IMPER ITALIA

TUNNELS and UNDERGROUND STRUCTURES

waterproofing systems

TPO/FPO and PVC-P
synthetic membranes

1936

Established since 1936, **IMPER ITALIA srl** is one of Europe's leaders in the production of synthetic and bituminous proofing systems and applications for roofing, water supply networks, tunnels and underground structures.
Since the 1980s Imper Italia materials have been used in natural and artificial tunnels for railway and road networks.
Today, with millions of square metres of SINTOFOIL and EUROFLEX / ECOFLEX waterproofing systems sold in Italy and abroad, it is one of the leading Italian manufacturers for public and civil engineering work.

2015

IMPER ITALIA joins the TECHNONICOL Group, one of the largest producers of waterproofing and insulation applications and bitumen shingles

PRODUCTION LINES

Two lines for synthetic PVC membranes and one for polyolefin membranes.

3 PRODUCTION LINES AT THE MARANO TICINO PLANT (NOVARA) - ITALY

11 TRAINING CENTER

7 RESEARCH AND DEVELOPMENT CENTRES

41 PRODUCTION PLANTS

UNDERGROUND STRUCTURES

All underground structures, including tunnels and foundations, should have a lifespan of many decades. This applies to all building components including waterproofing materials.

The waterproofing and protection system must remain intact for the entire duration of the structure.

Water has often been a major problem for underground works and even recently has been the cause of extremely costly damage.

Water infiltration not only damages concrete, but can also threaten the safety of vehicles inside tunnels.

This is why waterproofing membranes for underground structures must have outstanding physical and chemical characteristics and remain high-performing over very long periods of time.

MEMBRANES

The synthetic waterproof systems produced by IMPER ITALIA are designed, formulated and manufactured to specific application requirements, with optimisation of results in all respects.

The main characteristics of Imper synthetic waterproofing for underground structures are:

- Excellent weldability and ease of installation in harsh environmental conditions such as those found in tunnels.
- Softness and flexibility enabling it to adapt to irregular the installation surfaces.
- Extremely high tensile strength, load and elongation at break, static and dynamic puncture resistance. These are important features for a membrane designed to hold heavy protective guards on supports that are not always even and to withstand possible yielding or shifting of the ground.
- Suitability for installation in humid environments, including near sea water, chemical strength, resistance to attacks from bacteria, fungi, micro-organisms and plant roots.
- Easy access for quality checks during and post-application (pneumatic testing of weld sites with the double seam system).

WATERPROOFING SYSTEMS

When we talk about waterproofing tunnels or underground structures, it is more appropriate to talk about the whole waterproofing system rather than the individual waterproofing layer.

Indeed the waterproofing membrane relies on a whole series of primary and secondary functional elements in order to be effect. These components need to be compatible with each other and applied in the right sequence.

TYPICAL FUNCTIONAL FOUNDATION STRATIGRAPHY

1 - SOIL

2 - LEAN CONCRETE

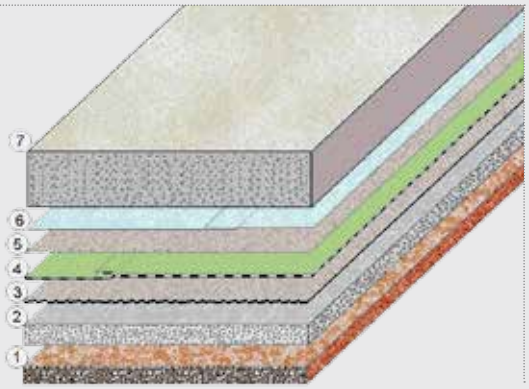
3 - NON-WOVEN GEOTEXTILE COMPENSATION LAYER

4 - SYNTHETIC MEMBRANE SEALING ELEMENT OR IMPERMEABLE LAYER

5 - NON-WOVEN GEOTEXTILE PROTECTION LAYER

6 - POLYETHYLENE FILM SEPARATION AND SLIDING LAYER

7 - FOUNDATION SLAB



COMPONENTS FUNCTIONAL LAYERS

BASIC SUPPORT – SUBSTRATE

The surface onto which the functional layers of the proofing system are installed.
It may consist of shotcrete, lean concrete, blinding, piles.

COMPENSATION LAYER

This compensate for uneven substrates, preventing damage to the waterproofing membrane.
Usually made of a non-woven geotextile weighing no less than 500 g/m².

DRAINAGE ELEMENT

Its function is to collect and dispose of water on the rear side of the waterproof layer (usually consists of corrugated hoses with micro slots).

SEALING ELEMENT OR IMPERMEABLE LAYER

This is installed on the intrados of natural tunnels or the extrados of artificial tunnels or on horizontal and vertical surfaces of foundations. It generally consists of a synthetic waterproof membrane with a thickness of no less than 2 mm, applied in a single or double layer, depending on the required technological solution.

SEPARATION AND PROTECTION LAYER

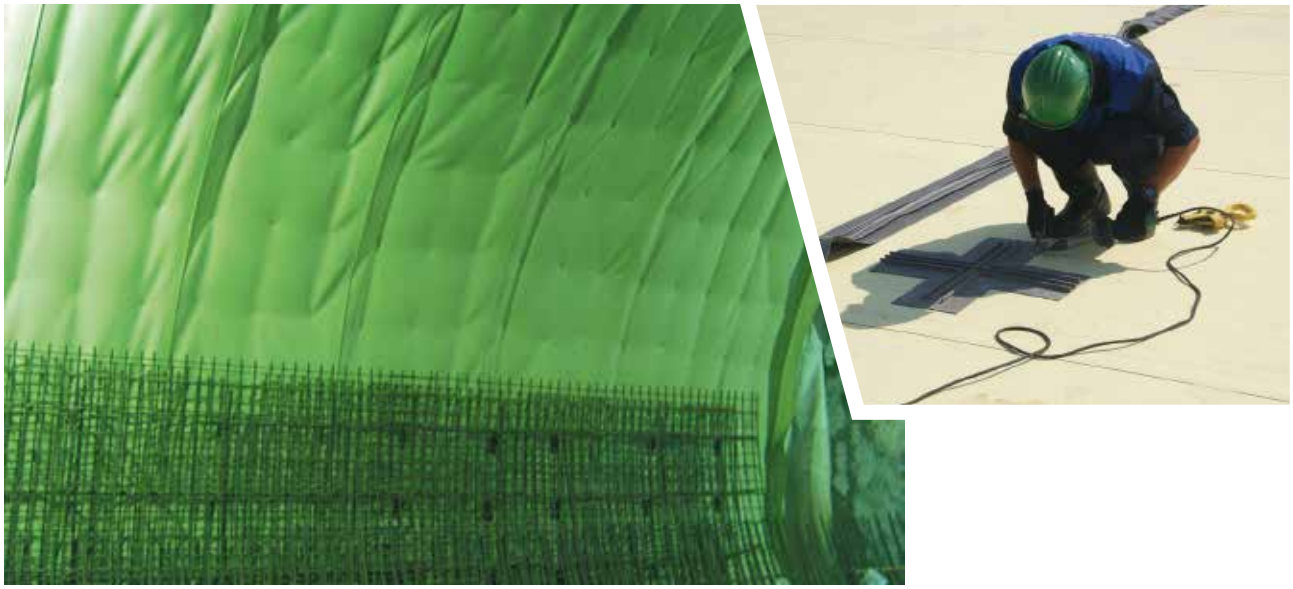
This separates and protect the waterproof membrane from the concrete casting the filling material and generally consists of a synthetic or non-woven geotextile liner weighing no less than 500 g/m².

PARTITIONING ELEMENT

This divides surfaces into sections to facilitate the location of leaks.
It is generally made of PVC-P or TPO joints.

INJECTION AND CONTROL ELEMENT

This enables the integrity of the sealed surfaces to be checked along with any resins injected into partitioned sectors. It is made of pipettes, valves and pipes



UNDERGROUND STRUCTURES

The waterproofing membrane in underground structures is always covered with concrete or soil/filling material. As they are not easy to inspect for infiltrations, higher safety standards are required during the manufacturing stage of waterproofing.

This requirement has led to the development of increasingly efficient and sophisticated waterproofing products and systems to ensure the confinement and straightforward detection of leaks. In some cases, they can also allow for the hydraulic seal to be restored, preventing the hefty cost of demolishing entire structures.

single-layer system	**IMPER SINGLE LAYER** Single-layer system which can be integrated with compartimentation.
sectioned single-layer	**IMPER ACTIVE JOINT** Single-layer sectioned system with injection tubes inside the compartimentation joint.
sectioned single-layer injectable system	**IMPER FAIL-SAFE SYSTEM** Sectioned single-layer injectable system for repair operations with water-reactive resins.
dual-layer vacuum system	**IMPER VACUUM SYSTEM** Sectioned dual-layer system which can be tested with the VACUUM injection system for repair operations with water-reactive resins.

IMPER SINGLE LAYER

SINGLE-LAYER SYSTEM

This is the most commonly used waterproofing system for tunnels and underground structures.

It consists of a single-layer PVC-P or TPO waterproofing membrane applied dry either fully or semi-independently using washers and fixing profiles, interposed with additional compensation, protection, separation and sliding layers.

A drainage system is always provided to collect and dispose of water.

IMPER FAIL - SAFE SYSTEM

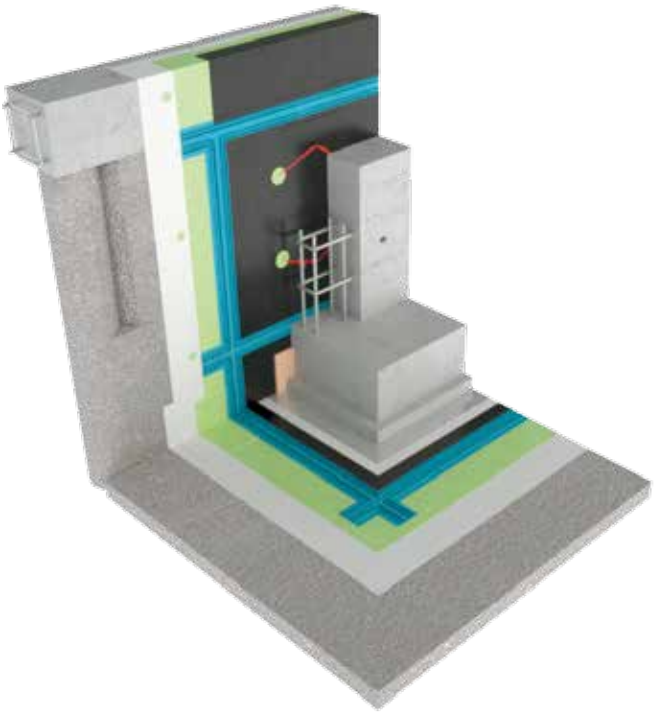
SECTIONED SINGLE-LAYER INJECTABLE SYSTEM

This system is one of the most common for waterproofing natural and artificial tunnels, foundations and underground stations.

The system offers compartimentation of surfaces for easy detection and confinement of infiltrations due to damage to the waterproofing membrane. It is also possible to inject water-reactive resins for repair operations on the waterproof seal of the damaged section.

A key part of the system is the use of a single-layer synthetic waterproofing membrane in combination with synthetic protection layer with the same formulation as the sealing element. This is welded along the edges of the partition joints and can create a gap between the two layers to enable the water-reactive resins used in the repair operation to flow into the damaged section.

Again, as this is a system, the sealing element and the protection element will be integrated with the primary and secondary elements needed to ensure the effectiveness of the chosen solution (partition joints, injection pipettes, pipes, shunt boxes etc.).



IMPER ACTIVE JOINT

COMPARTIMENTATION SINGLE-LAYER SYSTEM

This system integrates the previous system with the compartimentation of the surfaces with special PVC-P or TPO joints thermal fusion welded to the sealing element.

Inside is housed an injection pipe which can be used to inject water-reactive resins to repair the waterproof seal.

In this system, the partition joints are placed along structural joints and construction joints.

Again, as this is a system, the single-layer membrane will be integrated with the primary and secondary elements needed to ensure the hydraulic seal of the system.

IMPER VACUUM SYSTEM

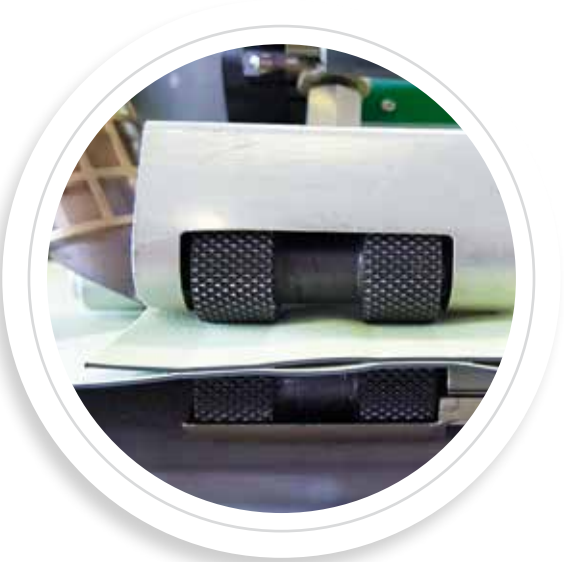
SECTIONED DUAL-LAYER, TESTABLE, INJECTABLE SYSTEM

This is currently the most advanced and most efficient system for proofing tunnels and underground structures.

It combines the ability to partition the surfaces and allows for repair operations with the injection of water-reactive resins. Welds and the entire partitioned sector can be test. This is carried out by creating a vacuum inside the sections using a special VACUUM pump.
A positive test means the welds and the entire section tested are sound. This is achieved in just one operation which can be repeated just before waterproofing works, after positioning the reinforcing bars, after casting the foundation slab and after the structure is complete.

The system's sealing element is a dual-layer PVC-P or TPO membrane with structured contact surfaces to facilitate the vacuum effect and the slip of the injected resins. The two layers are welded together to create sections with dimensions of approximately 100 m^2.

Again, as this is a system, the sealing element will be integrated with the primary and secondary elements needed to ensure the effectiveness of the chosen solution (protection and compensation layers, injection pipettes, pipes, shunt boxes etc.).



Synthetic membranes the most frequently used products world-wide for waterproofing tunnels and underground structures in general.

Contrary to the usual expectations, the strength of these membranes is the ease and effectiveness of welding overlapping layers:

- MANUAL
- AUTOMATIC

THERMAL WELDING

MANUAL THERMAL WELDING

Mainly used for details and for all welds that cannot be performed by an automatic welding device, manual thermal welding is performed using hot air dispensers.

AUTOMATIC THERMAL WELDING

Mainly used for welding side overlaps on waterproofing layers.
Automatic "hot wedge" or "hot air" welding devices with "double seam" system are used to test the pneumatic seal of welds.

As underground structures are inherently complex and difficult to inspect once completed, manufacturing and testing methods have been developed to check the integrity of the water proofing system in operation before the final concrete casting.

INSPECTION OF THE SEALING ELEMENT

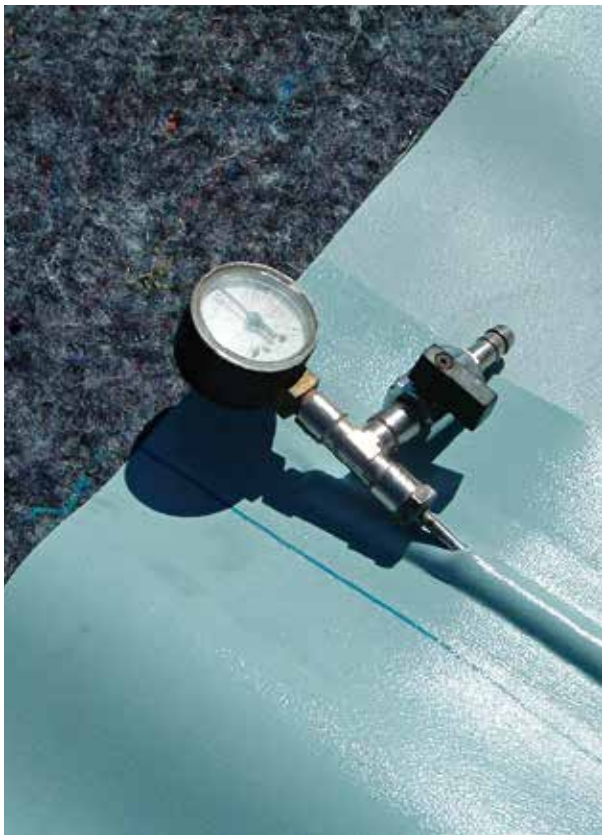
IMPER PVC-P or TPO proofing membranes for underground structures are supplied in two versions:

TRANSLUCENT

Transparent materials are used for these membranes to ensure the purity of the formulation, but also to enable immediate visual inspections of installed sealing elements.
Transparency also immediately highlights any imperfections or carbon residuo on welds. **"double seam"** overlap seals can also be tested using liquid contrast dyes.

SIGNAL LAYER

Membranes with two colours, light on one side and dark on the other.
This allows immediate control of the integrity of the sealing element in place.
If cuts or abrasions are accidentally produce on the surface during site operations, the darker colour of the underside will make them stand out on the light top surface.



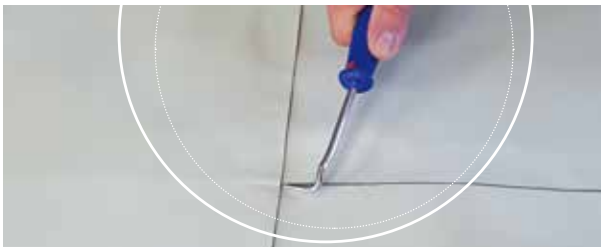
CONTROL AND TESTING OF WELDS

MANUAL welding

Overlap joins by manual thermal welding with a Leister hot air gun can be checked and tested by:

NON-DESTRUCTIVE MECHANICAL TEST

This involves passing a special hooked tool along the welding line, exerting sufficient pressure to detect any weaknesses or insufficient adhesion.



DESTRUCTIVE MECHANICAL TEST

Destructive tensile tests can be performed by removing a strip transversally to the welding line.
This test involves applying a tensile force to the two ends of the strip. If the weld is sound, the break will be outside of it.
This test is performed on sheets already installed and every day before the start of installation on a sample weld.

AUTOMATIC welding

TESTING "DOUBLE SEAM" WELDS

Almost all tunnel membranes, with the exception of the details, are welded to each other using automatic **"double seam"** thermal fusion welding machines.
This system involves welding together two strips of material (seams) by hot wedge or hot air, overlapping the edges of adjacent sheets, leaving a channel between the two welding lines.
This form of welding allows the pneumatic seal of the overlaps to be tested by blowing compressed air into the channel at a pressure of about 2 bar. The test is positive if pressure loss is not greater than 10% after about 10 minutes.
It is clear that a positive pneumatic test means that, the seams are welded perfectly without any margin of error.

VACUUM
BELL TEST

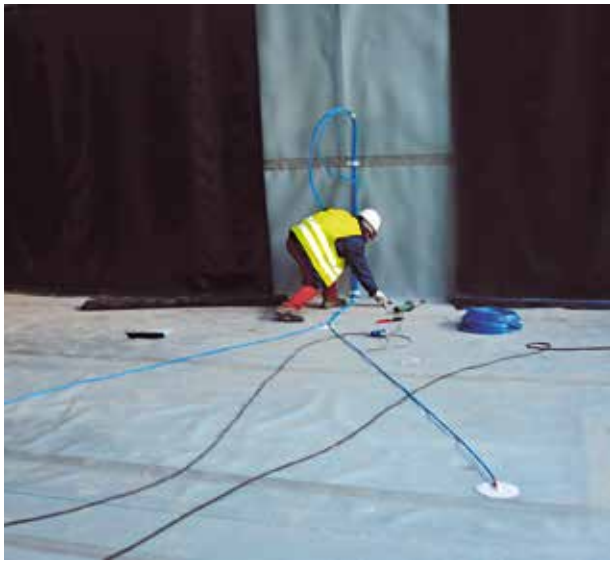
This tests tightness using a vacuum bell and is especially useful for critical areas such as corners or for welds between horizontal potions of membrane and vertical joints.

The supplied compressor creates a depression inside the bell.
A liquid is then used (usually soapy water) to identify any channels that have not been welded, by creating bubbles caused by the passage of air from the intrados of the membrane towards the section facing the bell.

VACUUM
PUMP TEST

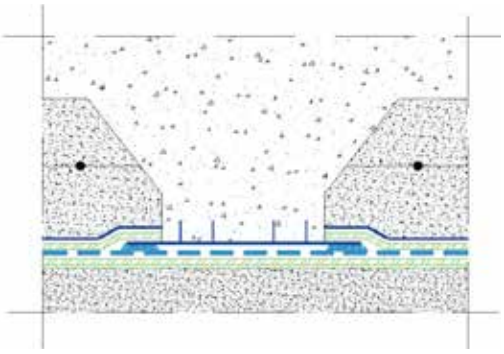
This is performed with the IMPER VACUUM SYSTEM and tests the seal of the partitioned section and the solidity of joints.

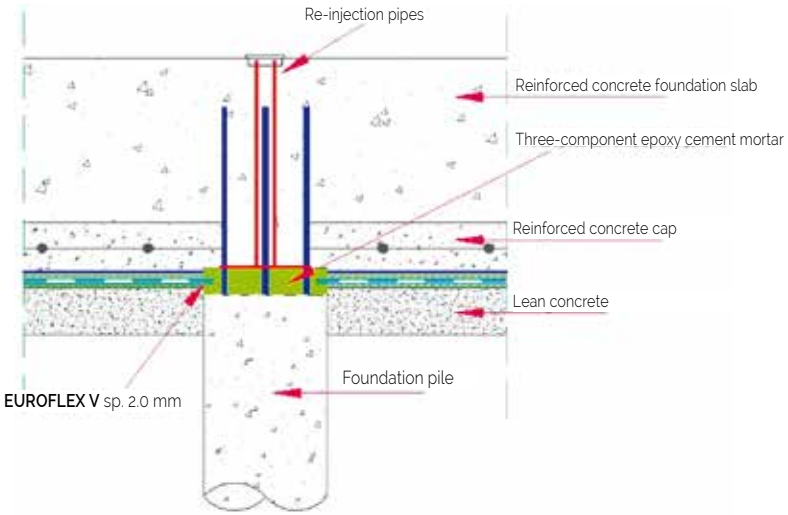
A vacuum pump is attached with a vacuum gauge and valve closure.
The end of this valve is connected via the PVC thermal fusion welded injection hose on the second waterproofing membrane.
After creating a vacuum with a 0.50 bar depression and closing the valve, two values (V1 and V2) are shown on the vacuum gauge 10 minutes apart.
If the seal is tight, the second value must be equal to or lower than the first with a maximum value of 0.10 bars.



With over 30 years of specific research and experience in the underground structures sector, IMPER ITALIA has developed products and systems to ensure the highest proofing standards for even the most extreme and complex cases.

Our technical staff helps customers find the right solutions and prepare tailor-made specifications and drawings especially for more complex systems, such as partitioning.





		SINGLE-LAYER SYSTEMS	SECTIONED SINGLE-LAYER INJECTABLE SYSTEMS	VACUUM SYSTEM
PVC-P	ECOFLEX V	◉	◉	◉
	ECOFLEX V RF	◉	◉	◉
	EUROFLEX V	◉	◉	◉
	EUROFLEX V RF	◉	◉	◉
	EUROFLEX V CRY	◉	◉	◉
	EUROFLEX V RF AT	◉	◉	◉
	EUROFLEX V CRY ST			◉
	ECOFLEX V PT		◉	◉
TPO/FPO	SINTOFOIL ST WPS	◉		◉
	SINTOFOIL RG WPS	◉		◉

TUGHRA TO

since 1936 IMPER ITALIA

Via Rita Atria, 9 · 10079 Mappano (TO) Italy · Tel (+39) 011 222.54.99 ·

imper@imper.it www.imper.it