Bridge 57, Huyton

The electrification of the main Liverpool to Manchester Victoria rail line required the strengthening of a large pedestrian underpass, Bridge 57 in Huyton, Liverpool.

BAM Ritchies Concrete Techniques division was appointed to undertake the complex works by virtue of their in-house capabilities to undertake the various aspects of the designed solution.

Bridge 57 completed.

The strengthening of the Bridge comprised a variety of works, including;

Installation of shear keys;

Prior to the installation of the adjacent road underbridge (Bridge 57A) Bridge 57 was the main access through the Rail embankment at this point.

Consequently, all of the main utility companies had historically routed their services under the footpath. This has resulted in a myriad of services being routed underneath the bridge foundations.

It was considered too complex a task to excavate and re-route the existing services to accommodate a conventional new foundation, therefore in order to transfer the additional loads imposed by the arch strengthening lining it was decided to install a series of shear keys into the abutment walls to transfer the additional loads through to the existing bridge pier foundations.

Whilst core drilling the abutment walls and installing the initial shear keys, it was evident that the condition of the existing brick and stone piers was not as anticipated during the works design.

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The injected grout was not being retained within the shear key holes and achieving the encapsulation of the shear keys as planned. Grout was emerging at adjacent holes, indicating substantial voiding within the abutment walls.

Due to the unforeseen ground conditions encountered, a grouting regime was carried out to consolidate the abutment walls and existing foundations.

A total of 35 M^3 of high strength grout was injected into the abutment walls to provide sufficient stability to enable installation and grouting up of the shear keys.

Installation of drainage;
The existing arch brick lining was experiencing significant water ingress at numerous locations.

Consequently, a network of bespoke fibreglass drainage channels were fixed radially to the arch at 1m centres to intercept as much of the water ingress as possible.

These drainage channels extended down to the top of the abutment walls, where they were incorporated into a collector drain at both sides.

The collector drains were arranged so as to fall with the existing slope of the footpath through the Arch.

Downpipes were installed, and fed into an existing drainage arrangement.

As the collector drains were to be incorporated into the Sprayed Concrete Lining, rodding eyes were provided at either end of the lining for future drainage maintenance.

Waterproof Membrane:
Although mechanical drainage systems are commonly incorporated into Sprayed Concrete linings, they do not guarantee that the lining will remain impermeable. Damp patches and slight water ingress does occasionally occur long after the completion of linings.

To ensure water tightness an impermeable, cement based, spray applied waterproof membrane was applied to the whole of the bridge

Initially, a 50mm layer of Sprayed Concrete was applied over the whole of the arch and abutment walls. This 50mm layer also embedded the drainage channels into the initial Sprayed Concrete layer.

After an initial curing period, a 2mm layer of an orange coloured Tamseal 800 waterproofing membrane was applied to the grey Sprayed Concrete surface. The pigmentation of the Tamseal provided a simple method of checking that a sufficient membrane layer thickness had been applied to conceal the underlying substrate.

A further 2mm layer of white Tamseal 800 was then applied to ensure that a minimum of 4mm waterproofing membrane had been applied.

After the subsequent fixing of reinforcement, the remainder of the Sprayed Concrete lining was applied, thereby ‘sandwiching’ the waterproof membrane between layers of Sprayed Concrete. When sandwiched between the layers of concrete the double bond between the membrane and the primary and secondary layers of sprayed concrete enhances the waterproofing membrane performance.

This method ensured that there would be no potential de-bonding issues as the waterproof membrane, being cementitious by nature remains an integral component of the Sprayed Concrete Lining

Installation of reinforcement;
The arch strengthening lining required a significant density of reinforcement to achieve the designed load bearing capacity.

Sprayed Concrete traditionally aims to utilise as small a diameter of bar as is possible, due to encapsulation considerations.

However, it was necessary to incorporate 2 layers of closely spaced 20mm diameter Radial Bars to comply with the required design.

To fix the reinforcement L shaped dowel bars were resin fixed into the arch and abutment walls and the 2 layers of reinforcement tie wired in place

Application of sprayed concrete;
The reinforced lining had a total uniform lining thickness of 450mm.

To ensure correct cover to reinforcement and to provide screed guides, HDPE Pipes were temporarily fixed to the arch radially. In addition stainless steel 'piano' wires were stretched longitudinally by means of barrel strainers to provide thickness guides and screed rails on the flat abutment walls.

The 50 N/mm2 dry-mix Sprayed Concrete was applied to the arch and walls in alternate panels, on a 'hit & miss' basis, and screeded to profile to the screed guides.

After the arch and abutment screed guides were removed, a 15mm 'Flash' coat of Sprayed Concrete was applied over the whole of the arch and walls to give a uniform aesthetic finish to the all of the exposed Sprayed Concrete surfaces.

A sprayed applied curing membrane was then applied in accordance with good concreting practice.

Facing brickwork;
To provide an aesthetically pleasing finish to the new arch by way of concealment of the exposed ends of the new concrete lining, and to match the existing brickwork feature, a single skin of brickwork was erected at each end of the Arch.

Stainless steel Halfen channels were attached to the end shutters and incorporated into the Sprayed Concrete Lining.

When the lining was complete and the end formers were stripped, the exposed channels were used in conjunction with stainless steel ties to ensure that the facing brickwork at each end of the lining remains in intimate contact with the concrete lining and does not detach in the future

Tarmac;
A 25mm layer of hard stone asphalt was applied to the whole of the subway and adjacent areas where construction works had taken place.

This significantly enhanced the overall appearance of the completed works.

The works were completed on time, to budget, and to the satisfaction of all concerned.

Location:
Liverpool

Client:
Network rail

Main Contractor:
Buckingham Group

Consultant:
Tony Gee & Partners

Date:
2014

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