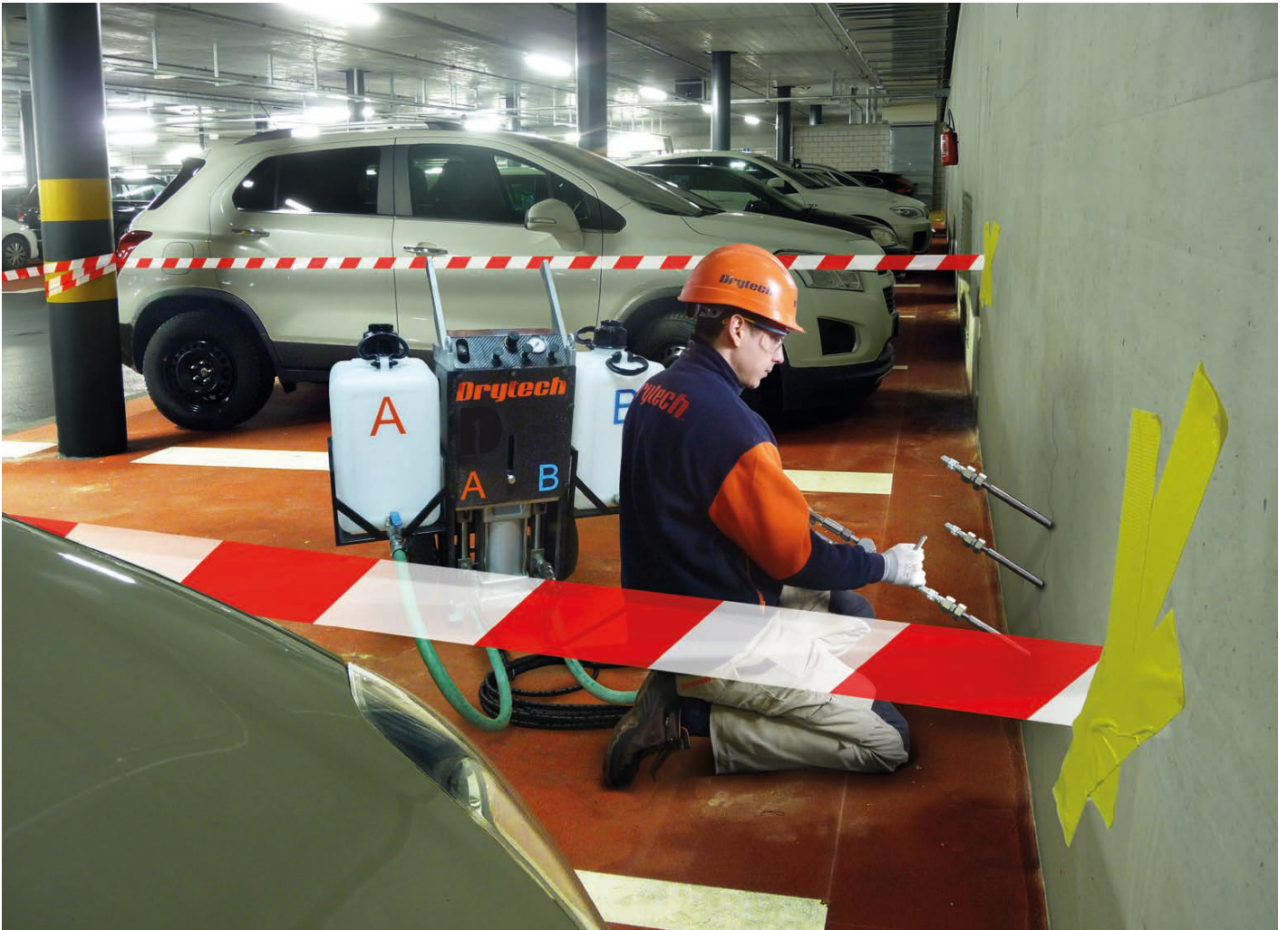


DrytechTM

Waterproofing System Engineering

INJECTION SYSTEMS WATERPROOFING IN RESTORATION



WE STOP WATER NOT THE TRAINS

NON-STOP SOLUTIONS

Drytech Restoration Systems, employing injection techniques, are used to waterproof structures against leakage and protect structural reinforcement.

The repairs are carried out from within the building: therefore no excavation or demolition work is necessary.

For example: The work was carried out during the night when the metro service was closed. There was no effect on the daytime train service as no demolition work was necessary.

In case of underpasses the restoration activities do not interfere with the traffic above.

In case of underground parkings only a few parking spaces in close contact with the place of injection are blocked.

Even the intervention of a dam does not require any water drain, as the DRYflex resin may be used in the presence of water under high pressure.





MILAN SUBWAY BEFORE



MILAN SUBWAY AFTER

INJECTION SYSTEMS

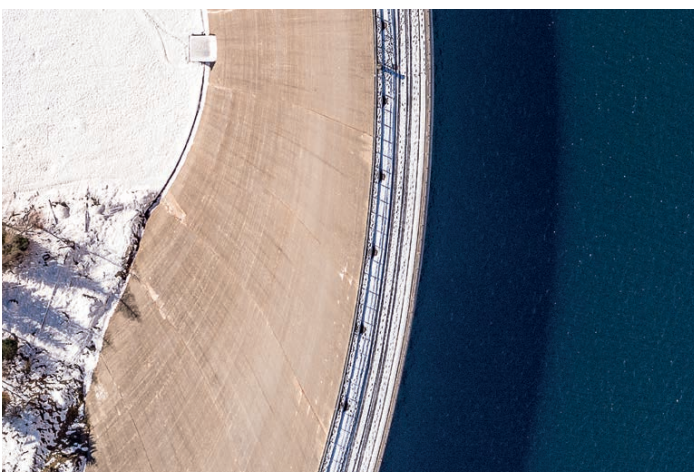
THE PLUS OF IMMEDIATE CHECK IN RESTORATION WORKS

TARGETED, IMMEDIATE CHECKABLE AND REPEATABLE INTERVENTIONS

The efficacy of the Drytech Restoration Systems resides in the precision of the single intervention.

Precise injections into the restoration area give an immediate result of the intervention.

Thanks to the elastic properties of the resin the DRYflex injections can be repeated and the maintenance of the restored object is guaranteed.



APPLICATIONS

Drytech Restoration Systems are used to resolve a complete range of problems: from small domestic leakage to cracks in dykes.

1. CONCRETE WATERPROOFING INJECTIONS

Waterproofing injection techniques for: cracks, cold and working joints, even subject to water under pressure, diaphragm walls, tunnels, dykes, purification plants, hydro-electric power stations, underground parkings, etc.

2. CURTAIN GROUTING WATERPROOFING INJECTIONS

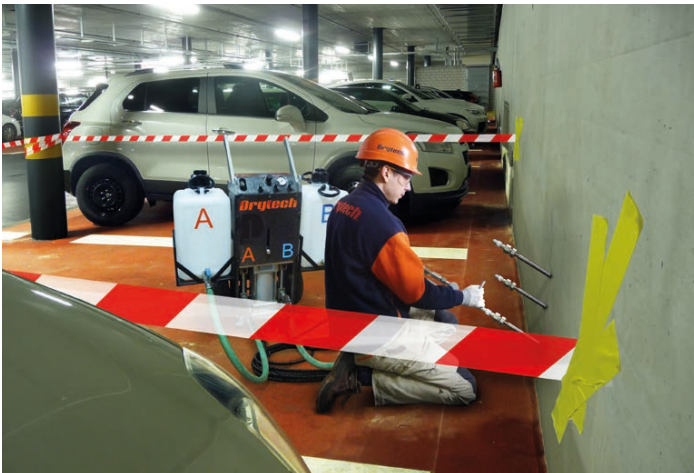
Waterproofing of stone or brick walls in contact with the ground using the curtain grouting technique.

3. STRUCTURAL REINFORCEMENT INJECTIONS

Structural reinforcement and waterproofing of walls made of stone, solid bricks or reinforced concrete.

4. INJECTIONS PROTECTING AGAINST CAPILLARY ACTION

Creation of a chemical barrier protecting walls in stone or solid bricks from capillary action.



Drytech has specialized in waterproofing since 1963 (www.drytech.ch).

Strengthened by this experience, Drytech undertakes worldwide research for the most advanced waterproofing systems, improving and applying them and thus consolidating its role as a specialist committed to helping businesses and private individuals.

TECHNICAL PROPERTIES OF THE DRYFLEX RESINS

ACRYLIC RESINS

Compatible with the environment and all waterproofing membranes. They can also be used to restore drinking water tanks. They are classed as domestic waste for disposal purposes.

High chemical resistance: ideal for waterproofing purification plants and collection tanks for aggressive water.

Excellent resistance to fire: they are not combustible and do not develop noxious gases when exposed to fire for long periods of time.

POLYURETHANE RESINS

Suitable for waterproofing and improving the ground condition as well as for injection into brick or stone structures.

Large cavities and significant water inflows can be stemmed with polyurethane within just a few minutes as a provisional measure.

EPOXY RESINS, MORTARS AND MICRO-CEMENT FOR INJECTION

Used to fill and structurally reinforce cracks and voids in walls and load-bearing structures, generally where structures are dry during injection.

SILICATE BASED RESINS AND CEMENT EMULSIONS

Stone or brick walls are waterproofed creating a chemical barrier to protect them from capillary action.

COMBINATION OF ACRYLATE RESINS WITH SILICATE OR CEMENT

Suitable for reinforcing structures and ground consolidation and for brick walls or the filling of concrete walls or molded parts.

DRYFLEX RESIN PRESSURE WATERPROOFING

PRESSURE WATERPROOFING

At the time of injection the resin has the same viscosity as water, thereby saturating the cracks, joints, cavities, honeycombs and concrete voids.

The resin forms a flexible gel within a few minutes. It expands in the presence of water, sealing the crack by pressure.

This reactive and reversible swelling effect remains constant over time and enables the resin to adapt to any movement in the crack, meaning that the effectiveness of the waterproofing remains unaltered.

NO PREPARATION OF THE CRACK

The effectiveness of the waterproofing, which acts under pressure, does not depend on the condition of the wall where the crack is located or the presence of oil or carbonates. This means that no cleaning is required leading to savings in time and costs.

IMMEDIATE CHECK

The intervention from within the building without any excavation or demolition and the effectiveness of the resin enable an immediate check of the restoration work.





INTERVENTION WITH WATER UNDER PRESSURE

The resin is perfectly effective even in the presence of water.

The injection pump can produce a very high pressure level - a few hundred bar - countering any water pressure present. This means that the Drytech System can also be used to restore active or inactive dams.

DURATION

DRYflex has passed the laboratory test of 100 transitions, equal to 20 years of working life.

The first applications date back to the early 1960's and the resin injected at the time is still an effective waterproofing agent.



DRYFLEX RESIN

COMPATIBLE WITH DRINKING WATER AND THE ARMOR

REQUIREMENTS	NORM	DESCRIPTION	DRYflex
<i>Basic requirements</i>	EN1504-5 Tabella 3C	U (S2) = intended use - concrete waterproofing injections. W (1) = minimum thickness of the gap 0.1 mm. (1/2/3/4) = injectable in dry, humid, wet, water-filled cracks. (5/40) = operating temperature 5-40 ° C	Compliant
<i>Water impermeability</i>	EN 14068	a 2x10 ⁵ e 7x10 ⁵ Pa	Compliant
<i>Viscosity</i>	EN ISO 3219	20-30 mPa.s	Compliant
<i>Reactivity</i>	EN ISO 9514	Gelation time between 10 sec and 45 min	Compliant
<i>Durability, dilatation and expansion</i>	EN 14498	The expansion must reach a constant level, according to the EN 14498 standard - conditioning regime A	Compliant
<i>Durability, sensitivity to wet / dry cycles</i>	EN 14498	Durability, sensitivity to wet / dry cycles	Compliant
<i>Compatibility with concrete</i>	EN 12637-1	Constant level of expansion after a maximum of 28 days and change in mass ≥ 10%	Compliant
<i>Corrosion behavior</i>	EN 1504-5 Tabella 3C	Without corrosive effects	Compliant
<i>Behavior to fire</i>	BS6853 BS EN ISO 4589-2	Smoke emission: <0,005 m ² /g According to BS6853: 1999 Annex D8.3 Flammability: oxygen index > 90, According to BS EN ISO 4589-2: 1996: Part 2	Compliant
<i>Compatibility with drinking water</i>	BS 6920-1: 2000	Odor and taste of water: <1 Appearance of water: color <0.6 Turbidity: <0.09 Presence of micro-organisms: <0.4 mg / l Content of substances harmful to public health cell morphology: satisfactory color of the culture medium: normal confluence of the monolayer: 100% metal release: compliant with the standard	Compliant
<i>Toxicity</i>	VwVws 17/5/1999	Water hazard class: (WGK) 1 (1 = low risk; 5 = high risk) Mammalian Toxicity LD50: > 2000 mg / kg Aquatic Toxicity EC: > 1000 mg / kg Bio-degradability: Biodegradable according to OECD 301 B Bio-accumulability: not bio-accumulative	Compliant

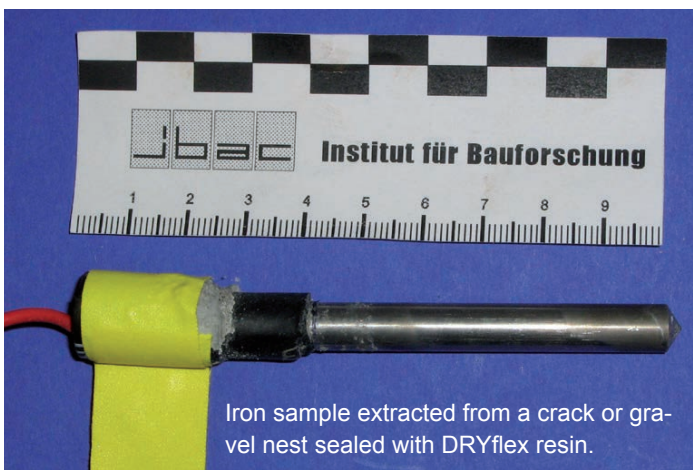
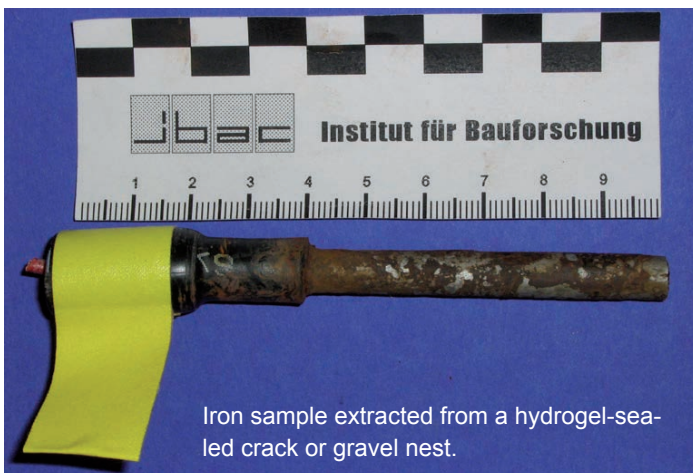
DRYflex resin has been subjected to conformity tests by independent institutes recognized by the EU.
The full version of the certificates can be requested from Drytech International SA, +41 (0) 91 960 23 49

REQUIREMENTS	VALUES
Crack width thermal expansion:	[ΔL_f ; until 25%,]
Expansion pressure force higher than hydraulic pressure:	> 1 Bar
Cracks width:	0.05 BAR
Waterproofness:	7×10^5 Pa
Constant water absorption, volume and weight:	> 30 < 80%
Sensitivity to wet / dry cycles:	> initial mass
Reaction time at 20°C for cracks:	≤ 10 seconds
Reaction time at 20°C, with dilution:	
- resin / water 1:3	≤ 40 seconds
- resin / water 1:5	≤ 120 seconds

NOT OXIDIZING

Many acrylic hydrogels favor the corrosion of the reinforcing iron because they isolate it from the passivating effects of oxidation guaranteed by the alkaline components of the concrete.

The Institut für Bauforschung of the University of Aachen has certified through its tests that the DRYflex resin does not oxidize the reinforcement either in cracks or in gravel nests.



INJECTION SYSTEMS MILAN SUBWAY

MILAN SUBWAY

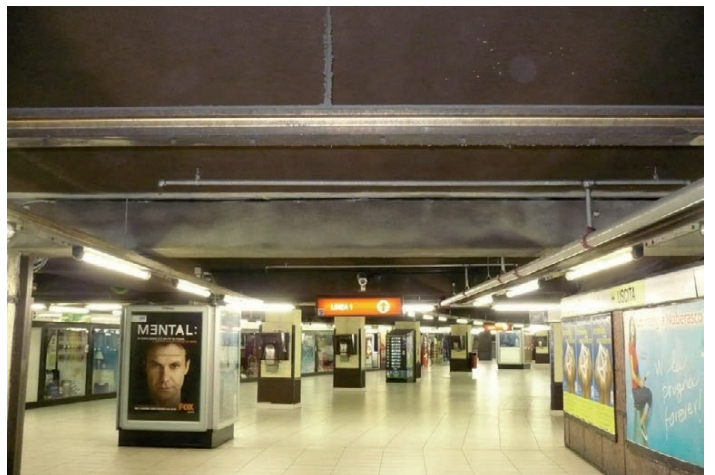
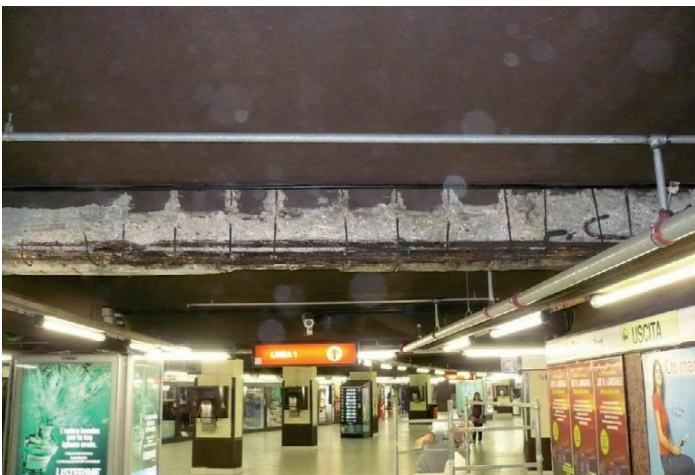
Drytech has carried out several restoration interventions on the M1 and M2 lines of the Milan underground.

All interventions, even those in the railway tunnels, were carried out during the night closure of the service, without interfering with the normal circulation of trains.

In the images, the waterproofing of the joint between the slab and the connection with the inverted arch, by means of injections of DRYflex expansive resin.



In the images a wall of the tunnel near the station S. Agostino before and after the waterproofing and finishing work. Below the restoration of the Cadorna station.



INJECTION SYSTEMS

PRESENCE INTERVENTION OF SEA WATER UNDER PRESSURE

DRY DOCK, GENOA

Rehabilitation of damaged joints in the walls of a dry dock.

The intervention was carried out from inside the basin, without having to reduce the pressure of seawater infiltrations.

In fact, the DRYflex resin is able to activate itself even in the presence of pressurized water.



The larger openings in the joints have been reduced with the insertion of wedges, in order to create the correct injection pressure.

The pressure produced by the injection machine D1 gradually saturates the joint expelling the water.

Within a few seconds DRYflex gels and expands, sealing even the most voluminous cavities by pressure.

The intervention also involved the joints between the podiums of the hull supports and the stalls.

The DRYflex resin is also resistant to aggressive waters, such as sea water, and is compatible with the environment, so much so that it is certified for use in drinking water systems.



INJECTION SYSTEMS RESTORING IN DEPTH

UNDERGROUND TUNNEL, LUGANO

The damage caused by infiltration does not concern only the concrete.

Constant exposure to water also involves the armature, triggering and accelerating the oxidation of iron.

One of the entrances to the tunnel of the high voltage line that crosses the city of Lugano, in Switzerland, has infiltrations under pressure, which made the concrete friable and produced the erosion of some reinforcing bars.

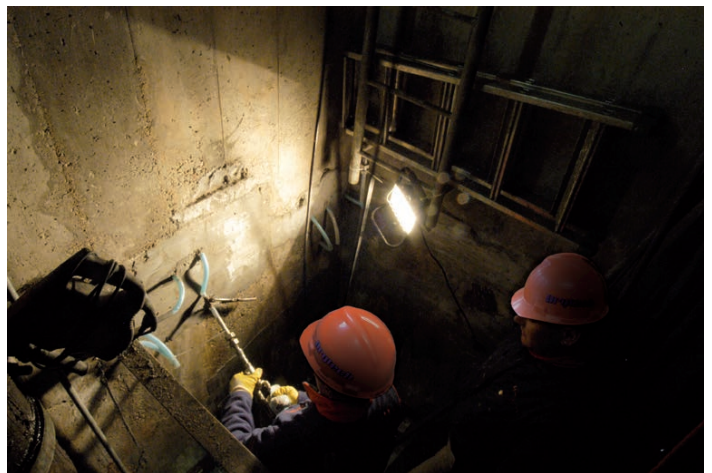


After removing the deteriorated concrete, drain pipes were installed to lower the water pressure, before proceeding with the reconstruction of the wall with quick-setting concrete.

Once the cement was consolidated, DRYflex resin was injected through the same decompression tubes.

The resin is also effective in the presence of pressurized water and, once injected, it is catalyzed in an expansive gel which sealed the cracks from which the infiltration originated by pressure.

By intervening from the inside, Drytech technicians were able to verify the waterproofing trend in real time.



INJECTION SYSTEMS

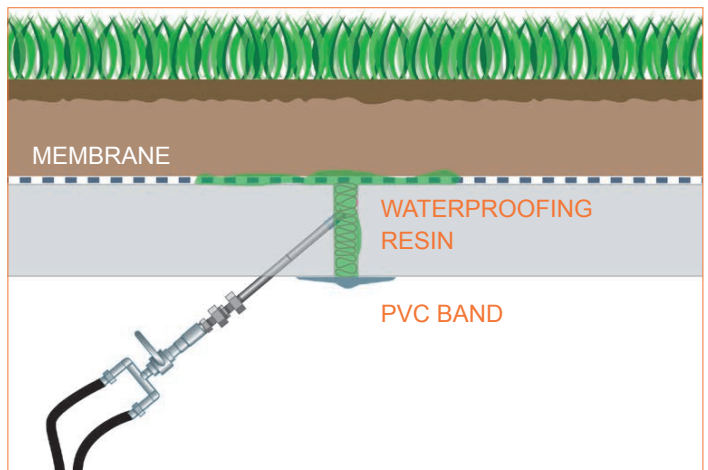
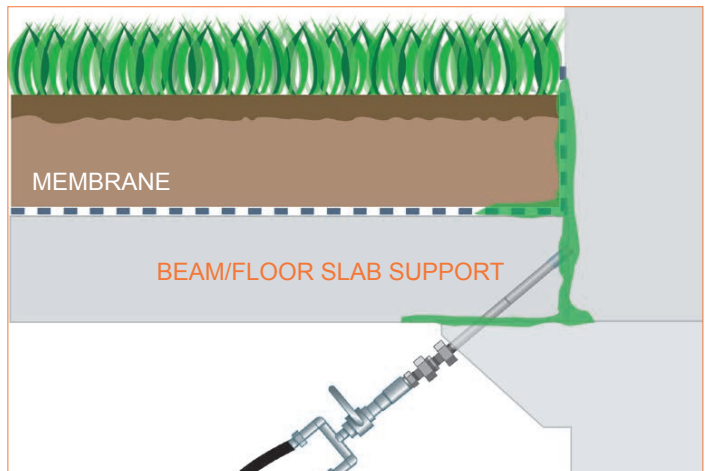
COLD JOINTS OF UNDERGROUNDS AND PARKING LOTS

UNDERGROUND CAR PARK, BASEL

Restoration of the floor slab movement joint and floor slab beam supporting the joint in an underground car park. The injection technique was used against water leakage caused by wear and tear of the floor slab connection joint and floor slab working joint membranes.

The work was carried out from within the building: therefore no excavation or demolition work was involved with no effect on normal use of the car park.

The acrylic resin injections, combined with the application of a PVC holding tape guarantee a tight seal even for movement joints.



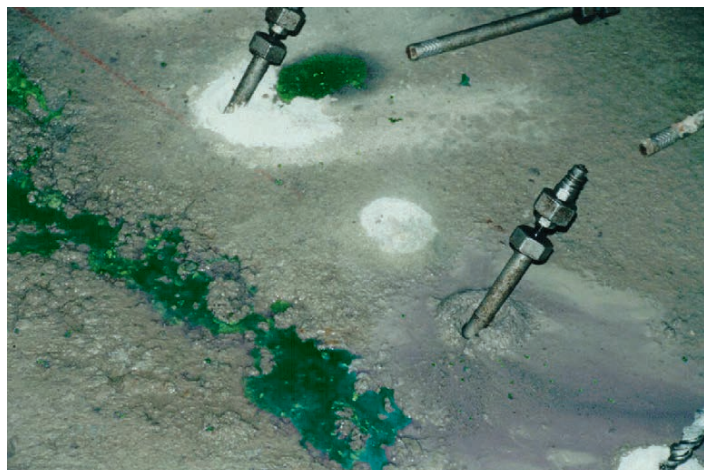
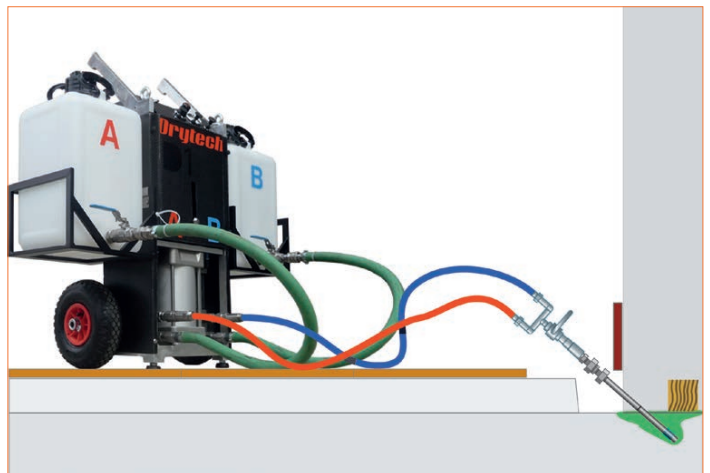
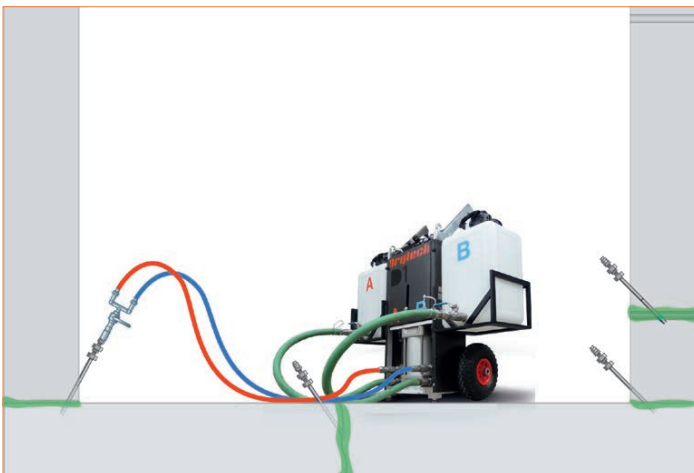
WATERPROOFING OF CELLARS BELOW THE WATER TABLE, LUGANO

Heavy rains created an underground water course and a consequent 1 m high pool of water around the building. The subsequent infiltrations caused flooding in the second level below ground which reached a height of 50 cm.

Defects such as joints, cracks, honeycombs and holes in the formwork spacers were waterproofed from within using injection techniques, guaranteeing the perfect water tightness of the cellars.

In the photographs: Drytech technicians prepare the battery of injectors along a crack in the concrete bed joint. The resin injected saturates the crack. A technician sucks up the water expelled by the pressure of the resin.

The resin is blue to distinguish it from the water. The pigment is reactive and the resin becomes completely colourless after a few minutes.

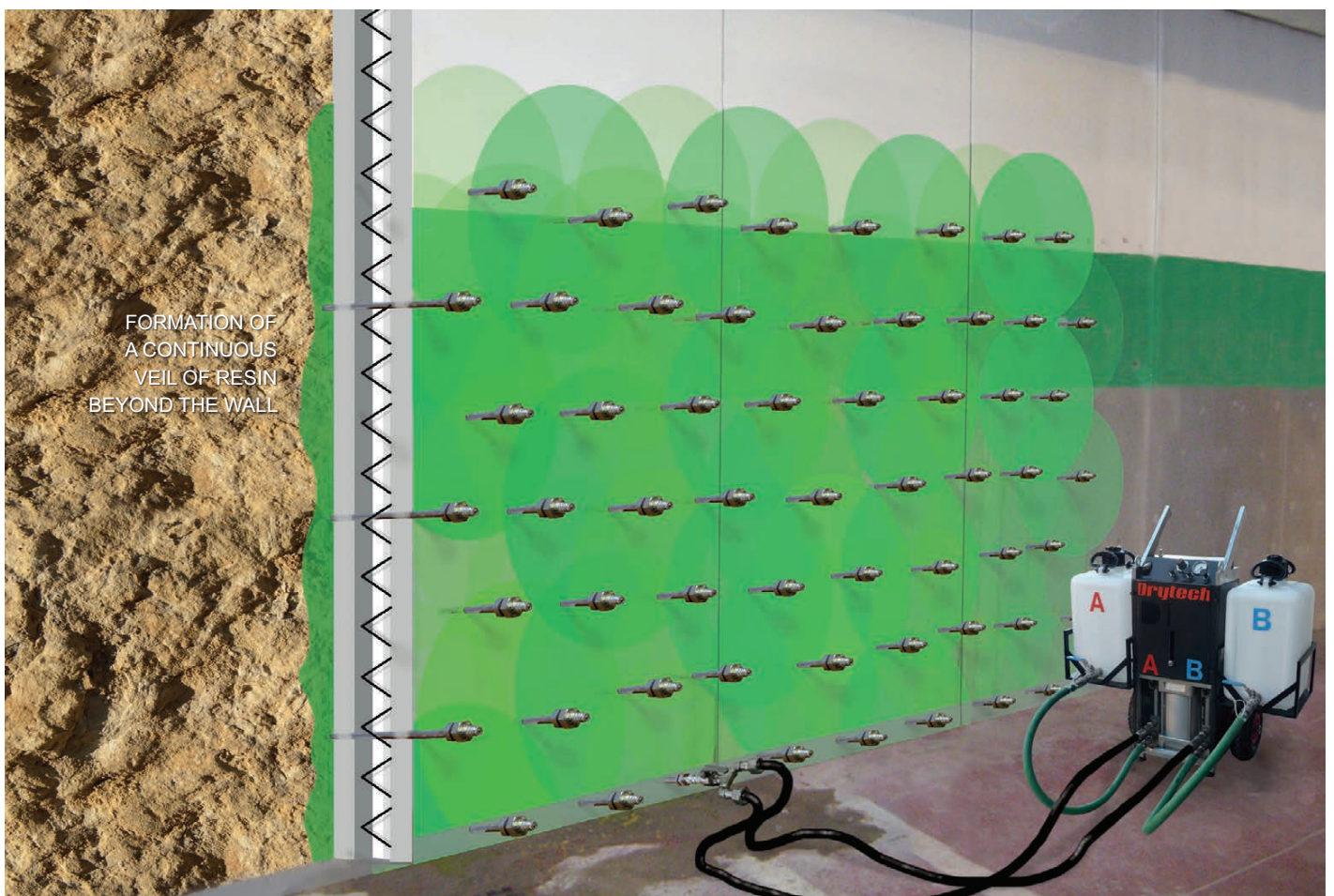


INJECTION SYSTEMS VEILING

Curtain grouting techniques are used particularly for porous or permeable structural elements creating a grout curtain of resin between the wall and the diaphragm wall or between the wall and the ground below.

The grout curtain technique complies with the WTA 4-6-98 recommendation.

Waterproofing injections of acrylic resin on the back of Predal walls between the Predal itself and the diaphragm wall.



The through grid holes injected resin is defonding radially from each point, creating an elastic and expansive curtain at the back of the wall.

It saturates also the joints between bricks, stone walls or precast sections (as in the photographs).



EX-POST SEALING GASKETS RESTORATION OF ELECTRICAL CABLES PIPES

Waterproofing is required to seal the joint between the through pipe and the structure that is crossed.

But if the duct has a leak or breaks in its external and underground path, it becomes a privileged channel for water.

The problem is even more serious if the cables of the electrical system have already been laid.

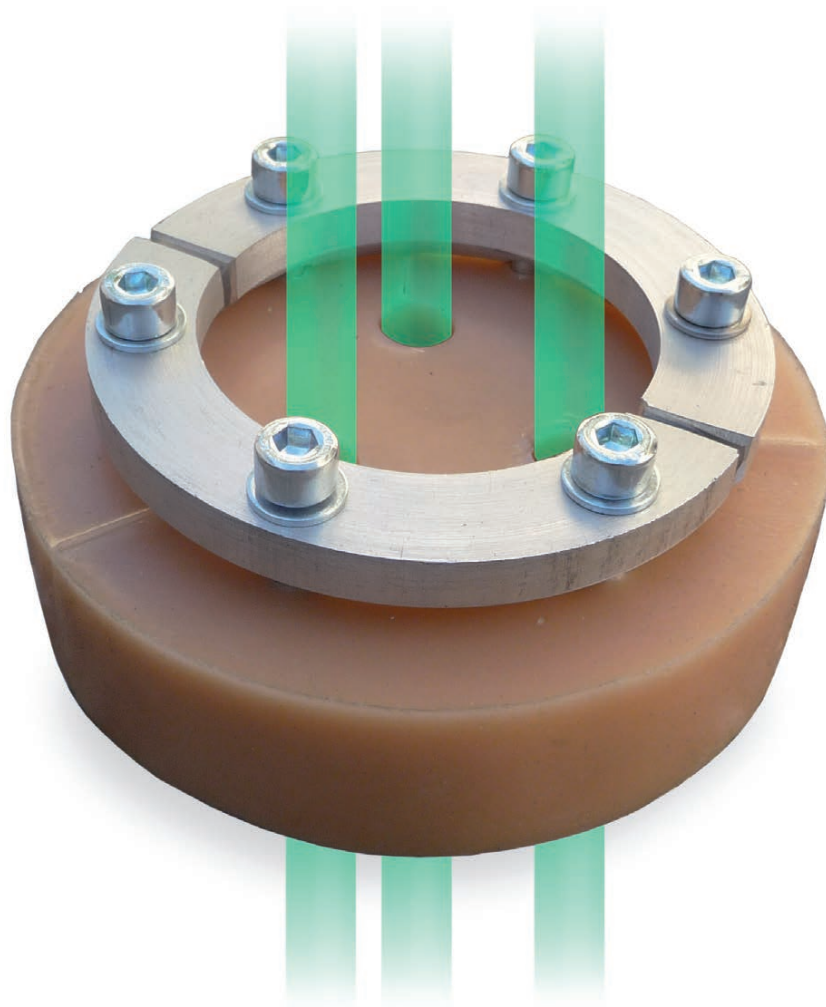
For these emergency situations Drytech has developed a special ex-post gasket system, which allows sealing of the light from the conduit and the cables that pass through it.

The gaskets are made to measure according to the diameter of the pipe and the type and number of cables passing through it.

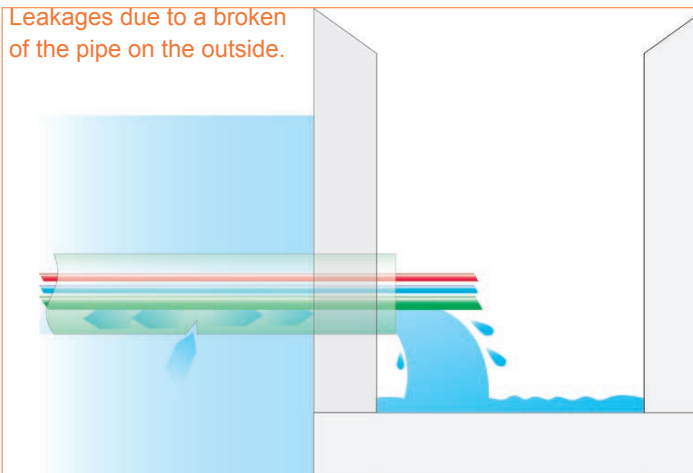
The installation does not require any structural intervention on the plant concerned, thanks to an ingenious system for incorporating the passing cables. The through grid holes injected resin is defonding radially from each point, creating an elastic and expansive curtain at the back of the wall.

It saturates also the joints between bricks, stone walls or pedral sections (as in the photographs).

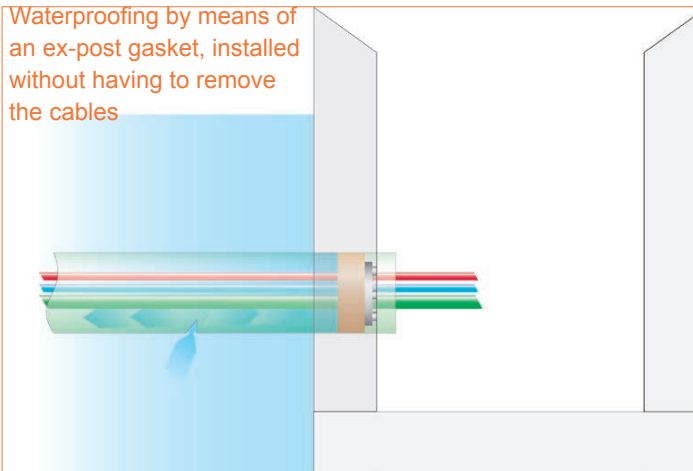
In the case of water coming with pressures above 3 bar, the system provides for the insertion of a double gasket to form an interpedicine which is saturated with DRYflex expanding resin.



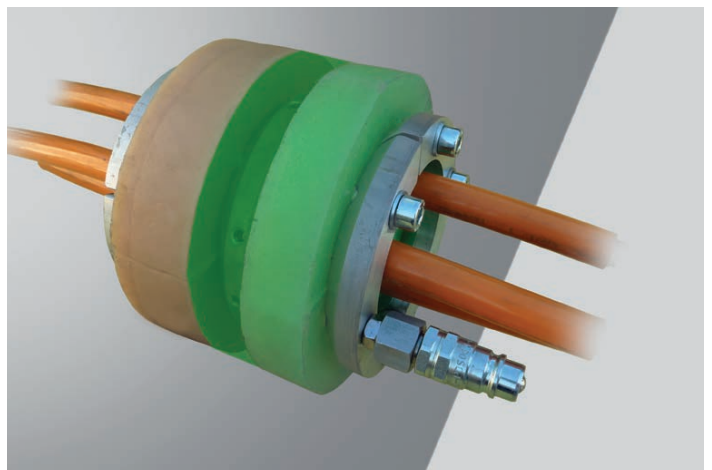
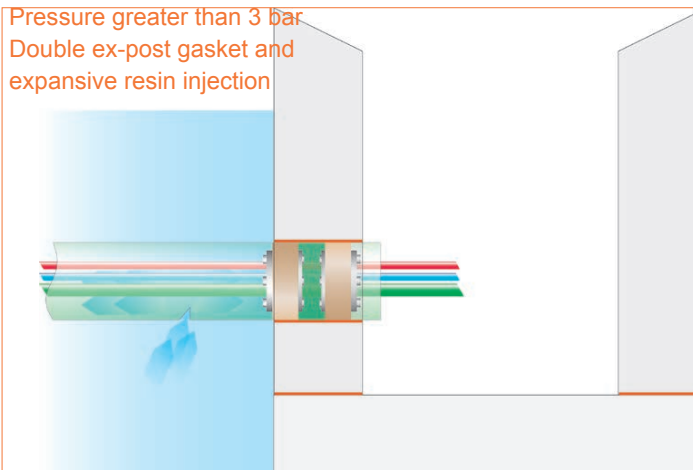
Leakages due to a broken of the pipe on the outside.



Waterproofing by means of an ex-post gasket, installed without having to remove the cables



Pressure greater than 3 bar
Double ex-post gasket and expansive resin injection



INJECTION SYSTEMS REINFORCEMENT

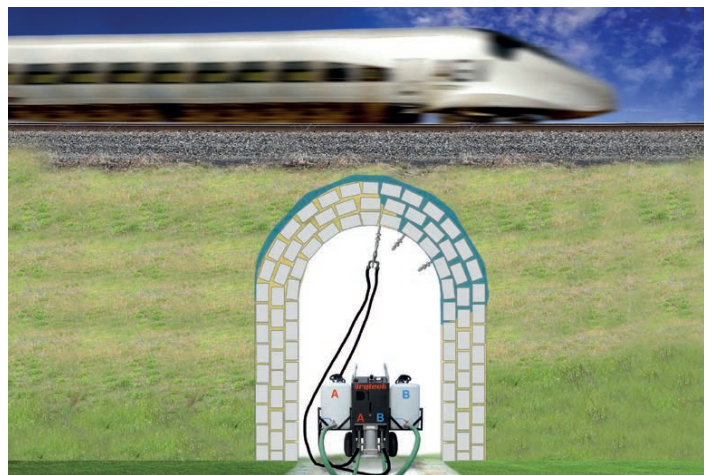
These techniques are applied above all when large quantities of material need to be injected. For example when the ground or the area to be filled assume the load-bearing function:

- > weak and instable ground (e.g. sand, sand mixed with gravel);
- > concrete beds without sufficient load capacity (e.g. limited dead load/insufficient reinforcement);
- > walls, for example in concrete or other materials, that do not support punctual loads (in this case the possibility to carry out injections of curtain grouting must also be checked).

Injections in a railway underpass made of natural stone and solid bricks. Waterproofing and stabilisation of the simple structure subjected to serious damage caused by frost.

The acrylic resins used in low-pressure injection techniques have proved to be particularly suitable for saturating the considerable voids in the structure.

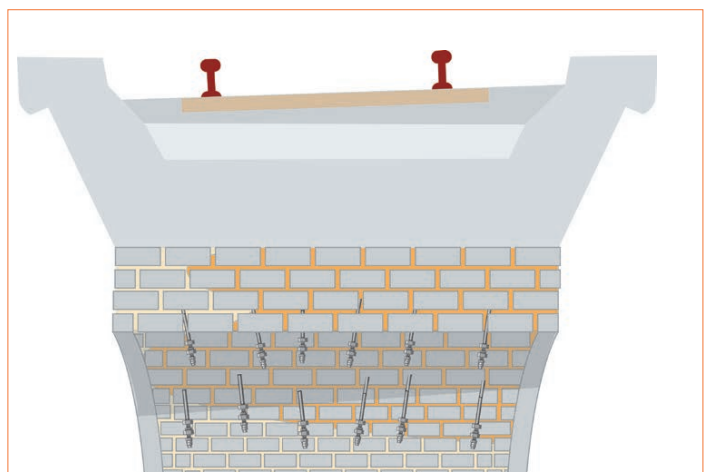
Carried out from within the vault, the work did not require excavation of the rail bed above, thereby avoiding interruptions in the circulation of trains. Night shift working was also not necessary.



VIADUCT ST. URSANNE

Built in 1875-76, it became a historic monument in 1900. The viaduct of St. Ursanne was fully restored between 2000 and 2002.

The original railway viaduct has been replaced with large prefabricated elements, whilst the high stone vaults have been reinforced with injections of cement mortar and micro-cement. The work lasted 8 months overall.



INJECTION SYSTEMS

RESTORATION OF MOTORWAY JOINTS

REPAIR OF STRUCTURAL CRACKS

Drytech waterproofed 1'700 m of joints of an important motorway artery by injecting with DRYflex expanding resin.

The intersections between the ring road route and the existing road network were created via many junctions with underground tunnels. Unexpected settlement following construction made some joints between sections of the carriageway permeable.

Drytech concentrated on injecting the joints with DRYflex expanding resin during the restoration work.

The work did not require the traffic to be interrupted but only a reduction in the lanes.

DRYflex resin can in fact be used effectively in the presence of water so that it was not necessary to drain the area before.

Waterproofing of the movement joints was done with traditional waterstop tapes.

In order to carry out the restoration work any parts falling off were therefore removed, the joints were injected and finally the restoration work was completed.



As well as being unaffected by water, the waterproofing power of DRYflex resin is not affected by the state of the joints which do not need to be cleaned before being injected.

Acting through pressure – and not by adhesion – the resin seals the joints and cracks without sticking to the walls. Due to its expanding quality it adapts to variations in the joint's thickness caused by the traffic and seasonal thermal expansion.



CHEMICAL CURTAIN CAPILLARY HUMIDITY

BOTTMINGEN CASTLE AND MOAT, BASEL

In 1986 Drytech replaced the waterproof gunite of the submerged part of Bottmingen Castle.

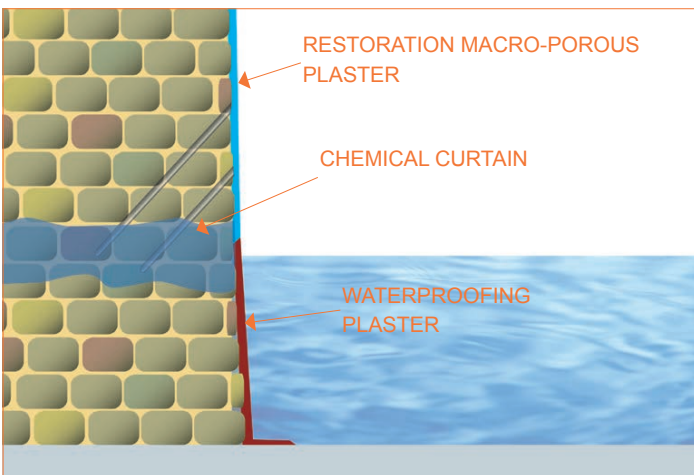
To prevent the capillary rise of water, injections of cement mixed with silicates were carried out before applying the macro-porous gunite.



1986

Below the outline of the work, a photograph of the condition of the submerged construction in 1986, before restoration and waterproofing.

In the photographs: removal of the old plaster and, below, application of the waterproof gunite for the part submerged in water.



1986

REAL EX-POST PLANS

With REAL “Rilievo Estensivo Aumentato Laser” (extensive overall laser survey) Drytech produces a virtual reconstruction of the restored building which contains all information of the intervention.

A complete archive that permits a quick and interactive consulting of pictures and data of the single interventions.

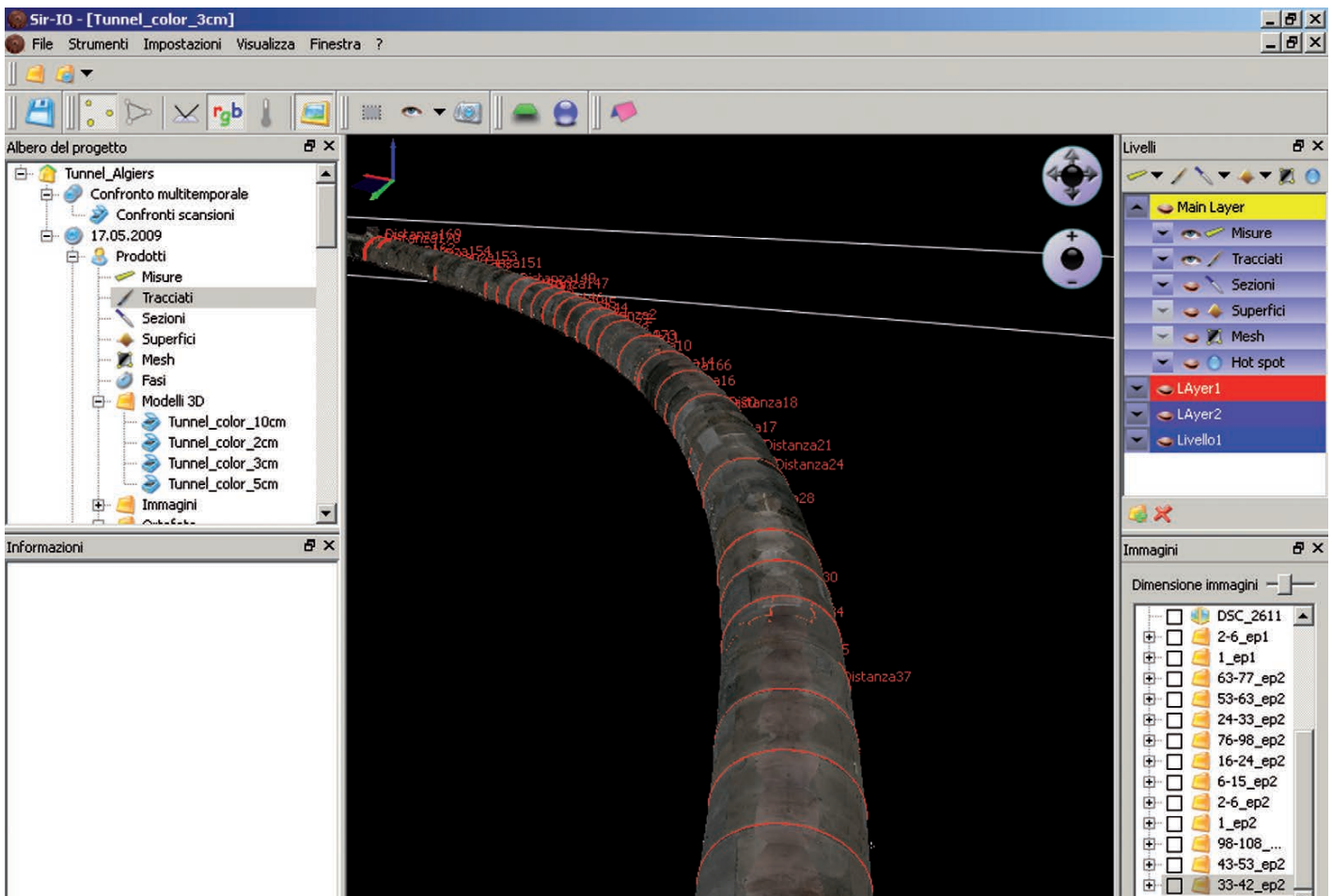
The software REAL has been developed by the company SIR from Turin (Spin-off of the Piemontese Polytechnic, www.sir.to.it), in collaboration with Drytech. It has been used for the first time in 2009 during the restoration process of the metro Algiers.

The REAL has got three application fields:

- > Restoration plans
- > Ex-post plans
- > As built plans (new constructions)

RESTORATION PLANS

With REAL the client can literally travel through the restored construction and consult the respective data of the single intervention areas, such as: position, dimension, type of intervention, material consumption, photographs before and after the restoration.



EX-POST PLANS

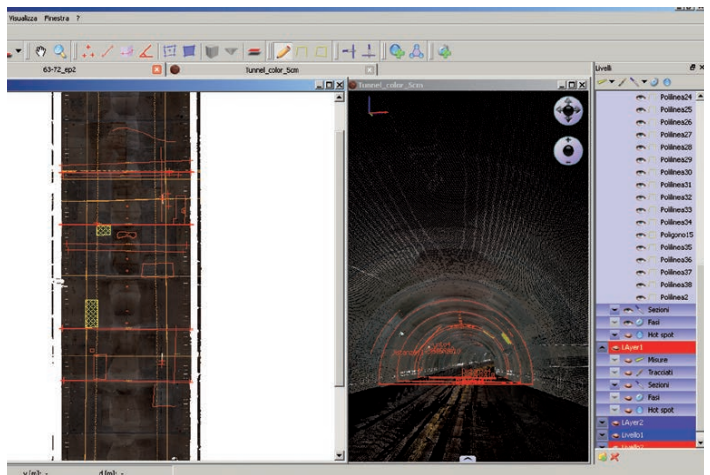
Plans of antique and old buildings are often not available anymore - like for instance the ones of the first built underground railways.

In such cases the client gets from the REAL database Ex-post plans of the structure in order to trace back and certify the restoration works.



AS BUILT PLANS

Developed primarily for restoration works, Drytech can use the REAL also in case of new constructions. This in connection with the quality dossier of the White Tank when the as built documentation and the work progression control is handed out to the client.



APPLICATIONS UNDER GROUND UNDER WATER UNDER PRESSURE

UTILITY TUNNEL UNDER THE RHINE ST JOHANN, BASEL

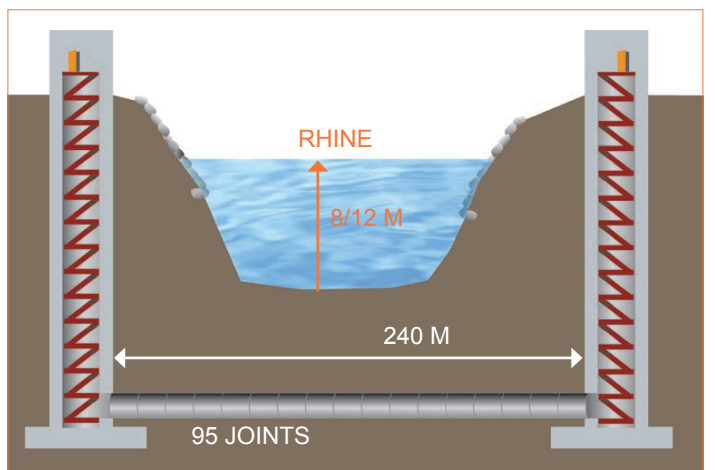
The utility tunnel running beneath the River Rhine at a depth up to 27 metres consists in 95 concrete pipes. The original tunnel was constructed using pipe jacking methods 3.50 m in diameter and had suffered significant damage over time.

A total of 2,000 meters of joints were restored by injecting acryl resin around all concrete pipes to the original watertight conditions.



Applications

- > Basements
- > Underground Car Parks
- > Dams and Reservoirs
- > Water Tanks
- > Swimming Pools
- > Sewers and Pipelines
- > Waster Water Treatment Plants
- > Marine Structures
- > Utility Adits
- > Road Tunnels
- > Railway Tunnels
- > Metros and Underground Stations
- > Immersed Tube Tunnels



AQUEDUCT SAN GIORGIO, CHIASSO

The important infiltration points happened where the carbon filters are fixed between the aqueduct tanks.

In order to re-establish the waterproofing of the tanks, injections with expansive resin through a battery of injectors have been made.

Thanks to this technique the waterproofing specialist can move rapidly between the infiltration points, adapting and modulating the injection to any specific need of the intervention. The efficacy of the work can be checked immediately.

ANTIQUE VAULTED CELLAR, ARISDORF

The restoration of the municipal vaulted cellar of the former school in Arisdorf has been made under the control of the Architectural Conservation Administration as the building is a listed one.

For the re-development of the antique cellar, exposed to continuous humidity and water infiltrations, the existing lime cast had to be removed, joints and stones have been cleaned. A chemical curtain has been built with waterproof DRYflex resin injections. Consequently the joints have been filled with DRYsec Waterstop mortar. Finally, the DRYsec macro-porous plaster has been applied.

At the end the cellar has been painted with white lime colour according to the original technique just as in the begin of 1900.



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Renovation of the piezometric tower with injections of expanding resin carried out from the outside by a nacelle, without having to empty the tank and therefore maintaining the water pressure in operation.