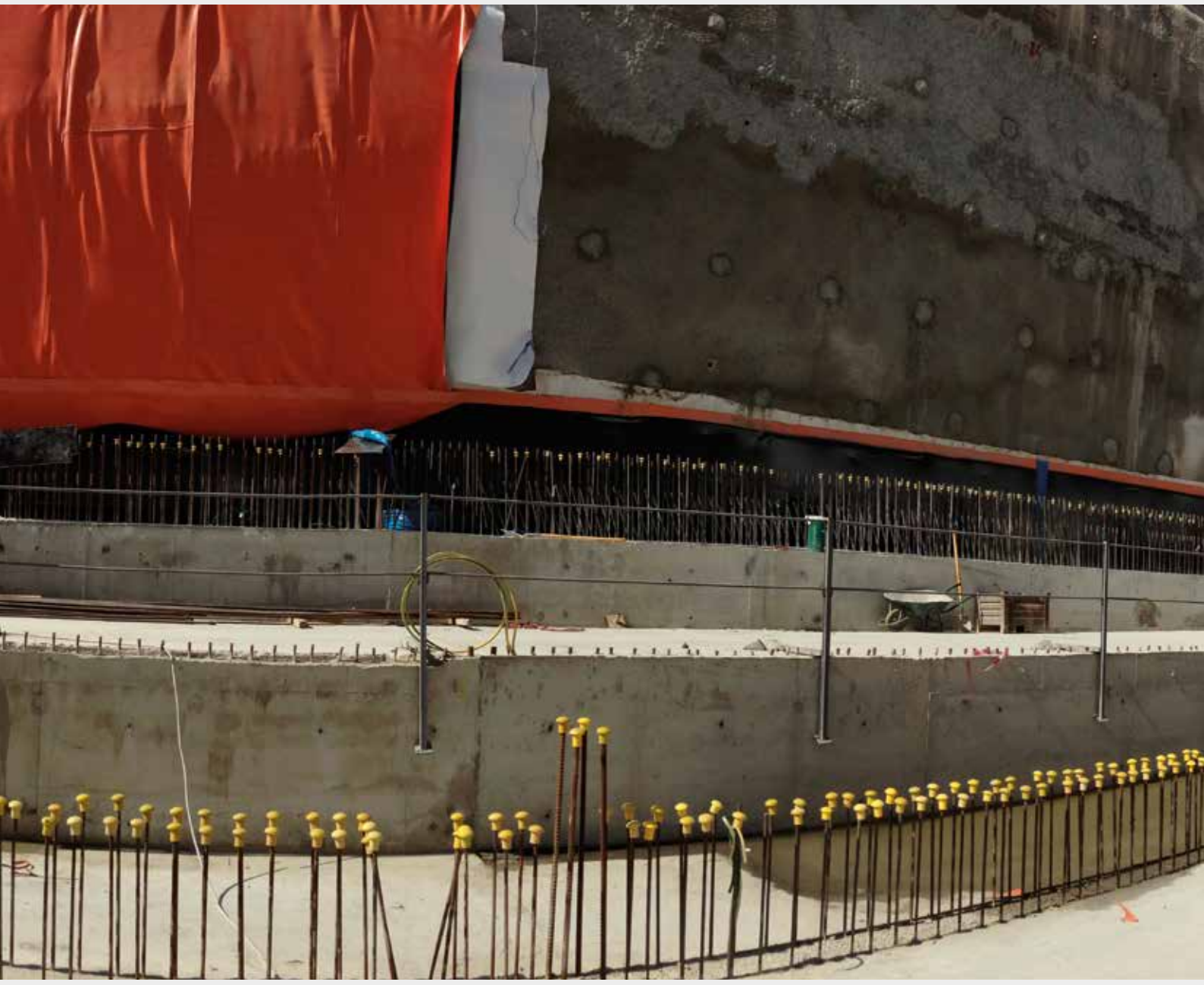


PRODUCTS

SYSTEMS

INNOVATION

TECHNICAL SUPPORT



C.P. MK6482030 (GB) 3/16

www.utt-mapei.com
hq.utt@utt.mapei.com

HEADQUARTERS
MAPEI SpA
Via Cafiero, 22 - 20158 Milan
Tel. +39-02-37673.1
Fax +39-02-37673.214
Internet: www.mapei.com
E-mail: mapei@mapei.it

/mapeispa