



**CIVIL**  
ENGINEERING

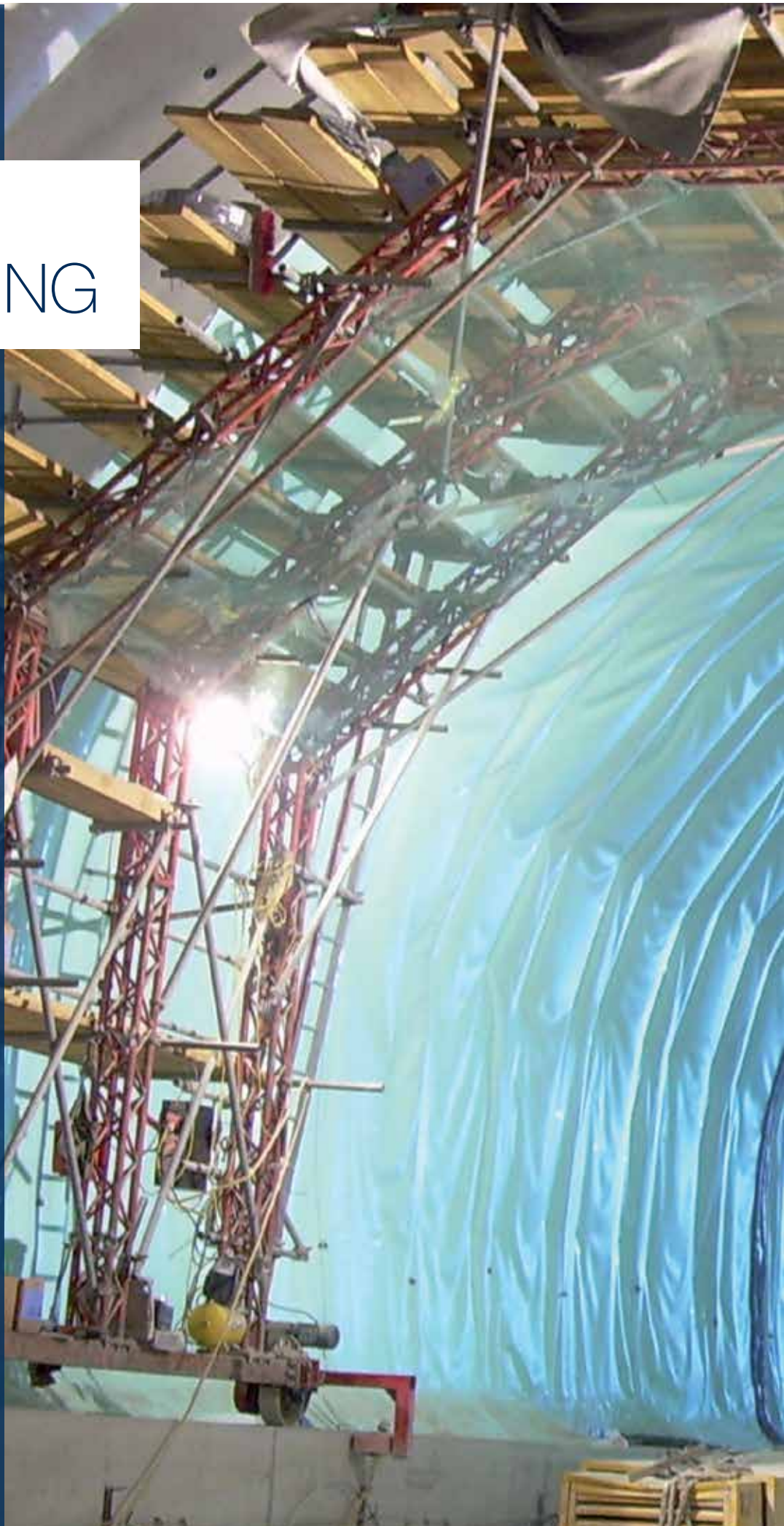
# TUNNEL WATERPROOFING SYSTEMS

# CIVIL ENGINEERING

## *INTRODUCTION*

An independent group since its creation over 100 years ago, SOPREMA is firmly established as one of the world's leading waterproofing companies. SOPREMA has been producing synthetic membranes for underground works since the mid 60's and has always been at the forefront of innovation.

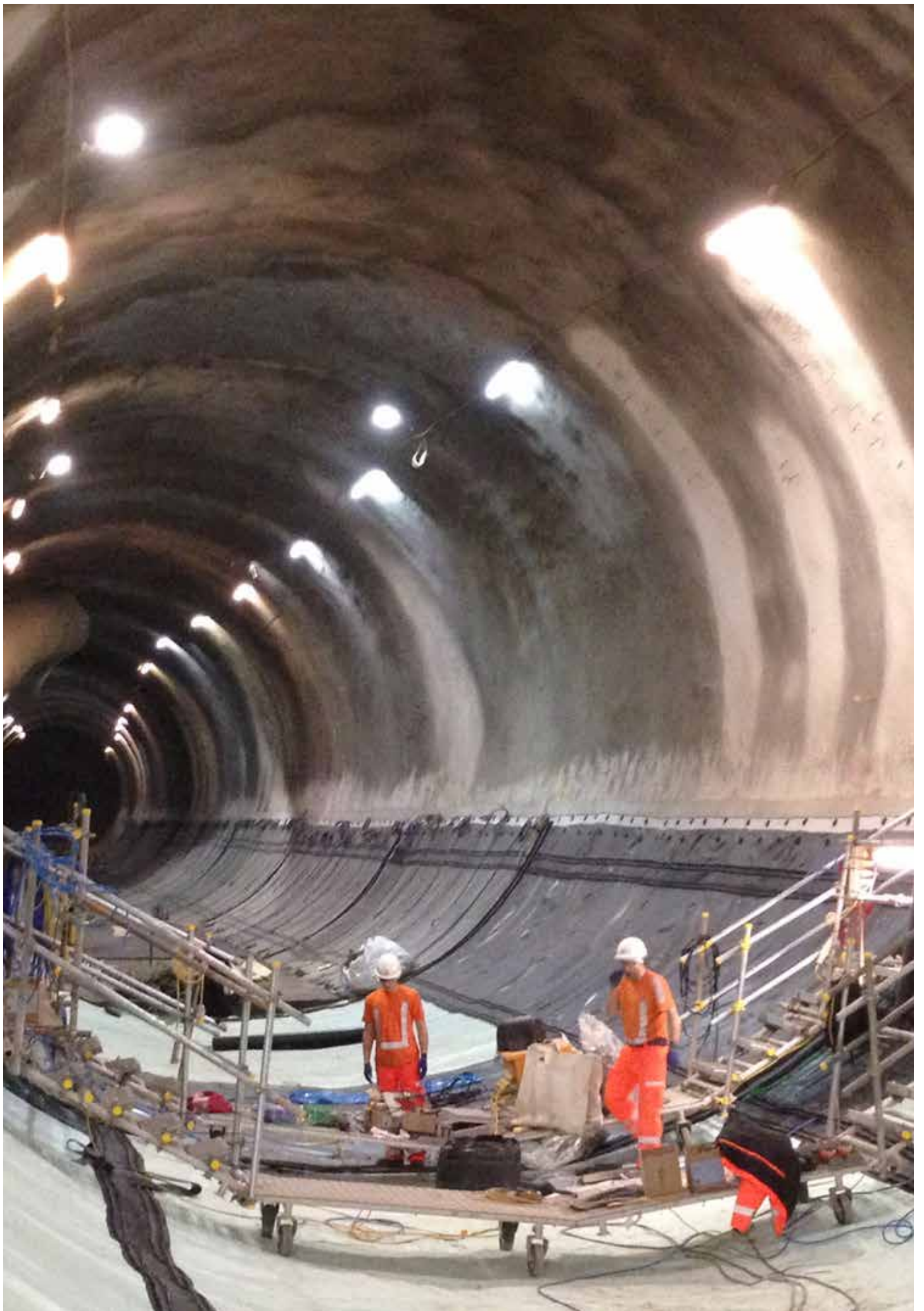
CivilRock® is a range of SOPREMA products designed to support the requirements of civil engineers for all types of structures including tunnels, underground and basement structures, bridges, car parks and much more.











# OUR EXPERIENCE

## MEETING PROJECT DEMANDS

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.

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.

The CivilRock® product range offers::

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

## 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.

## CERTIFICATION

Flagon membranes are manufactured in our factories which have UNI EN ISO 9001 and 140001 and the products fully comply with all relevant EU and DIN standards as well as having many other local accreditations.





# SOPREMA REPAIRABLE SYSTEMS

## FLAGON SYNTHETIC MEMBRANES

CivilRock® Flagon synthetic membranes are used as the waterproofing layer in the construction of bored tunnels and linings. The membranes offer multiple possibilities, capable of providing technical solutions for even the most demanding projects. Some examples of tunnelling projects where Flagon membranes have been used include the Northern Line Extension, Liverpool Street Station and Victoria Station.

Additionally the membranes can have specific features to meet the requirements of particular standards. For example, additives can be used to increase fire resistance. CivilRock® also offers all of the accessories and equipment necessary to carry out the projects: joints, injection hoses, laminated sheets, rondels, hot air welding and testing equipment.

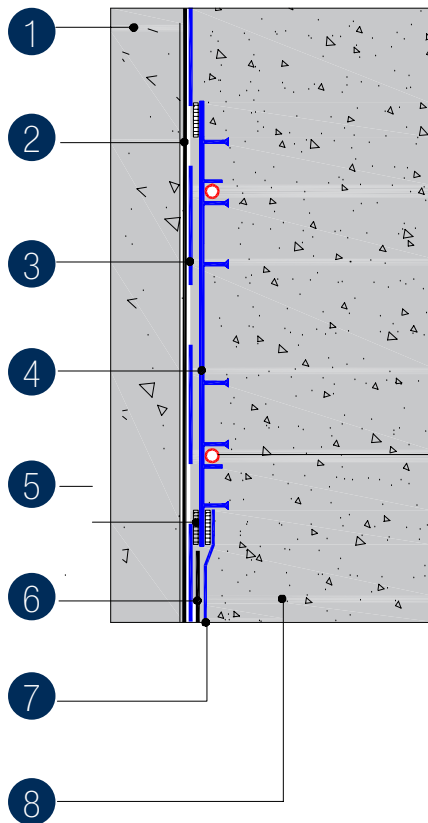
**This brochure will focus on two SOPREMA Repairable Systems:**

- **Flagon Tunnel Single Layer System**
- **Flagon Tunnel Vacuum System**



## FLAGON TUNNEL SINGLE LAYER SYSTEM

This Single Layer System is used when the installation needs to be monitored after completion and provide solutions for the necessary repairs. The integrity of the system can be monitored throughout its working life, repair operations can be carried out, even after completion of the project, without the need for expensive excavations.



### ADVANTAGES:

- + The waterproofing system can be repaired, even years after its installation, without any excavation or destructive investigation
- + The system allows for application on to wet or irregular substrates
- + Quality control of the waterproofing system is very reliable and easily achieved
- + The system is cost-efficient both from the viewpoint of materials and the installation time.



### RECOMMENDED SYSTEM

1	SUPPORTING ELEMENT
2	GEOLAND HT > 1000 GR/M²
3	FLAGON BSL 2.0 MM
4	WATERSTOP W6
5	WELDING
6	GEOLAND HT > 1000 GR/M²
7	FLAGON PVC PZ 2.0 MM
8	CONCRETE STRUCTURE



# SOPREMA REPAIRABLE SYSTEMS

## FLAGON TUNNEL VACUUM SYSTEM

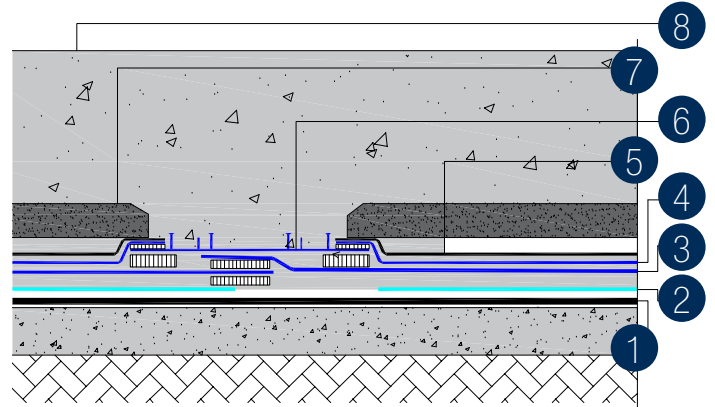
The SOPREMA vacuum repairable system is the most complete system. It offers the possibility of carrying out tests throughout the construction phases and also after completion. This system also makes it easy to find any defects on the applied membranes before the secondary lining of concrete is cast, avoiding extra excavation and uncontrolled injection materials.

Two layers of waterproofing membranes are used as a “double-ply” system and the entire area is divided into sections or compartmentalised. Each of these sections or compartments is sealed to form a “pocket” or “envelope” approximately 100m<sup>2</sup>. The top membrane has small studs on the surface so that once the compartment is formed there is an air gap maintained between the layers.

Once the system is sealed, each compartment has three or four injection valves which facilitate the vacuum. It is possible to test the water tightness of the pocket during construction, by sucking out the air with a suction pump to achieve a pre-defined negative pressure for a length of time. If any defects are found they can be quickly and easily repaired before the installation of the protection and lining. The entire system can be tested and the injection pipes can then be left in place to enable further testing as work proceeds.

The advantages of this system are that it allows to the contractor to control the water tightness of the installed waterproofing and to carry out repairs quickly and easily without the need for costly excavation.

The essential characteristics of a waterproofing membrane for underground works are for products that are flexible and provide outstanding physical-chemical performance, are durable and have exceptional workability and weldability.



### RECOMMENDED SYSTEM

1	GEOLAND HT > 1000 GR/M <sup>2</sup>
2	FLAGON BSL 2.0 MM
3	FLAGON BT/ST 2.0 MM
4	FLAGON PVC PZ 2.0 MM
5	GEOLAND HT > 1000 GR/M <sup>2</sup>
6	W4 WATERSTOP JOINT
7	CEMENT CAP
8	CONCRETE CONSTRUCTION





# PRODUCT AND SYSTEM DETAILS

## SUPPORTING ELEMENT OR SUBSTRATE

The supporting element is the surface on which the layers of the waterproofing system will be placed. It should be as smooth as possible, free from debris and other irregularities that may puncture the waterproofing layers.\*

## GEOTEXTILE

Because membranes are sensitive to local mechanical damage, a geotextile layer must be installed between the substrate and the membrane to protect the membrane against puncturing. Another function of the geotextile is to create a sliding surface below the membrane to avoid tensions/stresses inside the membrane or to allow movement of the concrete structure caused by temperature, settlement, dynamic loads, etc. and therefore to avoid fine cracks inside the inner concrete shell. The geotextile protects the membrane during construction and operation of the tunnel.\*

## FIXING ELEMENT

The geotextile is fixed onto the substrate with PVC disks, a minimum 4/ m<sup>2</sup>. The disks are secured through the geotextile and into the substrate with shot-fired nails. The disks are produced from the same compound as the waterproofing PVC membrane, so as to allow the welding of the membrane to the surface of the disks. The disks are specially designed to provide temporary anchorage of the membrane before the inner concrete ring is placed. At the same time preventing excessive stresses being applied to the membrane.\*

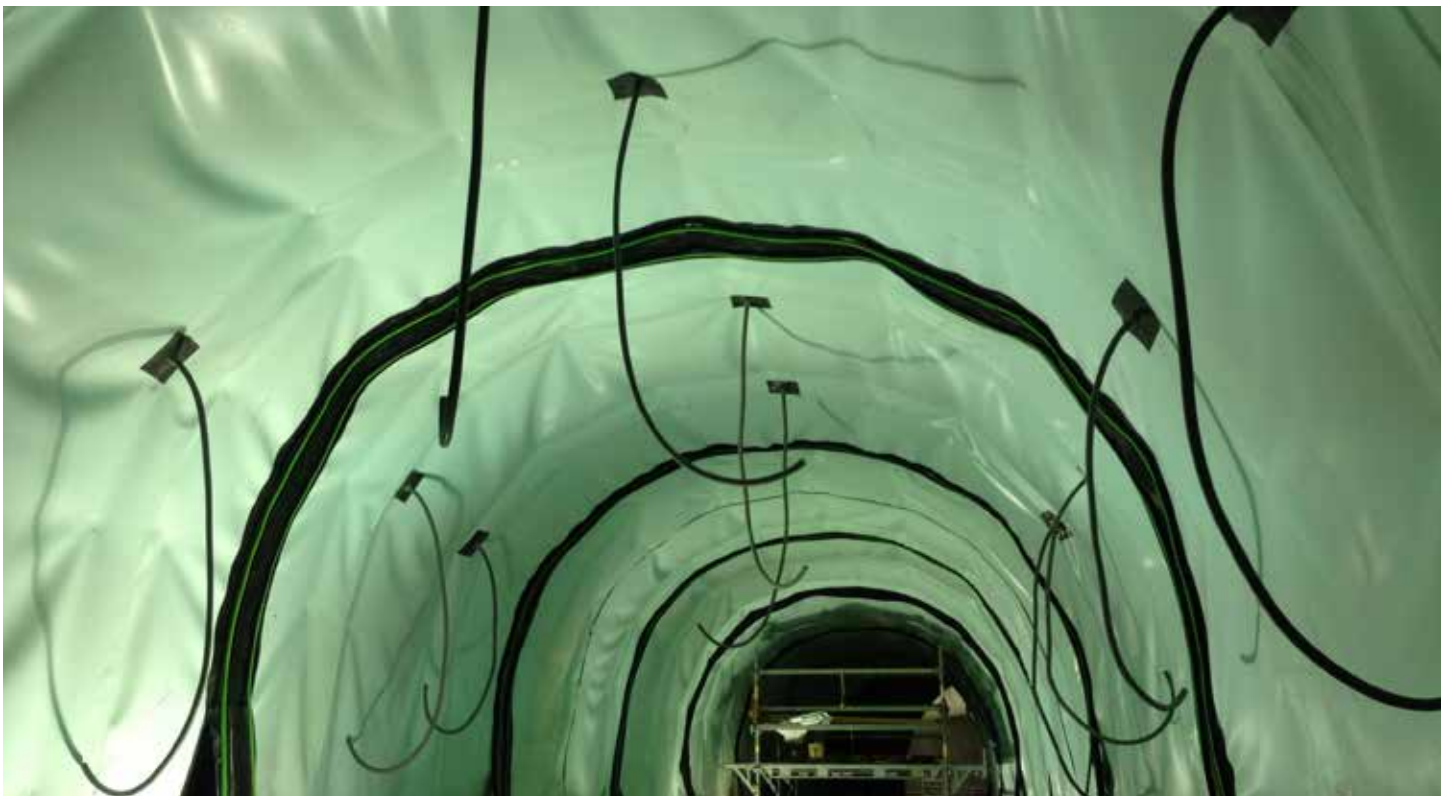
## WATERPROOF LAYER (SEALING SYSTEM)

Laying a synthetic membrane (of plasticised PVC) manufactured by coextrusion enables the production of a single layer membrane; each of the two surfaces being a different colour. This means that any accidental holes or tears in the material which may occur to the upper white surface during layer, become immediately visible as the black of the lower surface shows through.\*

## PROTECTION LAYER

Flagon PZ is a PVC protection layer for waterproofing membrane, manufactured by coextrusion which has a thickness 1.6mm.\*

\*For more information, please refer to the relevant technical data sheet.



# TUNNEL REFERENCES

## UK REFERENCES

### 2013

- Crossrail C305 Stepney Green Caverns – 4000m<sup>2</sup>
- Crossrail C300 Fisher Street Shaft – 1000m<sup>2</sup>
- Crossrail C360 Mile End Shaft -1000m<sup>2</sup>
- Crossrail C310 Thames Tunnel – 1000m<sup>2</sup>
- Crossrail C510 Whitechapel Station – 2000m<sup>2</sup>

### 2014

- Crossrail C310 Thames Tunnel – 2000m<sup>2</sup>
- Crossrail C305 Cross passages – 3000m<sup>2</sup>
- Crossrail C360 Elenor Street Shaft – 3000m<sup>2</sup>
- Crossrail C510 Liverpool Street Station – 20,000m<sup>2</sup>
- LUL – Victoria Street Station – 10,000m<sup>2</sup>

### 2015

- LUL – Vauxhall Station – 4,000m<sup>2</sup>
- Crossrail C510 Whitechapel Station – 34,000m<sup>2</sup>
- Crossrail C510 Liverpool Street Station – 18,000m<sup>2</sup>

### 2017

- LUL – Northern Line Extension – 30,000m<sup>2</sup>

### 2018

- Bank Underground station - 4,000m<sup>2</sup>







## EUROPEAN REFERENCES

### ITALY

GRA (Trionfale-Cassia-Boccea) - Roma 150,000m<sup>2</sup>  
 Autostrada SA-RC - Reggio Calabria (1) 150,000m<sup>2</sup>  
 Variante di Valico A1 - Firenze-Bologna 200,000m<sup>2</sup>  
 Autostrada A1 (Terza Corsia) - Firenze 200,000m<sup>2</sup>  
 Metro Brescia 100,000m<sup>2</sup>  
 Autostrada A3 SA-RC Galleria Mormanno 120,000m<sup>2</sup>

### FRANCE

3 tunnels de l'A89: Bussière, Chalosset et Violay 430,000m<sup>2</sup>

### PORTUGAL

Autopista Isla de Madeira 140.000 m<sup>2</sup>  
 A4 Amarante - Vila Real - tunnel du Marão - ongoing (4) 300.000 m<sup>2</sup>

### SPAIN

Tunel San Pedro 140,000 m<sup>2</sup>  
 Tunel La Caniza 120,000 m<sup>2</sup>  
 Tunel Bubierca-Dehesillas-Castejón 160,000 m<sup>2</sup>  
 Tunel de La Cabrera y Bunol (5) 155,000 m<sup>2</sup>  
 Tunel de M. Pesquera 187,500 m<sup>2</sup>  
 Tunel de la UTE San Pedro 315,000 m<sup>2</sup>

### AUSTRIA

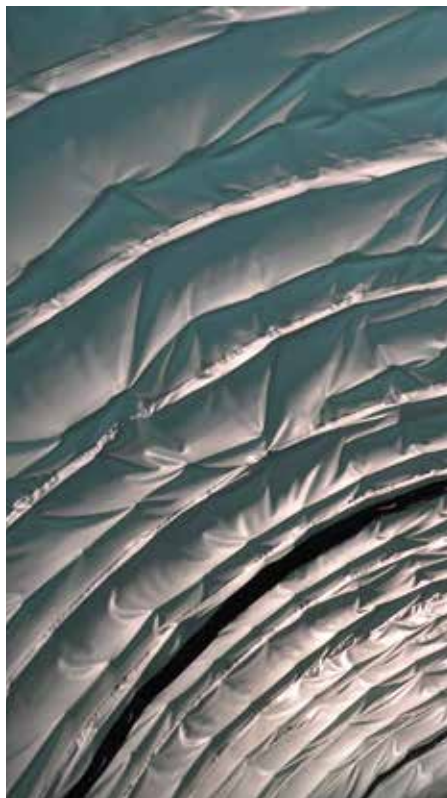
Landeck Tunnel 100,000 m<sup>2</sup>  
 Plaubutschunnel 270,000 m<sup>2</sup>  
 Strengen Tunnel S16 320,000 m<sup>2</sup>  
 Katschbergtunnel 150,000 m<sup>2</sup>

### GREECE

Asomata Veroia 100,000 m<sup>2</sup>  
 Polimilos 160,000 m<sup>2</sup>  
 Driskos 300,000 m<sup>2</sup>  
 Dodoni 100,000 m<sup>2</sup>  
 Kallidromo 500,000 m<sup>2</sup>  
 Kakia Skala (Highway) 250,000 m<sup>2</sup>  
 Paramithia 100,000 m<sup>2</sup>  
 T8 Ioannina 150,000 m<sup>2</sup>  
 Egnatia Odos Tunnels 500,000 m<sup>2</sup>  
 Athens Metro station Aigaleo-Botanikos 100,000 m<sup>2</sup>  
 Patra-Thessaloniki Detour St Konstantinos 250,000 m<sup>2</sup>  
 Tempi Valley Tunnels 300,000 m<sup>2</sup>  
 Panagopoula Highway Tunnel 220,000 m<sup>2</sup>  
 Platanos Highway Tunnels 120,000 m<sup>2</sup>  
 Metro Stations of Thessaloniki 100,000 m<sup>2</sup>

### IRELAND

Dublin Port Tunnel LotA 120,000 m<sup>2</sup>





**SOPREMA at your service:**

Do you have a question about a specific project, the products or application possibilities? Then contact our technical team, further information can be found on:

**[www.soprema.com.au](http://www.soprema.com.au)**



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