



[www.tunnelwaterproofing.com](http://www.tunnelwaterproofing.com)

# Tunnel waterproofing

SEAMLESS WATERPROOFING TO CREATE WATERTIGHT TUNNELS



**stirling lloyd**

THE TECHNOLOGY OF PROTECTION

[www.stirlinglloyd.com](http://www.stirlinglloyd.com)

# PASSION THAT HAS PRESERVED FOR OVER 40 YEARS

For over a quarter of a century, the development of new and ever more innovative ways to extend the life of structures has been at the very heart of our business. During this time Stirling Lloyd have been at the forefront of technological developments in the world of construction and civil engineering. It's a passion that has enabled us to become a leading manufacturer of waterproofing and structural protection systems.

With a truly global reach Stirling Lloyd has a worldwide network of offices, associates and authorised contractors that allows us to provide a complete solution – from manufacture to application and beyond, ensuring the success of our projects around the world.

Our commitment to a continual programme of research development and product improvement has produced numerous technological advances. Based on a wide range of specialist resin technologies these advances have formed the basis of our market leading waterproofing, maintenance and repair systems and have kept us at the cutting edge of protection technology.

As industry standards become ever more demanding – our research teams continue to shape the future of structural protection - setting the performance benchmarks for tomorrow and ensuring that Stirling Lloyd systems continue to protect the world's most important and iconic structures.

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## THE DRIVE FOR CHANGE

As buried or immersed structures, tunnels are more at risk from water ingress than most other types of structure and repairing tunnels can be difficult, expensive and highly disruptive.

Therefore construction has to be right first time - and every time. Only technically proven systems should be utilised in the construction and maintenance of these key infrastructure assets. Waterproofing that is less than 100% effective is leaking. At best this can be unsightly in areas exposed to the public such as in underground stations. At worst it will cause degradation of the structure itself, creating the potential of major remedial works and a shorter service life for the tunnel.

The waterproofing system for a tunnel should be an integral part of the design from the outset. The tunnel designer must consider the acceptable level of water ingress - which should effectively be zero.

### TRADITIONAL TECHNIQUES

Tunnel waterproofing has traditionally been based on sheet materials that are welded together on site to form a membrane. Waterproofing integrity is dependent on the continuity and quality of the numerous seams which are all potential weak points. This problem is exacerbated in tunnels of complex shape.

### SEAMLESS SOLUTIONS

Since the 1980's Stirling Lloyd has been protecting the world's principal transport infrastructure assets using unique seamless waterproofing techniques. These techniques, based on our advanced sprayed resin technologies, have been developed to address the five fundamentals of effective waterproofing.

# The five fundamentals of effective waterproofing

## CONSISTENCY

- Factory batched products
- No site batching/variation

## CONTROL

- Application by Stirling Lloyd trained specialists
- Unique on-site Q.A. regime

## SUITABILITY

- Designed specifically for the intended environment

## SEAMLESS

- No vulnerable joints
- Simplifies detailing
- Reduces risk

## PROOF

- Test & prove 100% waterproofing integrity during construction

**100%**  
**EFFECTIVE**  
**WATERPROOFING**

*First time, every time*

These principles underpin the Stirling Lloyd approach to providing new levels of waterproofing protection for tunnels. An approach that has been successfully utilised since 1989 in the four principal tunnel applications Immersed Tube, Cut and Cover, Bored (NATM / SEM / SCL Construction) and Suspended Decks.



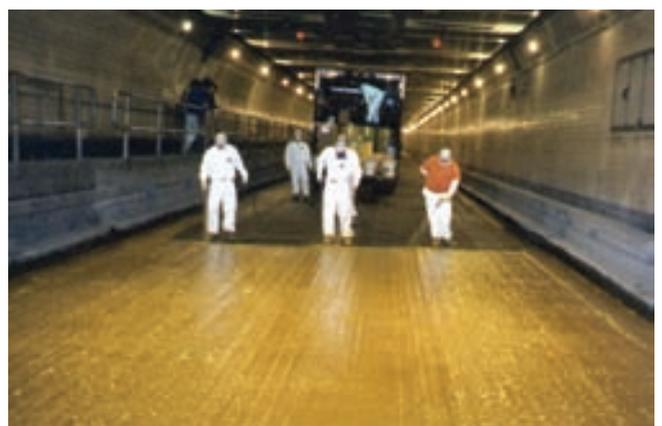
**IMMERSED TUBE**



**CUT AND COVER**



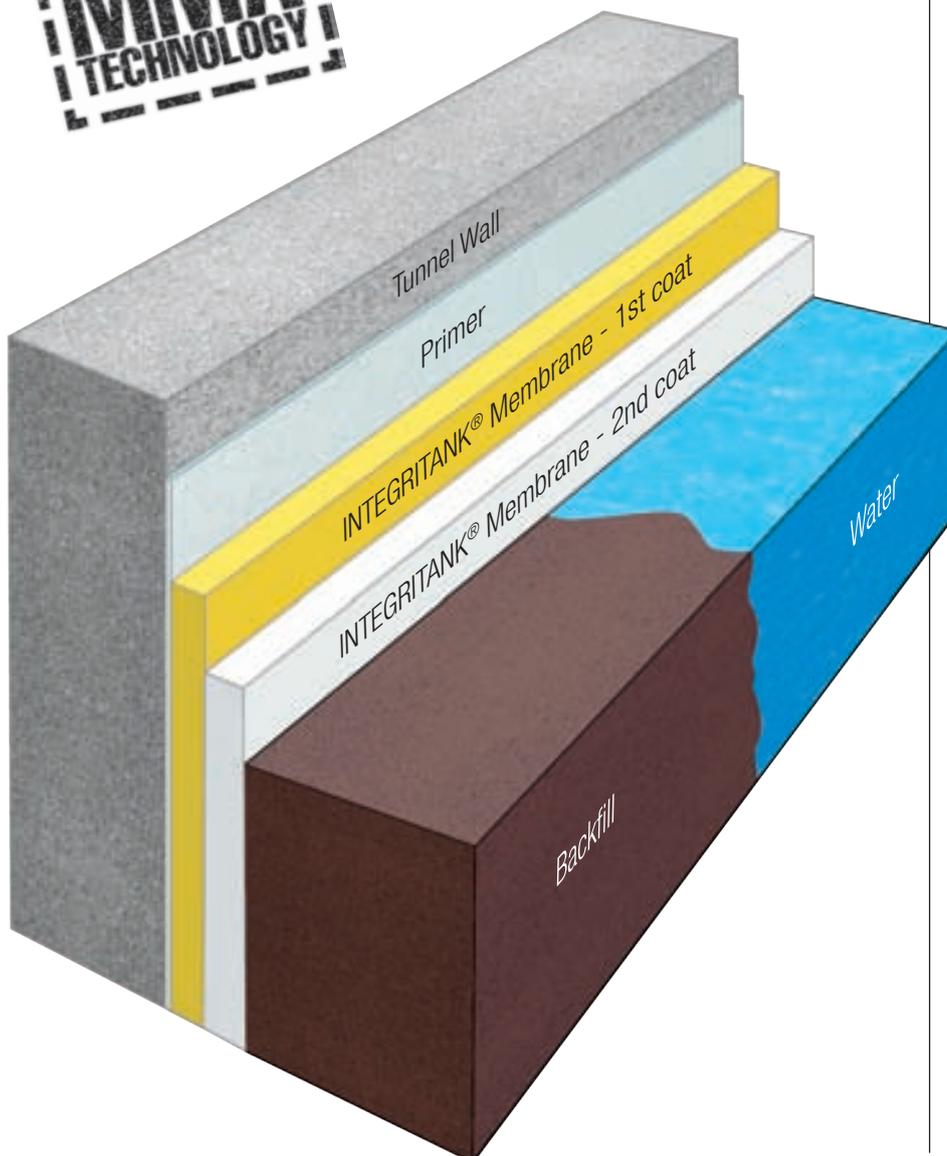
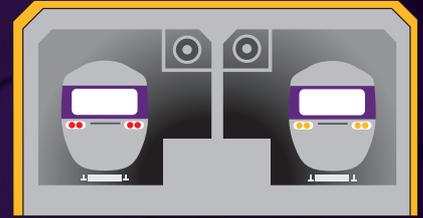
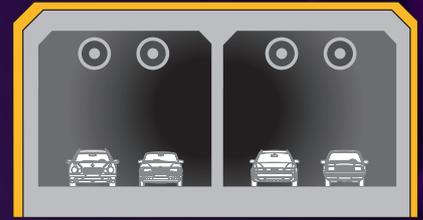
**BORED (NATM / SEM / SCL)**



**SUSPENDED DECKS**

# External waterproofing

INTEGRITANK®



## IMMERSED TUBE & CUT AND COVER TUNNELS

Immersed Tube and Cut and Cover Tunnels are subjected to a wide range of harsh environments and chemicals, therefore effectively protecting these important assets is essential.

Integritank is a spray applied, fully reactive elastomeric system based on our advanced Methyl Methacrylate (MMA) technology, which has been used to provide 100% effective protection for this construction method. Spray applied to the external walls of the tunnel prior to immersion or burial, the system is completely seamless.

The strong bond achieved by the Integritank system, together with its toughness, makes it the ultimate choice when specifying an external waterproofing system.

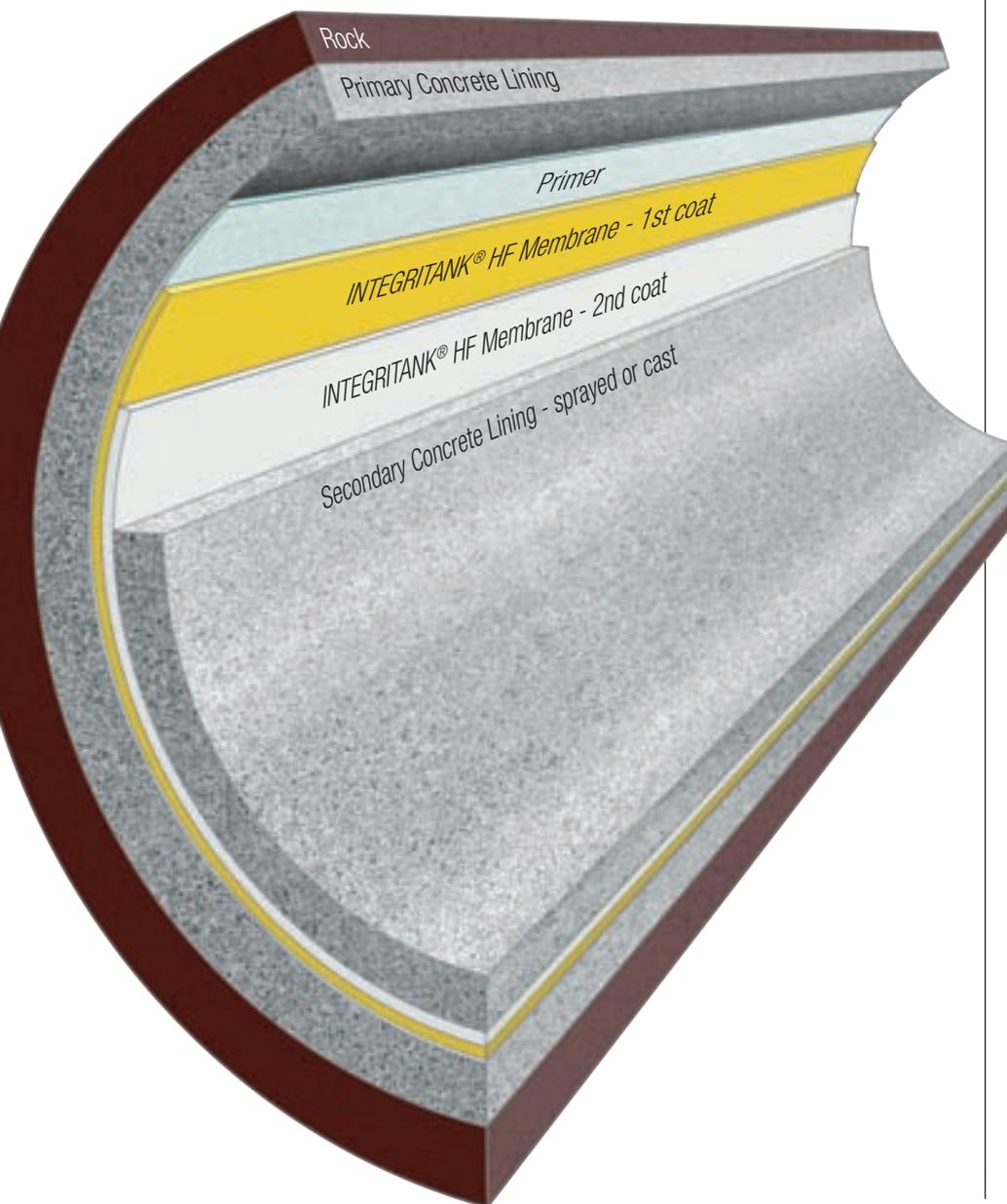
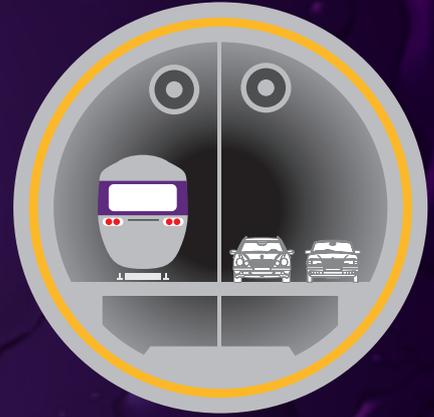


The system is highly durable; when used on cut and cover tunnels this robustness enables the system to withstand the back infill operation without additional protection. In the case of immersed tube tunnels this durability enables the system to withstand the transportation to the immersion site whilst also being resistant to seawater and water pressure once immersed.

Integritank's simple application technique provides rapid output and allows for programme flexibility to accommodate other trades. Used on numerous projects in a wide range of climates throughout the world, Integritank is a tried and tested system which gives the greatest levels of confidence for any Immersed Tube or Cut and Cover tunnel.

# Internal waterproofing

**INTEGRITANK® HF**



## **BORED TUNNELS** NATM, SEM & SCL CONSTRUCTION METHODS

Various systems have been used to attempt to waterproof tunnels constructed using these methods but few have successfully addressed the particular challenges presented. The development of the Integritank HF system has taken this uncertainty out of waterproofing bored tunnels.

Integritank HF is based on advanced resin technologies developed specifically for use in the confined spaces and conditions of a tunnel construction environment and for application between primary and secondary concrete linings.

Not only does the system achieve a high bond strength to sprayed primary concrete, but it is also robust enough to withstand the spray application of concrete for the secondary lining, lowering costs and enabling faster tunnel construction.



With a unique on-site quality assurance programme, Integritank HF achieves:

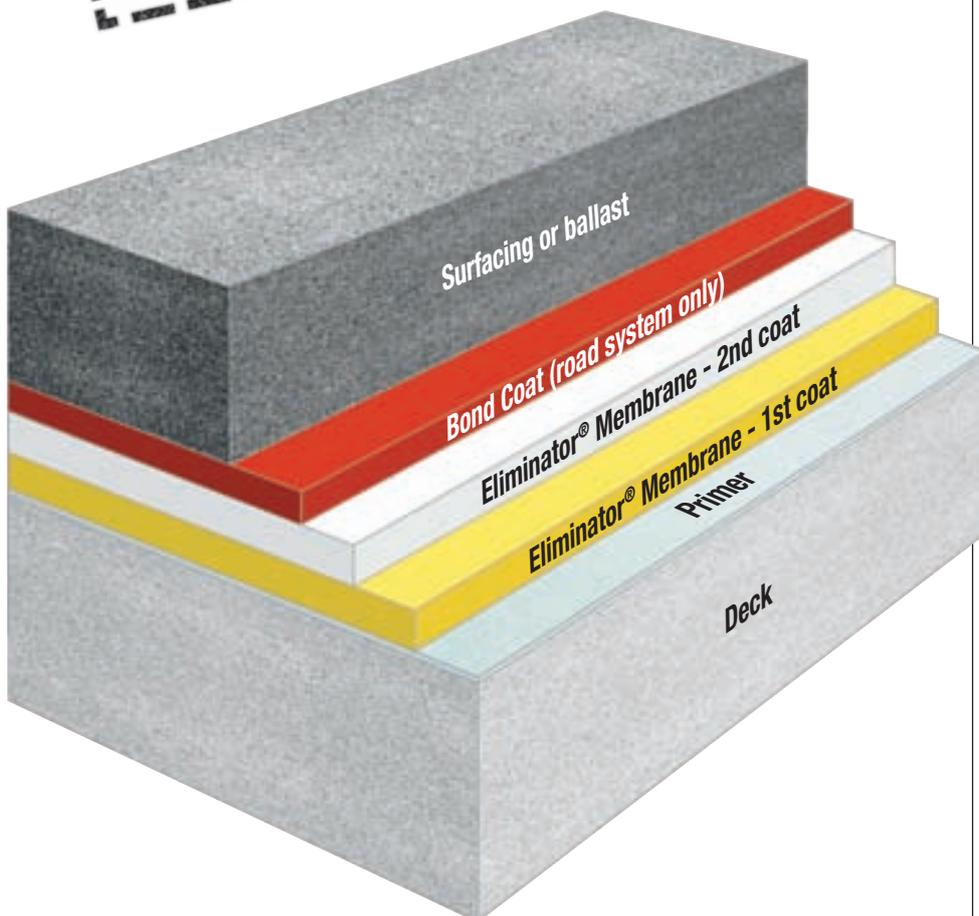
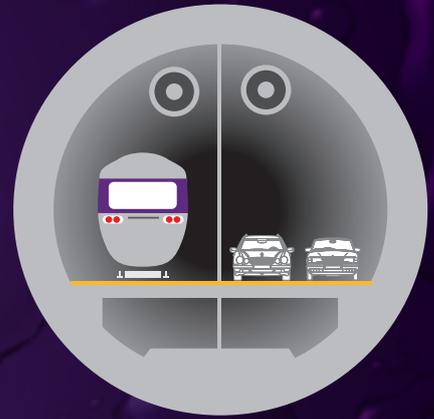
- A strong bond to the primary lining; proven by pre-application adhesion tests.
- Rapid and reliable coverage; with contrasting coloured coats for visual coverage checks, confirmed by continuous wet film thickness tests during application.
- 100% effective protection; tested using non-destructive electrical integrity tests to confirm there are no leaks prior to installation of the secondary lining.

The bond of the secondary concrete to the membrane and consequently the primary lining allows Engineers and Designers to take advantage of composite action between the primary and secondary linings, which has the potential to significantly decrease construction time and cost.

With 360° coverage from a single system, high output rates and simplified detailing Engineers now have a proven, effective solution to the challenges of waterproofing bored tunnels.

# Suspended deck waterproofing

ELIMINATOR®



## ROAD AND RAIL IN ALL TUNNEL TYPES

Where suspended decks form the roadway or rail track within a tunnel, the chosen waterproofing system has to do more than protect the concrete slab from corrosion. On a roadway it must also provide a sufficiently strong bond with both the substrate and the surfacing to ensure the heavy braking forces of the traffic do not cause the surfacing to deform and subsequently break up. This requirement is even more critical in tunnels as there is usually a much-restricted thickness of surfacing making the shear forces exerted even greater.

In addition, the system must be tough and resilient enough to withstand the high temperatures and physical pressure exerted by the surfacing operation.

The Eliminator system, which has been used to waterproof some of the most heavily trafficked suspended tunnel slabs in the world as well as thousands of bridges including a number of the world's most iconic structures, more than meets these requirements.



An advanced MMA resin based system, Eliminator is suitable for use with all surfacing types and has an unparalleled track record of success, in excess of twenty years, with thin asphalt surfacing – as a consequence of its excellent bond to both the substrate and surfacing. For rail applications the system has an even longer track record and is tough enough to receive rock ballast directly on to the membrane surface.

This world leading deck waterproofing system is ideally suited for the waterproofing of suspended road and rail decks in tunnels, bridge decks, culverts, elevated pedestrian walkways and station platforms.

# The proof

## STIRLING LLOYD TUNNEL WATERPROOFING SOLUTIONS



Our advanced resin systems offer many benefits that make them the best value waterproofing solution for tunnel projects where, by definition, quality cannot be compromised.

### SEAMLESS TECHNOLOGY

#### Eliminating Leaking Seams

Seams and joints in sheet waterproofing systems, however well they have been welded, are potential weak points creating a risk of failure. This risk is compounded where complex geometry necessitates detailing and a higher number of seams. Although complex grouting systems and other secondary containment measures have been a traditional approach to try to minimise the effect of leaking seams, by this time the vulnerable seam has failed.

Stirling Lloyd's rapidly spray applied systems provide a continuous membrane eliminating seams and joints and the risks they present, overcoming the primary cause of waterproofing failure.

### TESTING

#### Ensuring 100% Effective Protection

Confirming the integrity of an applied tunnel waterproofing system can be a challenge. Often leaks are only discovered once it is too late to rectify them, for example after the final concrete lining has been installed or the tubes have been

immersed, resulting in expensive, unpredictable and only partially successful remedial repairs.

The optimum solution is to test the waterproofing system BEFORE encapsulation or immersion using a non-destructive and reliable method, proving that the waterproofing is 100% effective.

As part of our unique on site quality programme all our membranes are subject to electronic integrity testing in-situ, that confirms complete waterproofing has been achieved, removing the threat of future time consuming and expensive remedial work.

## RAPID INSTALLATION

### Substantially Reducing Build Times

Liquid, seamless application eradicates the need for time consuming complex detailing, which together with the use of high output spray equipment and the materials fast cure ensures rapid application, facilitating contract progression.

In tunnels of NATM/SCL/SEM design, Integritank HF enables the use of sprayed concrete for the secondary lining, which dramatically reduces build times, while on refurbishment projects; our membranes rapid installation and one hour cure time provides a fast return to service with less disruption to tunnel users.

## THE COMPOSITE EFFECT

### Dramatically Reducing Costs

In tunnels of NATM/SCL/SEM design the use of Integritank HF can further reduce costs. Other waterproofing systems do not allow the primary concrete lining to be considered as a structural element. Integritank HF however, facilitates a composite action between the primary and secondary linings, resulting in a dramatic reduction in the quantity of concrete required, excavation needed, spoil generated, environmental impact and cost. It is estimated that the construction costs of the waterproofing and secondary lining may be reduced by up to 30% due to this composite effect.

## CRACK BRIDGING

### Preventing Future Leaks

All new concrete suffers from some degree of cracking with bored tunnels being particularly at risk from ground squeeze and drying shrinkage. Inflexible waterproofing that is bonded to the concrete will crack as the concrete moves and cracks resulting in an ineffective system and a leaking tunnel.

Stirling Lloyd's range of tunnel waterproofing solutions have excellent crack bridging capabilities and so retain their integrity even if the concrete suffers cracking.

## TWO COAT MEMBRANES

### Complete Coverage

Stirling Lloyd always advocates the use of two coat systems for tunnel waterproofing. The coats are applied in contrasting colours to allow for visual coverage checking prior to formal thickness tests, ensuring that all areas are appropriately covered. The two coat application gives the confidence that in the unlikely event a minor defect occurs in the first coat then it will be rectified by the application of the second coat.

## ROBUST AND DURABLE

### Withstanding Site Challenges

Any tunnel waterproofing membrane must be robust; site traffic, steel fixing, concrete placement and high levels of water pressure all present on-site challenges. Stirling Lloyd's systems are engineered for long term durability making them ideal for immersion, burial and covering by a secondary lining.

## TECHNICAL SUPPORT

### Expert Worldwide Assistance

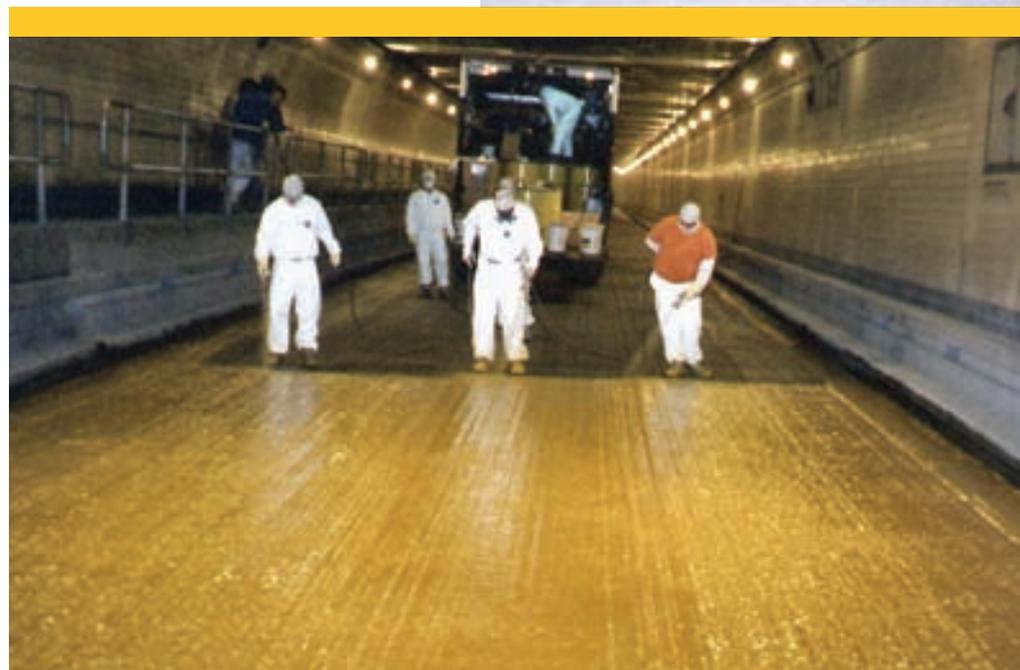
With over 25 years experience within the construction and civil engineering industries Stirling Lloyd's technical expertise is unsurpassed. Throughout the whole construction process, from initial design and planning through to project completion, Stirling Lloyd provides technical support globally; essential when

changing site conditions or unforeseen challenges need to be addressed. With assistance available by telephone, online and on site, Stirling Lloyd is your global waterproofing partner.

## WATER CONTROL

### Complete Tunnel Waterproofing Solutions

Stirling Lloyd can provide complete solutions for tunnel waterproofing. Even in tunnels where water ingress is already present Stirling Lloyd's membranes can still be applied after treatment with a range of specially developed water control systems.



## A COMPREHENSIVE PRODUCT PORTFOLIO

COVERING A RANGE  
OF MARKET SECTORS:



### BRIDGES

- Bridge Deck Waterproofing
- Waterproofing & Wearing Courses
- Expansion Joints



### TUNNELS

- Internal Waterproofing
- External Waterproofing
- Suspended Deck Waterproofing
- Water Control Systems



### STRUCTURAL WATERPROOFING

- Waterproofing Systems
- Expansion Joints
- Liquid Roofing
- Green Roof Systems



### HIGHWAY MAINTENANCE

- Anti-Skid Surfacing
- Surface Colour
- Patch Repair
- Crack Sealing Systems
- Road Markings



### CAR PARKS

- Waterproofing and Wearing Course Systems
- Intermediate Deck Coatings
- Anti-Carbonation Systems
- Expansion Joints
- Rapid Setting Mortars



### WATER & POWER

- Tanking & Lining
- Waterproofing Systems
- Linings for Underground & Surface Reservoirs
- Secondary Containment



### AIRPORTS

- Car Park Refurbishment
- Waterproofing & Wearing Courses
- Surface Colour & Demarcation
- Pavement Repair
- Waterproofing Systems
- Secondary Containment
- Expansion Joints



### RAIL

- Waterproofing Systems
- Waterproofing & Wearing Courses
- Anti-Skid Surfacing
- Rapid Setting Mortars

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THE TECHNOLOGY OF PROTECTION

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