



SIKA AT WORK

LONDON UNDERGROUND TUNNEL, EMBANKMENT

REFURBISHMENT: Sika® Carbon Fibre Reinforcement Polymer System (CFRP)

BUILDING TRUST



LONDON UNDERGROUND TUNNEL, EMBANKMENT



SIKA STRENGTHENS LONDON UNDERGROUND TUNNEL.

As part of a major strengthening programme on the London Underground, an innovative solution was required to provide long term strengthening to over 90 cast iron beams. Following an extensive design and specification process, the result is the UK's largest ever application of ultra high modulus composite reinforcement.

Covered Ways CW17 and CW20 are on either side of Embankment Station on the District line, built in the 19th Century using "cut and cover" techniques. The covered ways carry the weight of Embankment Gardens situated above the District line tracks. Although the cast iron beams were assessed and found to be adequate to support the intended loadings and in a good



serviceable condition, there was serious concern that the cast iron beams could be overstressed, under unforeseen overloading.

London Underground undertook a feasibility study to determine the best all round solution to complete this strengthening. Both economically and logistically the best solution was to strengthen the beams in-situ. London Underground had to ensure the chosen repair solution would have minimal impact on the tunnel headroom and could be installed during Engineering Hours (overnight when there is no train service) so as to cause no disruption to the District and Circle line services. With a reinforced steel element deemed too thick to be a viable option, a system that was thin yet extremely tough was required.

The solution to the challenge lay with Sika® Carbodur® UHM and a well planned application procedure. An Ultra High Modulus Carbon Fibre Reinforced Polymer (CFRP) system, Sika® Carbodur® UHM is designed for high performance and demanding reinforcement applications. The plates, measuring 7.3m long, 200mm wide (2 no per beam) and maximum 4.7mm thick and offering exceptional reinforcing capability, proved the ideal solution. With over 1,300mtr of Sika® Carbodur® UHM plates applied, it has marked the UK's largest ever project to use ultra high modulus composite.



Specialist contractor, Contrete Repairs Limited carried out the skilled application, having been appointed by LU Framework Contractor, Clancy Docwra. The process began with each beam, measuring 7.5m long and 0.5m wide, cleaned using a powerful grit blasting technique that removed grease, oil, rust and any other contaminants which could reduce adhesion. Once dried, a coat of SikaCor®-EG 1 primer was applied, followed by the application of a resin to prepare the surface.

Ensuring secure, reliable attachment of the Sika® Carbodur® Plates, Sikadur® structural epoxy adhesive was then applied to both the underside of the cast iron and the plate itself.

When placing the plate into position, full contact of the adhesive to the two surfaces guaranteed a long-term bond was achieved before a series of temporary supports were put in place whilst the adhesive cured. The excellent performance of the adhesive allowed installation to carry on throughout the winter months when low temperatures and condensation can cause problems for other adhesives.

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To minimise service disruption on the District and Circle lines, the entire process had to be completed during Engineering Hours (overnight when there is no train service) and was scheduled to be delivered in a series of shifts between 1am and 5am, over a period of six months. In each shift, the project team had to erect scaffolding, transport the equipment and materials to the desired location and clean and prepare the beams before applying the Sika Carbodur UHM plates and temporary supports. The supports, scaffolding and equipment was then removed to allow the underground to reopen.

“The Sika solution proved the most practical method to strengthen the beams. With severely restricted access, in terms of both space available and the four hour window in which we could work, its ease of application – combined with a carefully managed schedule – enabled the project to be delivered within the allotted timeframe,” said Olu Ogunwale, Contracts Manager at Concrete Repairs.

The bespoke Pre-Preg manufacturing process used to create the UHM plates also ensured maximum efficiency with the creation of homogenous individual plates to the exact design dimensions in terms of length, width and thickness. At Embankment, this included specifically designed tapers in the end of the plates to reduce peel stresses to absolute minimum, inclusion of a small cut out in the end of the plate for increased tolerance around a downstand in the soffit of the cast iron, and fully applied fire protection to all exposed surfaces of the plate.

By overcoming the extreme time and spatial constraints of the London Underground, the client, contractors and material suppliers demonstrated outstanding workmanship and expertise to complete the project on time and on budget.

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