



TUNNEL AND UNDERGROUND WATERPROOFING SYSTEMS

By PROTAN



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Introduction to Tunnel and Underground Waterproofing

In a world where mobility is essential, tunnels and underground constructions are at the core of a well functioning society. They are, however, constantly subjected to harsh environments and stresses, while required to last for decades or even centuries.

Water pressure, hostile chemical and bacterial environments, gas diffusion, geostatic stresses, vibrations due to traffic as well as weather variations, are among the numerous challenges underground structures need to face and withstand. It is thus vital that these constructions are based on high quality materials, including long lasting and reliable protection systems.

PROTAN has combined its expertise in waterproofing membrane technology and knowledge of tunnels and underground facilities to conceive a durable membrane system for all types of tunnels.



Enhanced Performance



Reduced Lifecycle Cost



Complete Solution Partner





Carefully selected raw materials to meet demanding requirements.



Processing raw materials into premium quality membranes by way of flat-die coextrusion.

PVC-P membranes for ease of installation and long waterproofing service life

Protecting critical infrastructure, securing mobility and providing a well-functioning society rest fundamentally on the quality of the materials and manufacturing processes we decide to use. For PROTAN the preferred choice is to apply membranes of plasticised PVC (PVC-P). Our high performance formulations ensure:

- Long-service life, with an expectancy longer than 100 years.
- High quality joints - easy to install, easy to check and with proven durability.
- Recyclable product with low carbon footprint.
- No harmful chemicals on REACH/ECHA's candidate list of substances of very high concern to human health and the environment.
- Does not contain DEHP (DOP) plasticiser.

Robust homogeneous multi-layer constructions with (or without) signal layer

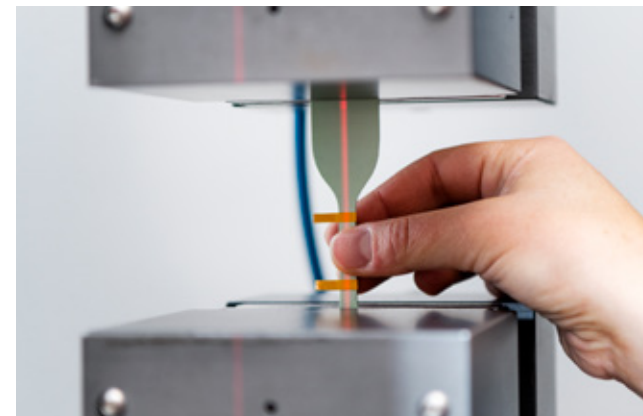
We make our membranes for tunnels and underground structures by flat-die coextrusion technology which secures premium quality throughout.

- Our membranes are made of homogeneous PVC-P.
- A bright coloured top layer serves as a signal layer as the rest of the membrane is dark coloured. Any small damage that may occur during installation will be observed as a scratch in the signal layer and can then be subject to further checking. This feature thereby safeguards the waterproofing capability of the complete membrane system.
- The total build up of the tunnel membranes consists of a bottom layer providing the waterproofing function. The signal layer is laminated on top of the waterproofing part.
- The complete membrane has excellent workability and welding characteristics.

Reinforced membranes for special applications

We also produce thinner tunnel membranes with textile reinforcement.

- These membranes are typically 1,5mm thick.
- The product is reinforced with a PET textile to provide strength and form stability.
- The membrane may also have a PP fleece laminated to the backside to provide better adhesion to concrete.



Factory production control according to the product standards EN 13491/13967 and national guidelines.



Premium quality tunnel membranes for waterproofing service for generations ahead.

Fit-for-purpose for demanding conditions and environments

To comply with all performance requirements, PROTAN tunnel membranes are designed, tested and documented according to characteristics proving mechanical-, thermal-, and hydraulic integrity as well as chemical resistance and durability. With third party audits and secured agreements for external monitoring, PROTAN also ensures that excellency in production and stability of the properties are maintained.

Mechanical, thermal and hydraulic integrity

- Water tightness
- Water permeability
- Mechanical properties (tensile strength, elongation, stiffness, resistance to tearing, resistance to impact)
- Joint strength
- Flexibility at low temperature
- Dimensional stability
- Thermal expansion

Chemical resistance and durability

- Resistance to weathering
- Resistance to oxidation
- Chemical resistance, acidic and alkaline water
- Root resistance
- Resistance to microbiological attack
- Resistance to fire
- Long term performance at high temperatures in air and water (70°C, 365 days)

PROTAN InfraPlan membranes satisfy European standards and national guidelines

The European product standards for waterproofing of tunnels and underground structures and a range of national guidelines serve as the framework that our membranes have to accommodate.

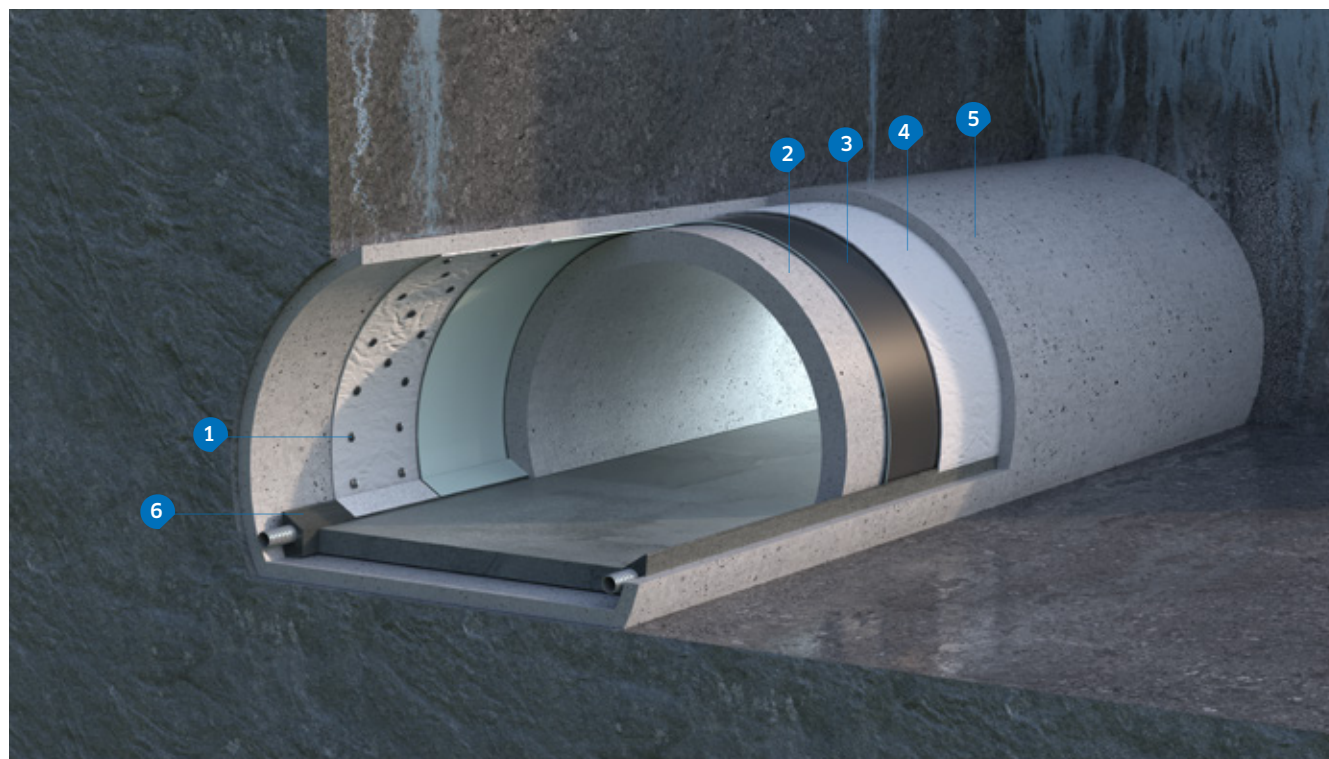
European product standards

- EN 13491: Geosynthetic barriers - Characteristics required for use in the construction of tunnels and associated underground structures.
- EN 13967: Flexible sheets for waterproofing - Plastic and rubber damp proof sheets including plastic and rubber basement tanking sheet. Definitions and characteristics.

National guidelines

- Austria; ÖBV - Tunnel Waterproofing Guideline.
- Germany; Guidelines:
 - ZTV-ING: Zusätzliche Technische Vertragsbedingungen und Richtlinien für Ingenieurbauten.
 - RIL DB 853 Eisenbahntunnel planen, bauen und instand halten.
- Norway; The Norwegian Public Roads Administration; Handbooks for tunnel waterproofing: N500 and R510.
- Switzerland; SIA 272: Abdichtungen und Entwässerungen von Bauten unter Terrain und im Untertagebau.

Umbrella/Drainage System



For partial waterproofing the most common tunnel application is the Umbrella System/Drainage System. This system is specifically designed for tunnels with dripping water conditions.

Examples of Application:

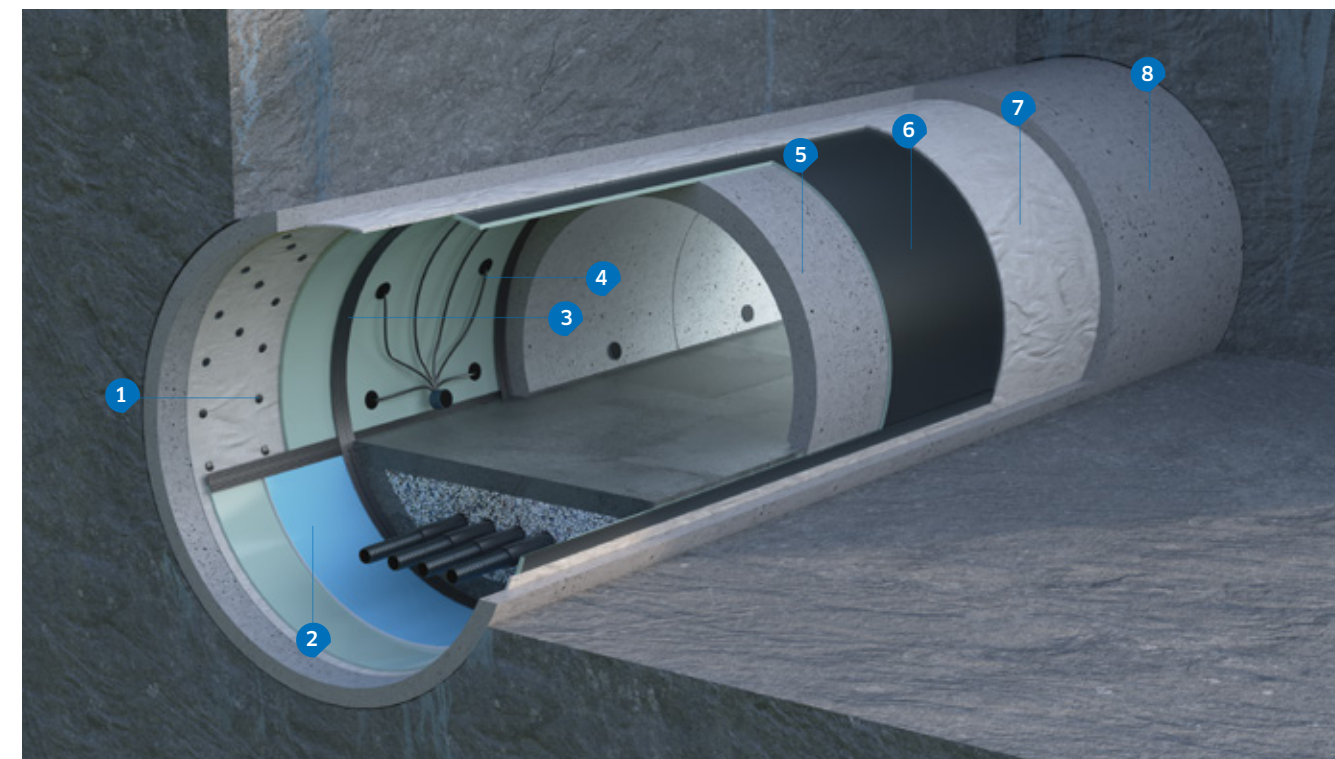
- Road Tunnels
- Railway Tunnels

System description:

1. PROTAN Disc
2. In-Situ concrete
3. PROTAN InfraPlan Tunnel Membrane
4. PROTAN Geo (Geotextile)
5. Shotcrete
6. PROTAN Drain (Drainage Profile)

PROTAN recommends to use InfraPlan P20, P22 or P22+ for drainage applications.

Single/Double Barrier System



PROTAN delivers waterproofing systems for both Single and Double Barrier applications.

Single Barrier System is for hydrostatic water pressure conditions including compartments and injection possibilities. Double Barrier System is also designed to withstand hydrostatic water pressure and combines a test and injection system.

The system consists of two tunnel membrane layers:

- First layer being the main membrane, maximum 4mm thick.
- Second layer, a 2mm membrane is placed on top of the first layer.

To obtain vacuum between the two layers, the second layer membrane is delivered with an embossed surface in contact with the first layer.

Examples of Application:

- Road Tunnels
- Railway Tunnels
- Shafts
- Pressure Galleries

System description:

1. PROTAN Disc
2. PROTAN Protect (Protection Sheet)
3. PROTAN Waterbar
4. PROTAN Inject (Injection hose)
5. In-Situ concrete
6. PROTAN InfraPlan Tunnel Membrane
7. PROTAN Geo (Geotextile)
8. Shotcrete

PROTAN recommends to use InfraPlan P32+ for the Single Barrier System for hydrostatic pressure.

For Double Barrier Systems, PROTAN recommends to use InfraPlan P32+ on the first layer and an embossed InfraPlan P20 as a second layer.

Tunnel Lining Type III (Norwegian Handbooks)



Norway, country of the world's longest road tunnel, has designed its own waterproofing system, created to fit Norwegian harsh weather conditions.

For tunnels with dripping water conditions, the Norwegian Road Authorities recommend to use a Type III membrane, a reinforced membrane that will provide strength and stability. The system consists of a waterproofing membrane mounted on an anchor grid, spaced with approximately 50cm to the shotcrete covered rock/mountain. On the inside, towards the traffic, the membrane is either covered with concrete elements or with shotcrete.

For shotcrete applications, PROTAN recommends geotextile (polypropylene fleece) laminated membrane for increased adhesion. This will minimize the shotcrete waste/rebound and reduce costs.

System description:

1. Anchor grid
2. Inner shotcrete
3. PROTAN InfraPlan P15R/RX
4. Rock/Shotcrete

PROTAN recommends to use InfraPlan P15R or P15RX for Tunnel Lining Type III

In addition to Mined Tunnels, PROTAN can also deliver full waterproofing systems for a wide range of applications for underground structures.

Cut and Cover – Umbrella System

For umbrella systems, a loose laid system for evacuation of water in tunnels with compartments, PROTAN recommends the following system:

- PROTAN InfraPlan Tunnel Membrane
- PROTAN Disc
- PROTAN Geo (Geotextile)

Thanks to its remarkable properties against groundwater and chemicals, PROTAN InfraPlan is a safe choice to ensure longevity of the waterproofing of drained systems.



Cut and Cover Tunnel Application.

Cut and Cover – Barrier System

For pressurized water conditions with compartments and injection system, PROTAN recommends the following system:

- PROTAN InfraPlan Tunnel Membrane
- PROTAN Disc
- PROTAN Protect (Protection Sheet)
- PROTAN Inject (Injection Hose)
- PROTAN Geo (Geotextile)
- PROTAN Waterbars or PROTAN Seal Tape

PROTAN InfraPlan membranes will provide a robust and durable system to withstand hydrostatic pressure in tunnels with barrier protection.

Cross-Passages

PROTAN also offers high performance solutions for waterproofing of cross-passages between parallel tunnels or as transition within sections.

Our PVC sealing tape PROTAN Seal Tape is designed to ensure continuity of the protection system, by keeping the same level of robustness along the structure and is a perfect fit for cross-passages applications.

Portal and Culverts

Root and microbiological resistance, stability and of course watertightness, are among the properties that make PROTAN InfraPlan membranes also an asset for portals and culverts.

PROTAN recommends use of InfraPlan P20/P22 for this type of applications as it combines all required characteristics while contributing to easy handling and installation.

Other systems and waterproofing solutions are available, PROTAN will assist you to find the most suitable system for your project.

PROTAN InfraPlan tunnel membranes are particularly developed to withstand harsh environments and to secure fast and high quality installation. Indeed, the nature of PVC membranes provides excellent workability, efficient and safe welding and waterproofing integrity for the full service life of underground structures.

PROTAN InfraPlan

PROTAN InfraPlan is a homogeneous, flexible PVC-P membrane designed for durability, reliability and flexibility. PROTAN InfraPlan is a high performance and polyvalent product, perfect for a wide range underground applications.



	P20	P22
Thickness	2,0mm	2,2mm
Signal Layer	Mint Green	0,2mm -0,05/+0,3mm
Material	PVC-P Can contain recycled material	

PROTAN InfraPlan +

PROTAN InfraPlan + is a homogeneous, flexible PVC-P membrane, specially developed to answer stringent requirements of the German and Austrian markets. PROTAN InfraPlan + is a perfect fit for high-demanding applications.



	P22+	P32+
Thickness	2,2mm	3,2mm
Signal Layer	Mint Green ≤ 0,20mm	
Material	PVC-P Max. 10% recycled material	

PROTAN InfraPlan R

PROTAN InfraPlan R is a textile reinforced PVC-P membrane, designed for strength and stability. InfraPlan R is also available backed with geotextile to limit shotcrete rebound and waste.

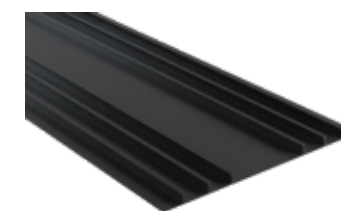


	P15R	P15RX
Thickness	1,5mm	
Colour	Dark Grey	
Material	PVC-P Can contain recycled material	
Reinforcement	PET Textile	PET Textile Backed Geotextile

CERTIFICATIONS

	N500	R510	ZTV-ING	RIL DB 853	ÖBV (4.6 and 4.7)	SIA 272
PROTAN InfraPlan P20	✓	✓	—	—	—	—
PROTAN InfraPlan P22	✓	✓	—	—	—	—
PROTAN InfraPlan P22 +	—	—	✓	✓	✓	✓
PROTAN InfraPlan P32 +	—	—	✓	✓	✓	✓
PROTAN InfraPlan P15R	✓	✓	—	—	—	—

A full range of accessories is available to make your waterproofing system fully compatible with InfraPlan membranes.



PROTAN Waterbar
 Material: PVC-P
 Dimension: 600mm - 6 ribs
 Colour: Black
 Also available in smaller dimensions



PROTAN Geo (Geotextile)
 Material: Polypropylene fleece
 Dimensions: 300g, 500g, 950g
 Colour: White
 Other weights available on request



PROTAN Protect (Protection Sheet)
 Material: PVC-P
 Thickness: 3,2mm including signal layer
 Colour: Light blue
 Also available in other thicknesses and without signal layer



PROTAN Inject (Injection Hose)
 Material: PVC-P
 Dimensions: Ø11mm, Ø19mm
 Colour: Blue



PROTAN Disc
 Material: PVC-P
 Dimension: Ø80mm
 Colour: Black
 Other: Built-in steel washer



PROTAN Drain (Drainage Profile)
 Material: Unplasticised PVC
 Dimension: 3mm x 220mm x 180mm x 250mm (32° angle)
 Colour: Black

Also available:

- PVC Seal Tape
- Anchor System (for Tunnel Lining Type III)
- Hydrophilic Strips
- Injection Connectors

Let's get to work

Get in touch with us to learn more about InfraPlan and how we can work together on your next project.

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