ABOVE:
Levita House.

INSET:
Striking design features.

SENSITIVE CORROSION PROTECTION OF LANDMARK SOCIAL HOUSING

“Breaking out and replacing all the contaminated concrete would be expensive and disruptive, leave a large carbon footprint and would not be in the spirit of one of the key principles of listed building restoration.”

David Bewley of **Concrete Preservation Technologies** (**CPT**) explains how a novel galvanic strip anode system was used at Levita House to control the corrosion of embedded steel beams and avoid unnecessary breakout of concrete.

We instinctively think of listed buildings as being ornate Georgian or Victorian structures of historical significance, built by artisans and exuding a grandeur with obvious aesthetic appeal. However, there are a growing number of mid-20th Century structures being awarded listed status, which face unique challenges when it comes to the preservation of original features. A critical challenge is the control of expansive corrosion in reinforced concrete elements.

Grade II-listed Levita House is part of the Ossulston Estate, located in the London Borough of Camden between Euston and Kings Cross. Built between 1927 and 1931, the Ossulston Estate was highly innovative in terms of layout and elevation and is a rare British example of the architectural ideas pioneered in the Karl Marx-Hof

complex in the city of Vienna, where high-standard, high-density homes were designed and built to create tight-knit communities for workers.

CHLORIDE ION LEVELS

Levita House features reinforced concrete access balconies framed by concrete-encased steel columns and beams. In July 2021, concrete testing works identified elevated chloride ion levels in a number of the north elevation columns and beams, along with carbonation that had reached the steel at localised areas of low cover. Contamination with chlorides, or carbonation, can disrupt the protection afforded the embedded steel by the high alkalinity of the concrete. When both contaminants are present, the corrosion risk is exacerbated.

Where the concrete had cracked and delaminated due to the effects of expansive corrosion, the concrete was broken out and replaced. However, the risk remained of future corrosion-related damage to currently sound, but contaminated, areas of concrete. Breaking out and replacing all the contaminated concrete would be expensive and disruptive, leave a large carbon footprint and would not be in the spirit of one of the key principles of listed building restoration, which is to retain as much of the original building fabric as possible.

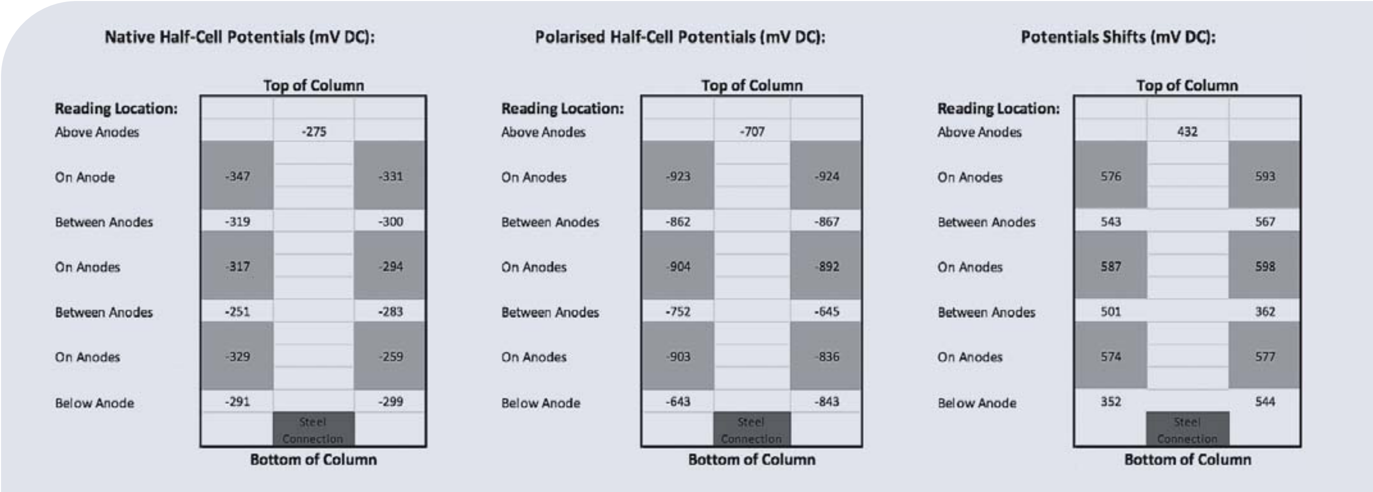
Specialist external refurbishment contractor Kafften approached CPT to design an appropriate corrosion

TOP LEFT:
Cracking and delamination of concrete cover.

TOP RIGHT:
Corrosion of a beam flange.

ABOVE LEFT:
Installation of a strip anode into a saw cut.

ABOVE RIGHT:
Checking the installation.

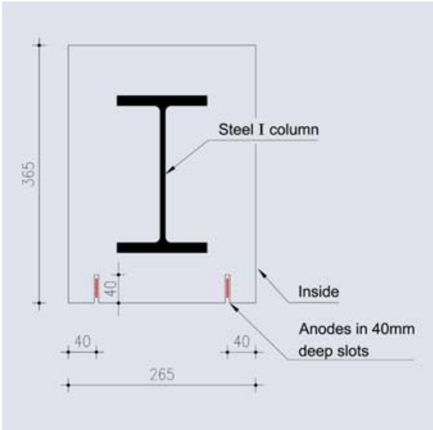


control system to protect the columns and beams identified as being at risk. Cathodic protection is a proven method of controlling corrosion of embedded metals. The two main types of cathodic protection are impressed current (ICCP) and galvanic (GCP). ICCP requires a permanent power source, plus monitoring equipment, to be housed on-site and the services of a corrosion engineer to be engaged annually to service and maintain the system. The power and control systems can be vulnerable to vandalism or accidental interference from other maintenance activities. Sadly, some systems are installed at great expense and then forgotten about. GCP does not require an external power source. Instead, the current is generated by the potential difference between an embedded sacrificial alloy anode and the steel reinforcement.

CHALLENGE

A GCP system was deemed most appropriate due to cost, the ease and speed of installation and the lack of any on-going maintenance. The challenge was to design a minimally invasive system to deliver maximum protection to the outer surface of the I-section flanges. It is here that the build-up of corrosion products had caused the cracking and delamination of the concrete cover. Due to the geometry of the columns and beams, a standard cylindrical anode would not have been the optimal solution. Instead, an innovative galvanic strip anode was proposed.

The strip anodes have the advantage of sitting in the concrete cover zone over the flange so that the protective current is directed where it is most needed. Furthermore, the surface area of a strip anode is significantly larger than a comparatively weighted cylindrical anode and the current produced is proportional to anode surface area. So, the design both maximises current output and distributes the current in the most effective manner.



Following a successful trial installation, to determine the practicality and efficacy of the system, the project proceeded using a combination of 500mm and 250mm length zinc alloy strips, all 20mm wide × 3.5mm thick, embedded into 6mm-wide × 40mm-deep saw cuts. A typical beam required a loop of ten anodes, while each column required a loop of six anodes. Each anode was connected to a titanium feeder wire, which was riveted to the steel section at the start and end of each anode loop.

ABOVE: Testing of steel potentials pre- and post-anode connection.

LEFT: Column section.

BELOW: Completed project.

SHIFT IN STEEL POTENTIAL

The system was tested on completion by measuring pre- and post-anode connection steel potentials on selected beams and columns. The shift in steel potential in all cases was far in excess of the 100mV acceptance criteria for steel passivity in BS EN ISO 12696[1]. The large potential shift is indicative of high early current output from the galvanic strips. This is desirable as the cathodic reactions on the steel repel chlorides and rebuild a protective alkaline layer on the steel surface. This move to steel passivity reduces the demand on the galvanic anode system, enabling a 20-year design life to be achieved.

It is envisaged that there will be multiple applications for galvanic strip anode technology; not only for the protection of embedded steel I-sections, but also for heavily reinforced structural elements where the narrow space between reinforcement bars impedes the use of drilled in cylindrical anodes. C

Reference:

1. BRITISH STANDARDS INSTITUTION, BS EN ISO 12696. *Cathodic protection of steel in concrete*. BSI, London, 2016.