



Solutions for waterproofing civil engineering works



# Civil Engineering Underground Hydraulic Bridges

# underground works

**SOPREMA**  
GROUP

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## unique expertise

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# SOPREMA

## introduction

**S**An independent group since its creation over 100 years ago, **SOPREMA** is firmly established as one of the world's leading waterproofing companies, producing more than 150 million square metres of membranes a year.

**SOPREMA** has a global industrial presence with a workforce of over 4 300 individuals and a turnover exceeding 1.2 billion Euros. With 15 production facilities, including 11 in Europe, 18 subsidiaries and 40 distributors, 4 training centres and 5 research and development laboratories which are heavily focused on sustainable development, we operate in more than 80 Countries around the World.

Close collaboration between a dedicated team of specialists and the research and development laboratories, means that our product portfolio is innovative and perfectly in step with the demands of the market and current standards.

Thanks to its acquisition in 2007 of **FLAG SPA**, an Italian company producing synthetic membranes, **SOPREMA** has strengthened its expertise in the field of synthetic waterproofing.

**FLAG** develops high performance synthetic membrane made of both PVC and TPO for waterproofing tunnels, underground structures, retention ponds, canals, etc.

A leader in this market, **FLAG** has over 40 years experience and has accompanied its clients everywhere in the world, to lay over 100 million square metres of waterproofing membranes.



for all civil engineering  
projects

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**S****SOPREMA** has a wide range of products to meet the needs of all types of civil engineering structures:

- Bituminous waterproofing
- Synthetic waterproofing (PVC and TPO)
- Liquid waterproofing

In order to meet the specific demand, **SOPREMA** has created the **CivilRock®** range, which offers products designed to support the requirements of civil engineers for all types of structures:

- Civil engineering structures, bridges and car parks
- Tunnels, underground & basement structures
- Basins, hydropower dams, canals, lakes, ponds and tanks including those to be used to store potable water

**CivilRock®** covers all the activities connected to these structures, which were previously covered by the group's different brands: **SOPREMA**, **FLAG**, **Alsan®**... This has given us the chance to offer a more complete range which better matches the requirements of clients, project managers and contractors.

With its different types of products, **CivilRock®** offers waterproofing or sealing solutions adapted to virtually all built structures. All the **SOPREMA** group's factories are certified ISO 9001 with some also certified ISO 14001, ISO 16001, ISO 18001.



## ■ WATERPROOFING: SYNONYMOUS WITH DURABILITY AND SAFETY

Waterproofing is one of the essential issues when building underground structures.

In today's market, projects require to be designed for a life in excess of 100 years and so the products used must meet demanding requirements in terms of performance and duration.

To guarantee the durability of structures, it is essential to protect them from the effects of water in order to avoid metal corrosion and concrete carbonation. This is one of the roles of the waterproofing.

For road tunnels, the presence of water can also create risks to the safety of traffic. In railway tunnels, signals and electrical systems can be damaged by water infiltration.

The quality and durability of the products used are essential to the user safety.

The waterproofing products and solutions used must be adapted to each project in order to meet not only the technical requirements, but also the budgetary obligations. The choice of the solution will play a fundamental role in the final operating cost of the structure.

Each project must be completed by a competent and experienced contractor and the installation must be planned from the design stage.

When waterproofing any underground structure, it is necessary to distinguish between a system of protection against water ingress where there is no pressure involved, a system of drainage or a solution that must withstand considerable levels of pressure. In the first case, a system with protection in the crown is sufficient, whereas in the case of a structure under pressure, it will be necessary to waterproof the whole structure with higher performance systems.

## ■ WHAT TYPE OF WATERPROOFING TO CHOOSE?

CivilRock® proposes two main ranges of products for underground works:

- Synthetic membranes
- Bituminous membranes

Synthetic membranes are used as the waterproofing layer in the construction of bored tunnels and linings.

Thanks to the multitude of possibilities that these membranes offer, they are capable of providing technical solutions for even the most demanding projects.

Bituminous membranes are laid fully adhered to structures which are to be backfilled. Therefore, these solutions are particularly suited to open cut structures built in the open air using prefabricated elements or with covered slabs. These membranes have excellent performances in terms of puncture and root resistance.



## **A SUITABLE SYSTEM OF SYNTHETIC WATERPROOFING**

The waterproofing system must be designed appropriately and suitable materials used.

**CivilRock®** proposes different solutions varying from the most sophisticated to the simplest, from the most economical to the safest.

The system used will depend on the degree of reliability required. The properties of the geomembrane waterproofing system will vary according to the thickness of the membranes, whether or not it is compartmentalised, the use of mechanical protection and in some cases the possibility of carrying out tests and repairs. It is even possible to install a system that guarantees the possibility of carrying out tests during construction, but also throughout the lifespan of the structure, to facilitate its maintenance.

There are numerous solutions ranging from a simple geomembrane to very technically sophisticated systems to meet the specific requirements of underground structures.

The main options are:

- A single-layer system
- A single-layer system with compartmentalisation
- A single-layer system with compartmentalisation and the possibility of injection
- The **FLAG Vacuum** system



The **FLAG Vacuum** system is the most complete system. It offers the possibility of carrying out tests throughout the construction phases, but also after completion. This system also makes it easy to find any defects, which can then be repaired at low cost (no excavations or uncontrolled injection).

In all cases, to guarantee the correct installation of a waterproofing system, a qualified contractor must be chosen. The implementation of suitable procedures and adequate quality control with experienced installers is the key to success.

**CivilRock®** provides numerous contractors with support, whether in terms of training and technical development or on the economic and commercial side for projects all over the world.



## **■ SPECIALLY DESIGNED MATERIALS**

**CivilRock®** works with the **SOPREMA** group's research and development laboratories to create and test new products specifically designed to meet the requirements of underground works projects. This has enabled us to put together an offer perfectly suited to our clients and partners.

The **CivilRock®** product range for tunnels and underground structures has been designed, formulated and manufactured to meet the needs of each project and the requirements of installers:

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- Excellent weldability
  - Flexibility and mechanical strength
  - Resistance to micro-organisms and perforation by roots
  - Long service life.

The membranes may also have specific features to meet the requirements of particular standards. For example, additives can be used to increase fire resistance.

**CivilRock®** also offers all the accessories and equipment necessary to carry out the projects: joints, injection hoses, laminated sheets, rondels, hot air welding and testing equipment. Numerous other products provide solutions for all types of issues.

## **■ A DEDICATED TEAM**

The **CivilRock®** team consists of people who work exclusively on civil engineering projects. They are technicians rather than sales people and will help to design the project.

Working closely with the researchers in R&D, the **CivilRock®** team develops new products adapted to and compatible with different construction materials.

Throughout Europe, these specialists work alongside designers, engineers, general contractors and installers to provide help and advice to ensure the successful completion of the waterproofing project.

**CivilRock®** also accompanies its partners on projects outside Europe.

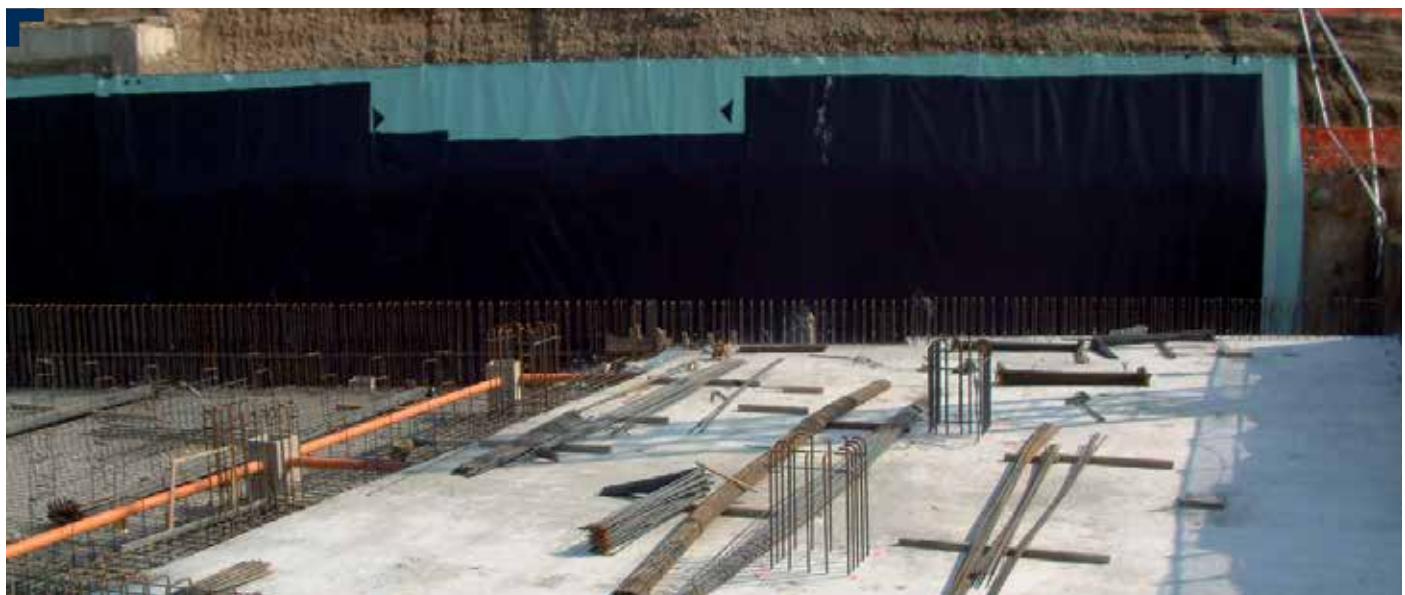


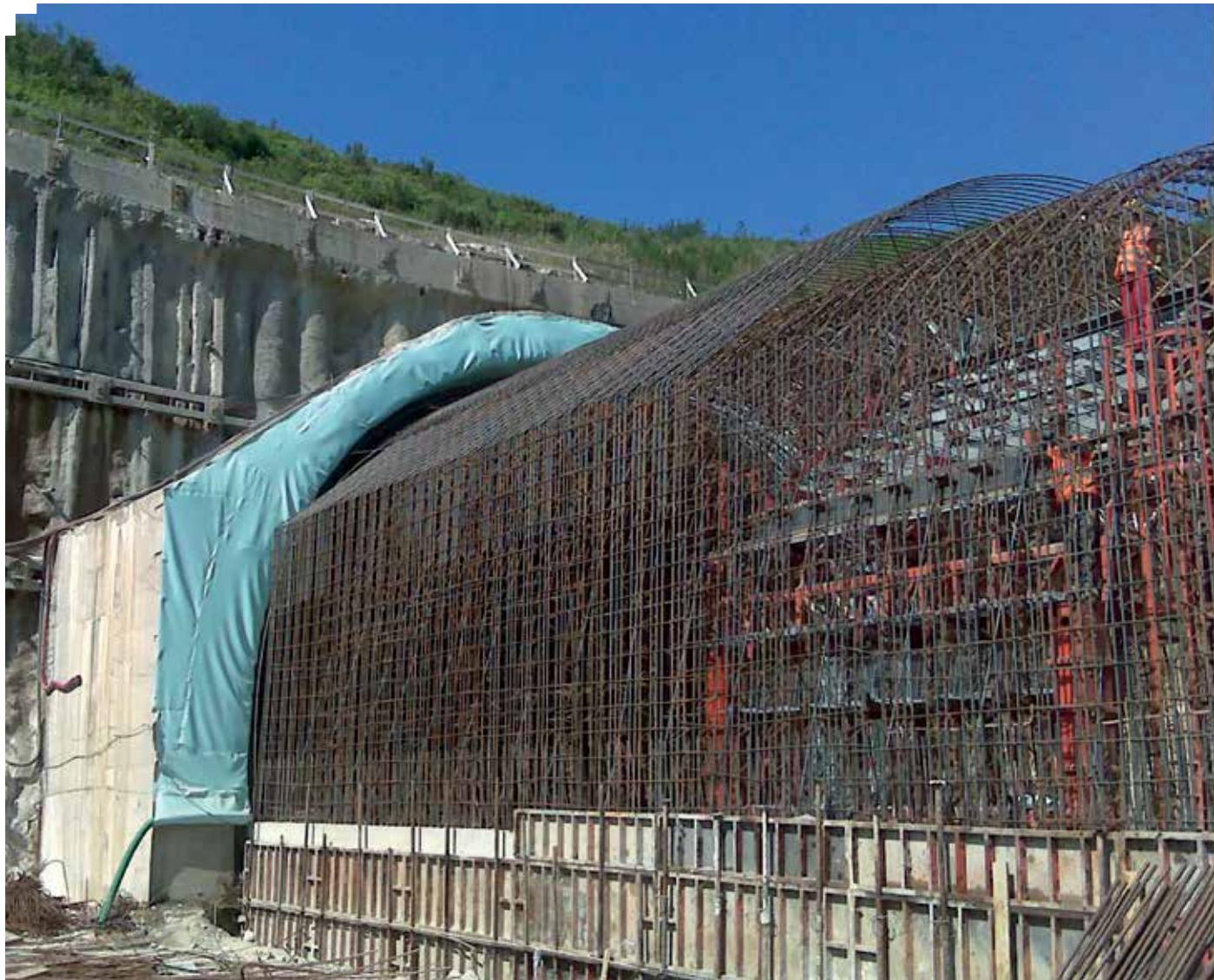
## ■ THERMOFUSION WELDING

**CivilRock®** membranes are welded using hot air or by heated contact, either by hand or mechanically. It is preferable to use manual welding only for the ends of the joints between membranes. Careful use of the welding nozzle and good rolling will ensure correct assembly of the membranes. It should be noted that the quality of the welding depends on many factors: temperature, speed, rolling, the operator's attention... This is why it is preferable to use a mechanised method.

The heat welding machine (the SALDAMAX) consists of two heating cones which weld the membranes to each other to produce a double seam and a central groove. The machine allows a maximum overlap of 100 mm, but 80 mm is recommended.

The machine is self-guided. As well as producing regular welds, the double welding technique allows the quality of the weld to be tested. Simply apply pressured air to the central groove and wait to see if the pressure diminishes. The quality of the weld can therefore be checked along all its length.





## MAIN PRODUCTS FOR TUNNELS AND UNDERGROUND STRUCTURES

	<b>Flagon® Tunnel</b>	<b>Flagon® BSL</b>	<b>Flagon® BT/I</b>	<b>Flagon® BT France</b>	<b>Flagon® PM/SL</b>	<b>Antirock® PR</b>
<b>Intended use</b>	Tunnels	Tunnels Foundations Underground structures Backfilled structures	Tunnels Foundations Underground structures Backfilled structures	Tunnels Foundations Underground structures Backfilled structures	Tunnels Foundations Underground structures Backfilled structures	Structures under backfill
<b>Description</b>	Geomembrane two-coloured PVC-P with signal layer	Geomembrane two-coloured PVC-P with signal layer	Translucent PVC-P geomembrane	Translucent PVC-P geomembrane	Geomembrane two-coloured TPO with signal layer	Bituminous membrane adhered to the substrate
<b>Thickness</b>	2.0 mm and 3.0 mm	2.0 mm and 3.0 mm	1.5 mm, 2.0 mm and 3.0 mm	2.0 mm	2.0 mm and 3.0 mm	4.0 mm on selvedge
<b>Approvals &amp; Certifications</b>	CE	CE NPO Fire Centre (Russia)	CE	CE Technical approval CETU (France) ASQUAL (France)	CE	Technical approval CETU (France)



## OTHER PRODUCTS

- **Elastocol® 500 TP:** Universal primer for bituminous membranes
- **Aquadere® TP:** Solvent-free primer for bituminous membranes
- **Ep5 Performa:** Bituminous membrane
- **Flashing® TP:** For waterproofing upstands and details
- **Flagon® PZ:** PVC-P membrane
- **Flagon® PZ 1,9 France:** PVC-P membrane for **Flagon® BT 2.0 France**
- **Flagon® BT/ST:** Translucent, structured PVC-P membrane for **Flag Vacuum** system
- **Flagon® P:** TPO membrane for waterproofing tunnels undergoing renovation
- **Flagon® PM/SL:** Two-coloured TPO membrane with signal layer
- **Flagon® TPO PZ:** Protective TPO membrane for **Flagon® P**
- **Flagon® TPO PZSL:** Two-coloured protective TPO membrane with signal layer
- **Protecdrain® and Protecdrain® filtre:** Drainage sheets
- **Sopramur®:** Waterproof coating for foundations
- **Accessories PVC:** Waterstops, laminated sheets, injection hoses and fastening washers
- **Accessories TPO:** Waterstops, laminated sheets, injection hoses and fastening washers

# major references



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underground



# major references

## REFERENCES - UNDERGROUND STRUCTURES, TUNNELS

### France:

- A89 - Le Violay, Bussières and Chalosset tunnels - 320,000 m<sup>2</sup>
- South-east TGV line - Lot 3M (Marseille tunnel) - 230,000 m<sup>2</sup>
- Toulouse metro (Lot 2) - 50,000 m<sup>2</sup>
- Météor station (Paris) - 11,200 m<sup>2</sup>
- CEA VALDUC (centre for nuclear studies) - 17,000 m<sup>2</sup>
- La Hague storage centre (2nd phase) - 3 000 m<sup>2</sup>

### Italy:

- Over 10,000,000 m<sup>2</sup> have been installed in underground structures projects in Italy

### Spain:

- Bubierca-Dehesillas-Castejón tunnel - 160,000 m<sup>2</sup>
- La Cabrera y Bunol tunnel - 155,000 m<sup>2</sup>
- M. Pesquera tunnel - 187,500 m<sup>2</sup>
- La UTE San Pedro tunnel - 315,000 m<sup>2</sup>
- Arlaban tunnel - 180,000 m<sup>2</sup>
- Piteira, Barro y Outeiro tunnel - 187,000 m<sup>2</sup>

### Czech Republic:

- Metro Line IV (C2 Prague) - 570,000 m<sup>2</sup>

### Turkey:

- Ankara metro - 240,000 m<sup>2</sup>
- Istanbul metro (several sites) - over 240,000 m<sup>2</sup>

### Austria:

- Wienerwaldtunnel - 560,000 m<sup>2</sup>
- Vomp tunnel - 390,000 m<sup>2</sup>
- H2 Brixlegg tunnel - 260,000 m<sup>2</sup>
- Strengen tunnel S16 - 320,000 m<sup>2</sup>
- Plaubutschtunnel - 270,000 m<sup>2</sup>

### Bulgaria:

- VITINJA tunnel - 24,500 m<sup>2</sup>
- TOPLY DOL tunnel - 44,000 m<sup>2</sup>

### Slovenia:

- Trojane - 160,000 m<sup>2</sup>
- Podmilj - 50,000 m<sup>2</sup>

# works in Europe

### Portugal:

- Isla de Madeira motorway - 140,000 m<sup>2</sup>
- Lisbon metro - 25,000 m<sup>2</sup>

### United Kingdom:

- CTRL 410 North Downs tunnel - 130,000 m<sup>2</sup>
- Ramsgate tunnel - 30,000 m<sup>2</sup>
- Hindhead tunnel cut and cover - 5,000 m<sup>2</sup>
- Tyne tunnel SCL - 8,000 m<sup>2</sup>

### Ireland:

- Port of Dublin tunnel - 120,000 m<sup>2</sup>

### Croatia:

- Brinje/Gric tunnel - 150,000 m<sup>2</sup>
- Krapina tunnel - 200,000 m<sup>2</sup>

### Montenegro:

- Sozina - 54,000 m<sup>2</sup>
- Vrmac tunnel - 60,000 m<sup>2</sup>

### Greece:

- Tunnel Driskos - 270,000 m<sup>2</sup>
- Tunnel Kakia Skala (Highway) - 25,000 m<sup>2</sup>
- T8 Ioannina - 150,000 m<sup>2</sup>
- Egnatia Odos Tunnels - 500,000 m<sup>2</sup>
- Patra-Thessaloniki Detour St Konstantinos - 250,000 m<sup>2</sup>
- Tunnel du métro Holargos - 55,000 m<sup>2</sup>
- Tunnel Egnatia Odos - 500,000 m<sup>2</sup>
- Tunnel Grevena - 400,000 m<sup>2</sup>

### Switzerland:

- Montaigre tunnel - 30,000 m<sup>2</sup>
- Cut and cover method - 60,000 m<sup>2</sup>



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