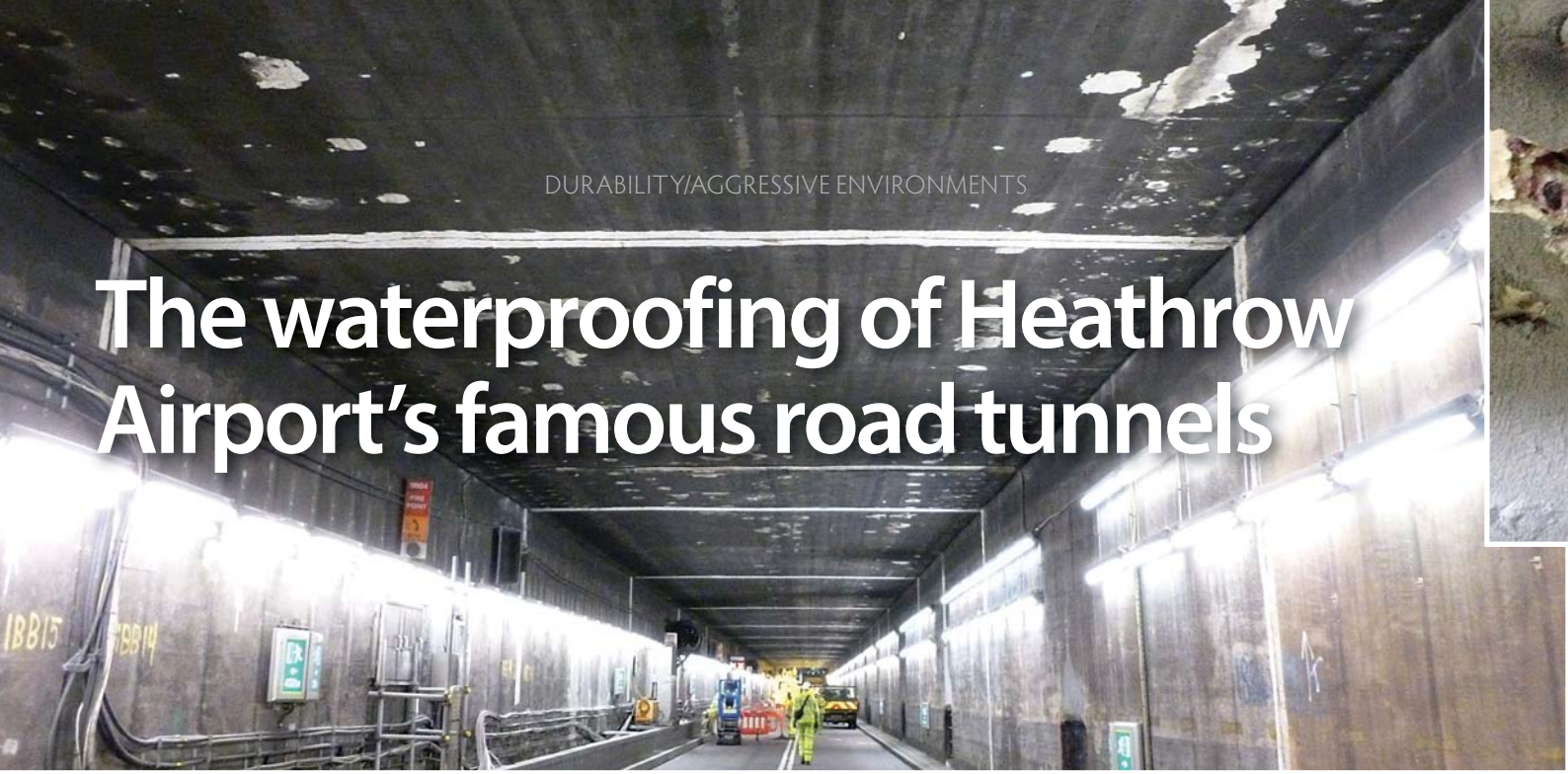
The waterproofing of Heathrow Airport's famous road tunnels



A major three-year project is currently being carried out to refurbish and strengthen the famous road tunnels leading to Heathrow Airport. The tunnels form one of the major routes into the airport off the M4, the A4 and other local roads. They were built in 1955 as part of the original airport construction and work is being carried out to modernise and strengthen them, while enhancing safety standards and allowing for the new generation of heavier planes, which use the runway above. ***Chris Lloyd*** *of* ***Flexcrete Technologies*** *reports.*

A total of 630m in length, the road tunnels are twin-bore with two lanes per bore and two additional single-lane side bores. Around 55,000 vehicles use the tunnels each day when entering or exiting Terminals 1–3 at Heathrow. They also form a main arterial route for all key services that keep the airport running.

Costing in the region of £85 million and being carried out by principal contractor BAM Nuttall for Heathrow Airport Holdings (formerly BAA), the tunnel strengthening and refurbishment work is valued at around ten times what it cost to build the original structure. The scope of work includes installing: new ventilation equipment; lighting systems; telephones; CCTV systems; drainage; doors and escape routes; emergency signage; and tunnel closure systems. This requires the tunnels to be stripped back to their bare structure to allow structural repairs and waterproofing of the tunnel joints to be carried out.

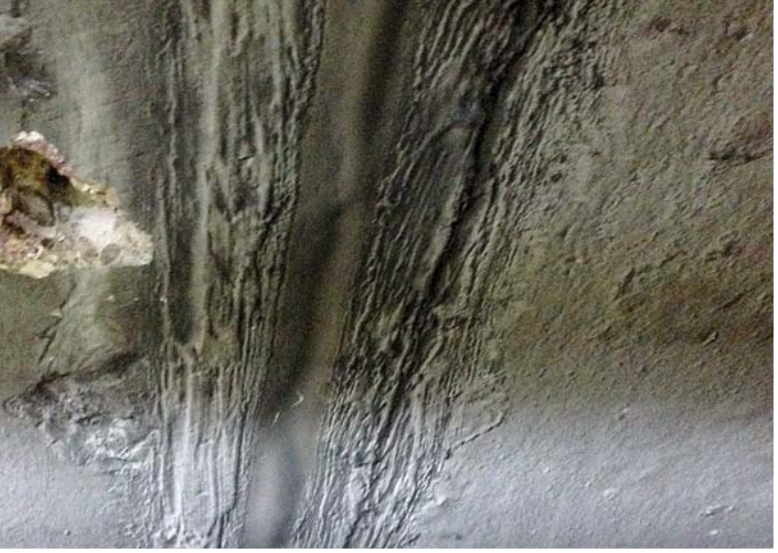
As the work cannot disrupt the daily running of the airport, it is carried out between 10.30pm and 5.30am five days a week. Every week night one of the tunnels is closed, with the other acting as a contraflow to keep traffic moving. All work is planned out step-by-step and full-scale mock-ups of the tunnels have been built off-site so that operatives can practise what they have to carry out each shift.

Prior to the works being carried out, a structural survey was undertaken by BAM Nuttall. This revealed that the surface of the soffit was largely covered in a 2–3mm thick layer of black exhaust soot, which in locations was peeling off to reveal a white specular reflective paint. The survey also revealed leaking, damaged or blown joints between the sections of the tunnels, areas where concrete had been removed during the lifetime of the tunnel, exposing structural reinforcement and visible cracks in the concrete.

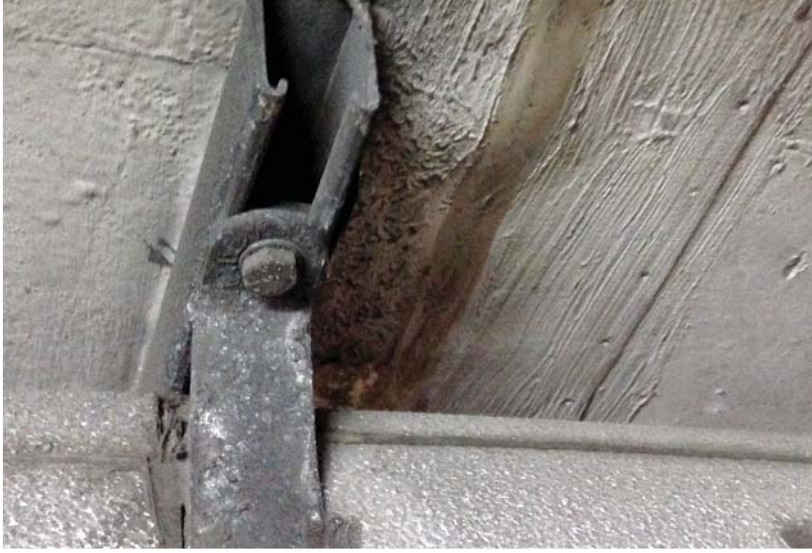
The outbound main bore tunnel comprises a total of 42 concrete sections, each 15.25m in length, and the survey revealed this had significantly more concrete infill repairs than the inbound main bore. Most repairs were found to be structurally solid when struck with a hammer. Any reinforcement that was exposed did not appear to have experienced any significant corrosion and was observed to be stripped clean of concrete, suggesting hydro-demolition or an intentional box-out during construction.

Waterproofing is a critical part of the design criteria of infrastructure and Mott MacDonald–Bentley, acting on behalf of BAM Nuttall, specified Flexcrete products for the waterproofing of the expansion joints in the tunnels, following successful

Inside the access tunnel during waterproofing of the expansion joints.



Signs of failure.



The expansion joints in the access tunnel had previously been waterproofed with a Hypalon over-bandage system adhered with an epoxy resin.

use of other materials at Heathrow Airport spanning several years. The expansion joints in the access tunnel had previously been waterproofed with a Hypalon over-bandage system adhered with an epoxy resin, but this had become damaged and had reached its design life so needed replacing. Following its removal it was necessary to fill voids and defects to reinstate the surface profile. Monolevel 844SP, a single-component, polymer-modified engineering-grade screed, was rapidly applied by trowel to provide an even substrate for coating.

Drainage channels

Any water seeping through the joint sections was then controlled and directed into drainage channels using Cemprotec 2000-S. This consists of an outer non-woven polypropylene fleece surrounding a thermoplastic waterproof polyurethane membrane, which has an elongation of 600% to accommodate any movement across the joint. It is supplied in two widths: smaller joints were covered with 120mm tape and any joints larger than 40mm were treated with 200mm tape.

Cemprotec 2000-S was adhered to the surface using Cementitious Coating 851, a two-component, water-based cementitious coating which is backed by British Board of Agrément certification and is CE marked in accordance with BS EN 1504 Part 2[(1)]. Applied by brush or spray techniques at just 2mm thickness, the coating provides the equivalent of 100mm concrete cover and resists positive and negative water infiltration at pressures up to 10 bar. With a water-based, non-hazardous, non-toxic formulation, it releases no strong odour or harmful solvents during application, which is critical in enclosed environments.

The coating forms a hard, highly alkaline barrier, which not only protects concrete from aggressive elements but also has enhanced chemical resistance. 851 provides an effective alternative to recasting or even demolition of precast and in-situ reinforced concrete, where the cover to the reinforcement has failed to give sufficient durability to attain the specified design life. Chloride attack is one of the primary causes of damage on reinforced concrete infrastructure exposed to de-icing salts.

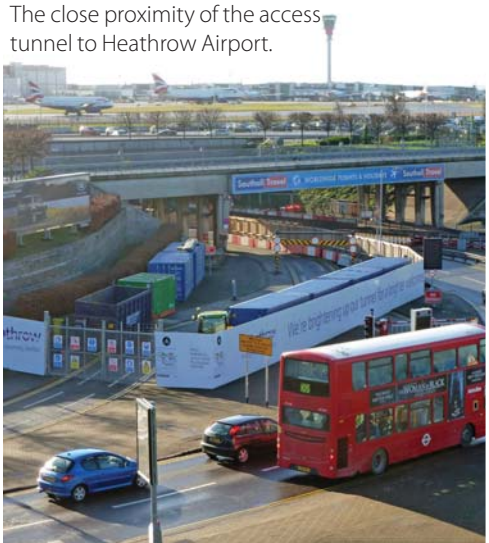
In 1988, a 2mm-thick film of 851 was applied to a concrete slice and sealed in a chloride ion diffusion cell in the laboratory at the Vinci Construction Technology Centre and it is still going strong today. Tests carried out show that the barrier properties are such that a steady state of flux of chloride ions through the coated concrete has not been attained after a test period spanning 27 years, whereas the control concrete achieved this in just 28 days.

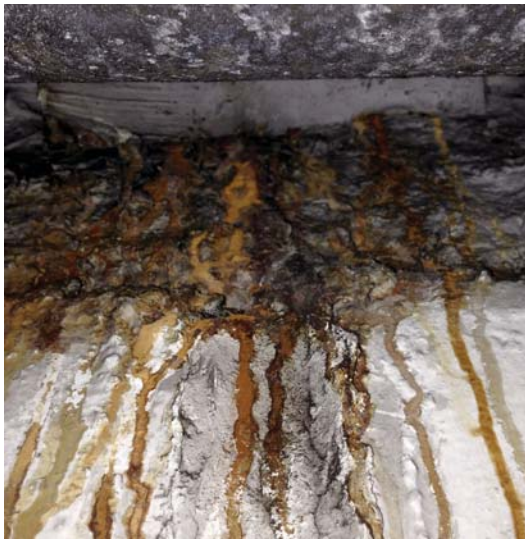
The waterproofing of the Heathrow Airport road tunnels has formed a key part of the overall refurbishment and strengthening contract. The project is now well over halfway through and will ensure structural stability of the tunnels and enhancement of safety systems for many years to come. ■

Reference:

1. BRITISH STANDARDS INSTITUTION, BS EN 1504. *Products and systems for the protection and repair of concrete structures. Definitions, requirements, quality control and evaluation of conformity. Part 2 – Surface protection systems for concrete*. BSI, London, 2004.

The close proximity of the access tunnel to Heathrow Airport.





Rusting and exposure of steel reinforcement.

Preparation works.