

FLAG TUNNELLING AND UNDERGROUND STRUCTURES WATERPROOFING SOLUTIONS





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History

A Worldwide market leader

Flag S.p.A., the world leading company for over 40 years in manufacturing high tech synthetic membrane in PVC and TPO/FPO for the waterproofing of tunnelling construction, underground transport systems and below ground structures.

In 2007, FLAG S.p.A. enters into the prestigious Group Soprema

"We are confident of our future and very proud of our past. The Soprema Group has been around for over 100 years, and we intend to be here for the next 100 years"



Today the Soprema Group is a Worldwide Leader in manufacturing waterproofing systems, producing more than 150 million square meters per year. With 16 Production Facilities, 12 Subsidiaries and 50 Distributors we cover more than 80 Countries around the World.



Flag has been producing synthetic membranes for underground works since the mid 60's, when its materials were used in the construction of the first underground railway lines in Milan and Rome and in the first tunnels of the L'Aquila-Teramo motorway.

Since then, over 100 million square metres of Flag waterproof membranes have been applied all over the World. In the past 40 years Flagon membranes have been used for the most prestigious road and underground railway tunnels and also for the basements and foundations of some of the World's most celebrated buildings.

Today, Flag is one of the World's leading manufacturers of synthetic membranes for waterproofing major civil engineering works.



Waterproofing inspiration... high-performance solutions

The waterproofing is an essential component in any underground construction.

Underground Construction is now expected to conform to a life in excess of 100 Years. This means that the requirements of the products used in the construction are very high and the quality and durability of the waterproofing systems are particularly important.



Most below ground applications, whether tunnel or basement, generally require a system solution to be designed on a project by project basis and the costs of producing such a system are relatively low in comparison with the overall construction costs. The benefits that can be achieved however are considerable.

The waterproofing system designed with membranes consists of various materials for sealing, draining and protecting whilst also facilitating inspection and repair possibilities both during and after construction.

The correct laying or "installation" of the products by qualified applicators is essential and regular inspection and Quality Assurance are vital to ensure a fully functional system.

Water and moisture penetration are a concern in any structure. The main problem is that almost all rock and soil contains water either draining from above (seepage) or penetrating from below. In some cases the water may be under considerable pressure.



This water can come from a variety of sources: surface water will penetrate down into the ground, whilst broken pipes and sewers are an unexpected source of liquid. The watertable must be taken into account as should migrating water vapour. Underground streams and lakes often run below or past sites and Perched watertables can be a factor, whether naturally occurring or manmade.

It must be assumed that all basements or tunnels will come into contact with water at some time during their life and therefore will all require a waterproofing system.



Geomembranes are used to restrict liquid migration from one area to another.

They are often used also to line canals and man-made water ways to prevent water leakage and also to increase flow rates.

PVC and TPO/FPO membranes are today widely used to prevent water ingress into belowground structures including being used as liners for tunnels and waterproofing for basements.



When planning any underground structure it is necessary to design to keep the construction dry, not only for the reliability and functionality of the building but also for safety reasons (specially for underground transport system and railway tunnel). It

is imperative that water be kept away from the structure and the inner working area. This can only be achieved by incorporating an appropriate waterproofing system.

The creation of an underground site should be undertaken with the appropriate involvement of experienced waterproofing companies and detailed engineering planning.

Thanks to the vast experience over many years Flag has developed some of the most advanced waterproofing systems for underground construction



Flag provides a wide range of solutions designed according to the site water condition and the budget of the investor.

These solutions range from the simple Single Layer System through to very technologically advanced Vacuum System (double layer) which is unique as it allows impermeability testing to be carried out not only during construction but also once completed.

The Vacuum System also facilitates the localised repair of a damaged area without the need for costly excavation.

Flag also supplies Single Layer systems with Compartmentalisation and Injection Systems applied on the construction joints or directly on the compartment.



Waterproofing Systems

The Single Layer System

The single layer system is as its name suggests, and is made up of an adjustment or protective layer of geotextile and the subsequent membrane. This system is designed to be simple and in-expensive to install but does not incorporate any protection to the installed membrane and has no facility for the injection of resins or grouts for future repair. The system is not divided into sections and offers only basic passive protection.



Compartmentalization

This system incorporates the basic requirements of a geotextile and appropriate membrane but also includes waterbars at construction joints. To limit the flow of water in case of leakage, the waterproofing membrane is divided into sections. Waterbars are welded onto the membrane to compartmentalise the system at the location of the construction joints before the concrete is cast. In this way it is possible to prevent water tracking from one compartment to the next. These water stops can also be placed at additional locations if so desired, to reduce the size of the compartments. The membrane is then protected by the installation of an additional protection membrane (Flagon PZ) or second geotextile.

Flag Active Waterproofing System (F.A.W.S.)

To seal the compartments, special re-injectable grouting hoses are installed onto the waterbars. These hoses are then used to inject cement to fill voids and later to inject resin if a leak occurs in the compartment. The hoses can be re-used if there are subsequent problem.

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.





Flag Fail Safe Waterproofing System

An alternative system to seal the compartment consists of injecting the resin through injection valves that are welded onto the membrane.

The valves are not completely welded on the membrane and have some openings which allow to the resin to flow in the compartment and therefore seal it.

Each compartment should be no larger than 100 m² and up to 4 injection valves are required per compartment.



The Flag Vacuum System

Two layers of waterproofing membrane 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 100 m².

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 3 or 4 injection valves which facilitate the vacuum.



It is possible to test the watertightness 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.

Vacuum test

Typically 3 or 4 injection pipes are used per compartment and the hoses should be clearly marked and collected to be located in an appropriate position so that once the basement or tunnel is complete the ends of the pipes are hosed within an access box to facilitate future testing and repair.

The walls or vault and floor sections are partitioned separately and the hoses from left, right and floor should be easily identifiable.

Should there be any water ingress into any compartment once the structure is complete it is possible to identify any leaks as the water will be forced up the injection pipes.



“Tailor Made” Philosophy



It is then possible to inject a water-reacting resin through the same pipes into the compartment which will form a gel with the water and completely reseal the pocket, thus providing a fail-safe system.

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.

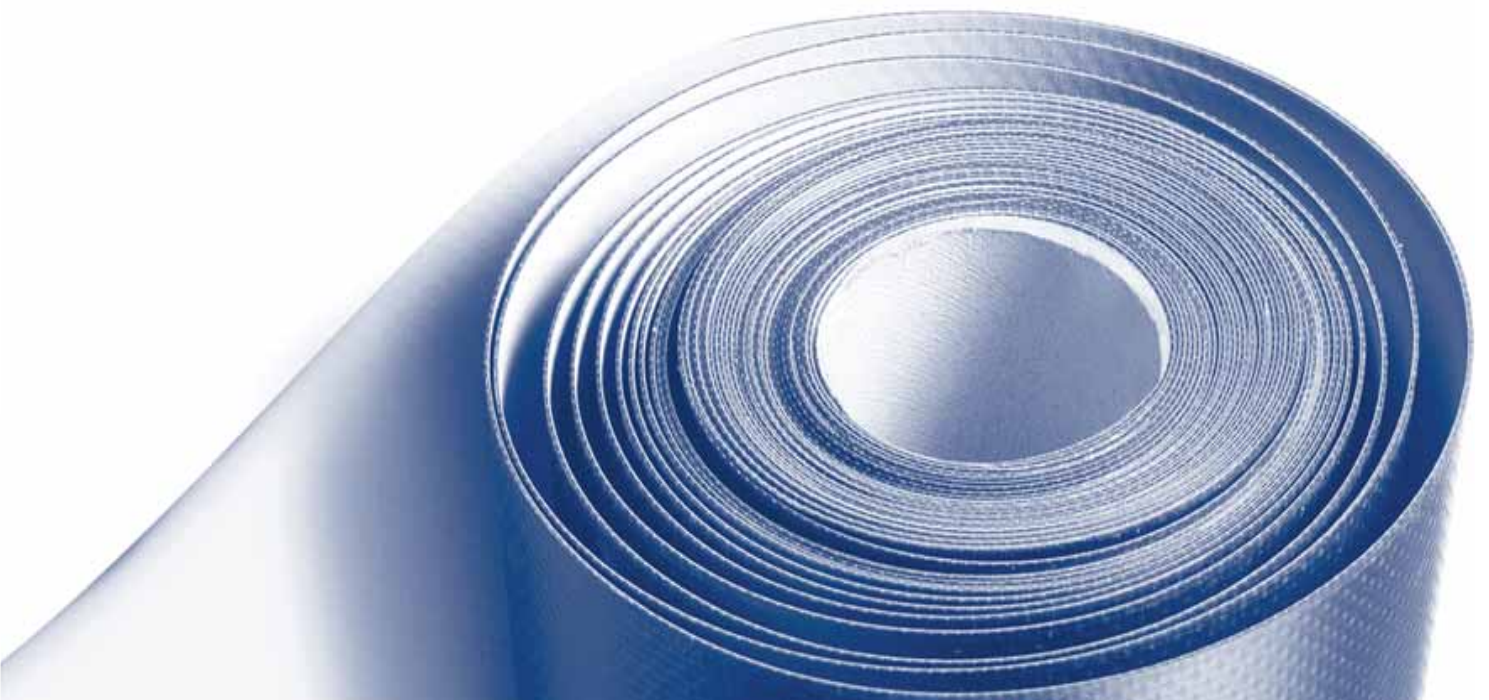
Given the specific and critical nature of the work to be waterproofed, life expectancy should be measured in decades rather than years.

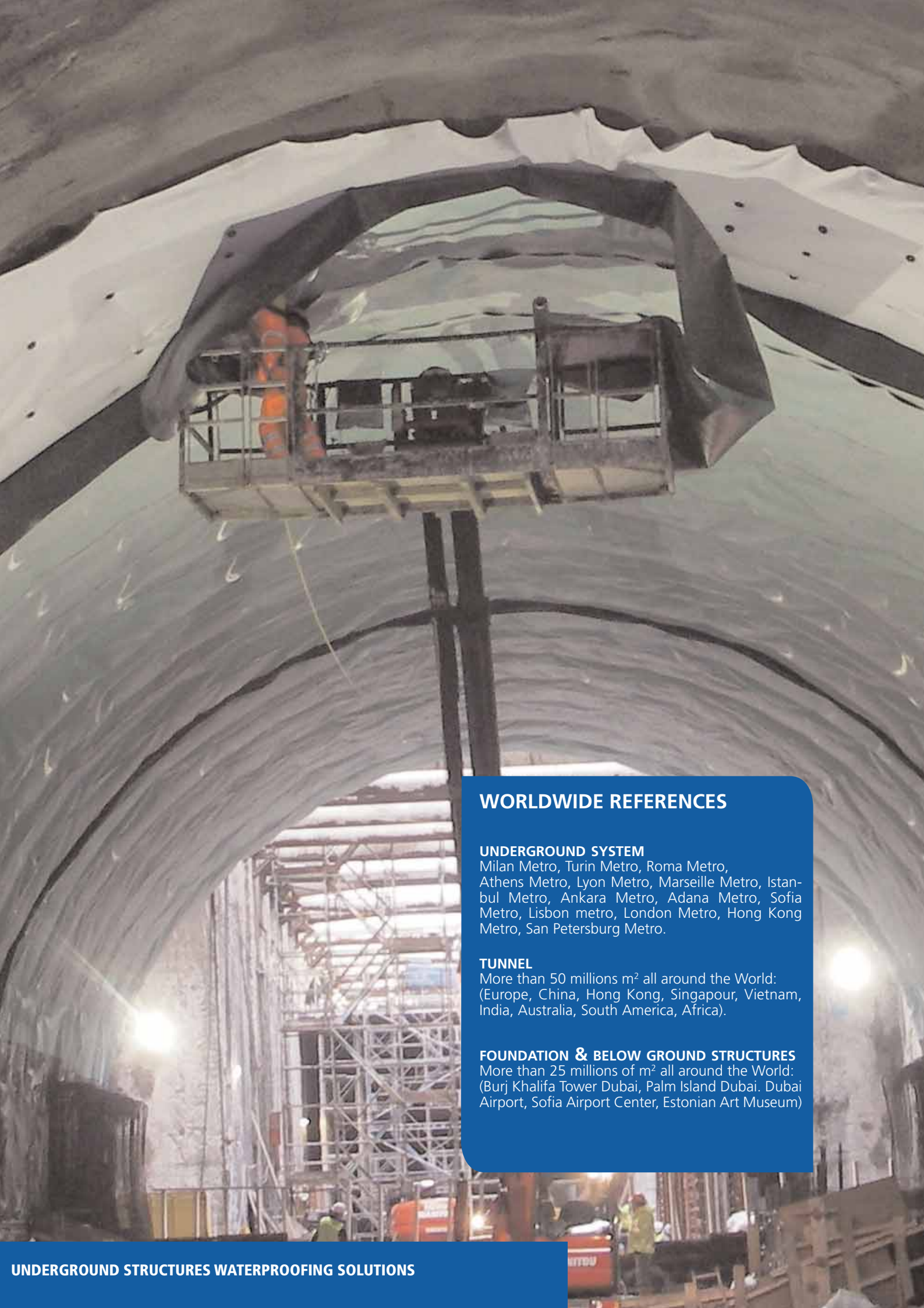
“Tailor Made” Philosophy

FLAGON membranes have been designed, formulated and manufactured according to specific application needs, based on a “tailor-made” philosophy.

This approach ensures optimisation of results from every perspective: mechanical resistance, resistance to ageing and micro-organism attack, flexibility, ease of installation and, last but not least, environmental protection. The membranes are non toxic and can be formulated to be fire resistant according to general requirements and International Norms.

Flag also provides a full range of accessory products including waterstops, protection fleeces and injection hoses.





WORLDWIDE REFERENCES

UNDERGROUND SYSTEM

Milan Metro, Turin Metro, Roma Metro, Athens Metro, Lyon Metro, Marseille Metro, Istanbul Metro, Ankara Metro, Adana Metro, Sofia Metro, Lisbon metro, London Metro, Hong Kong Metro, San Petersburg Metro.

TUNNEL

More than 50 millions m² all around the World: (Europe, China, Hong Kong, Singapour, Vietnam, India, Australia, South America, Africa).

FOUNDATION & BELOW GROUND STRUCTURES

More than 25 millions of m² all around the World: (Burj Khalifa Tower Dubai, Palm Island Dubai, Dubai Airport, Sofia Airport Center, Estonian Art Museum)

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