

Turnham Green Station Signalling Equipment Rooms

Client: FM Conway on behalf of London Underground

Location: Turnham Green, Chiswick

Value: £1.8m

Duration: 10 Months

In Brief...

During a recent project at Turnham Green Tube Station for FM Conway, on behalf of London Underground (LU), Barhale were able to demonstrate how Early Contractor Involvement (ECI) enabled the development of a realistic and successful cost plan. This in turn led to collaborative interaction at design stages and the delivery of a successful project in line with the agreed cost.



The condition of the arches prior to works. The team carefully removed excess spoil from the embankment to mitigate the risk of subsidence



The view from underneath the arches shows the extent of the spoil to be removed

Background to the project...

As part of London Underground's "4 Lines Modernisation Programme", they planned to build six Signalling Equipment Rooms (SER) within the existing rail arches underneath Turnham Green Station. The new signalling system will allow trains to run closer together, meaning a more frequent service and shorter wait times, allowing more passengers to be carried. Furthermore, this new technology would enable London Underground to reduce delays and improve reliability.

The scope of works required excavation of the existing rail embankment under the six arches, installation of extensive temporary works formed by sheet piles braced by frames against the viaduct wall, along with the following:

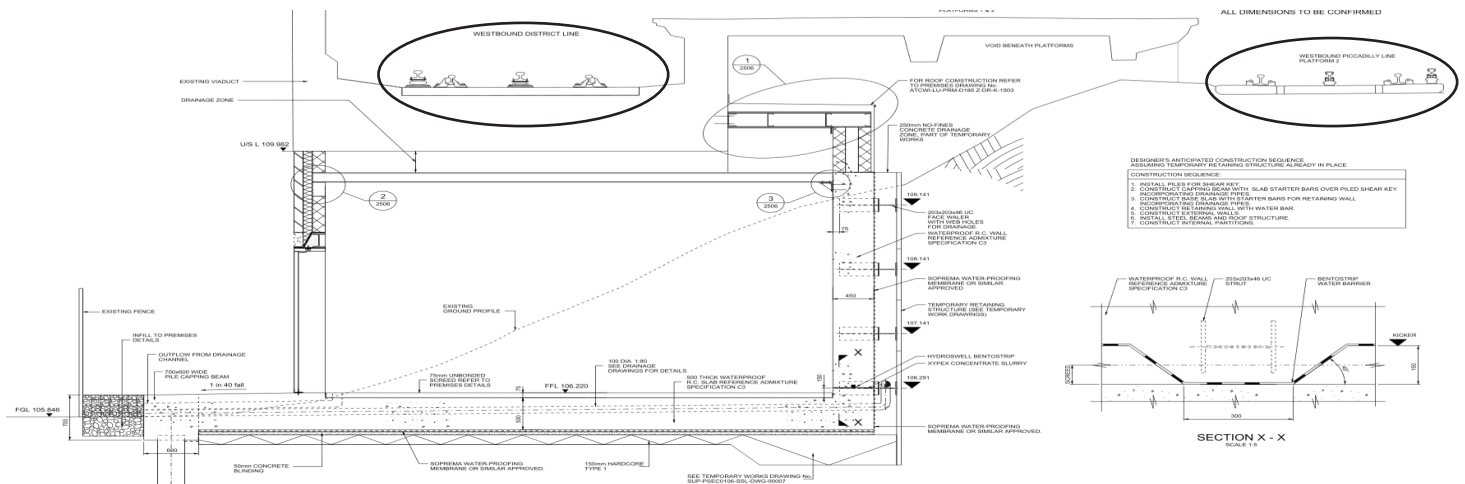
- Installation of sloped access stairways and edge protection barriers
- Temporary drainage system modifications
- Excavation and temporary support of the embankment
- Construction of a 'No-fines' concrete wall
- Excavation of invert, backfill with type 1 and concrete blinding
- Reinforced concrete slabs and walls
- Pipework installation

This was a high risk project. The works would be taking place in a restricted area with limited head-room, and in very close proximity to live railway lines (District Line and Piccadilly Line on the Underground network). As, shown in in the diagram below, the incorrect process for removal of the embankment could have destabilised the railway above. The eventual method (developed by Barhale) would involve digging through the existing embankment at the back of the arches. The biggest risk therefore was settlement, resulting in undermining. Our main objective during the ECI stage was to develop a methodology which mitigated and controlled settlement from occurring.

Early Contractor Involvement...

Barhale were approached by FM Conway and London Underground (LU) during the development phase of the project. We were initially engaged under a £10,000 ECI order to develop a suitable methodology and temporary works design sequence for the construction of 6 no Signalling Equipment Rooms (SER) under the District line viaduct at Turnham Green. London Underground had previously developed a temporary works design however the sequence needed formalising to enable a safe and effective delivery.

Early Contractor Involvement (ECI) was therefore essential to the successful delivery of the scheme. Had any element of the design, sequencing or methodology been incorrect, it could have led to an undermining of the live tracks. This had the potential to cause a train derailment, resulting in; loss of life, damage to third party infrastructure, huge fines and an unfathomable amount of reputational damage.



Initial design drawings. Note the proximity of the live rail lines circled

Development of Cost Plan...

Within the ECI Phase we developed a comprehensive cost plan. As the method was developed, we then built our price and programme to meet that method. The key to success during the ECI and cost plan development was collaboration with our Clients. We delivered several interactive presentations to FM Conway and London Underground. These face to face meetings enabled us to provide details of our methodology, and in turn, gave London Underground and Conway confidence in our approach and our cost plan.

These presentations were treated as opportunities for consultation and collaborative working; rather than pre-determined lectures. Not just; “this is how we will do it”, but rather; “this is how we are proposing to do it. What do you think? Are there any changes or suggestions you think would be beneficial to incorporate?”

Adopting this approach from the outset enabled our team to build a successful working relationship with the clients. Questions and challenges from all stakeholders were taken on board and incorporated in to our approach, which helped develop a sequence and methodology which was correct and accurately forecast at the first instance; supporting the Barhale ethos of delivering projects “Right First Time”.

As part of the cost plan at ECI stage, Barhale identified “Tool Box Items”, which would provide mitigation to potential risks within the contract. These Tool Box Items were a set of pre-agreed tools and methods which could be used in the event of an emergency. This involved:

- Identifying the keys risks during the ECI stage and sharing these with the clients
- Determining acceptable mitigation measures to combat these risks, and agreeing these ‘emergency approaches’ with the clients
- Setting a small pot of money aside to allow us to procure what was needed at the start of the project

By addressing this at the ECI stage, we were able to ensure that in the event of an emergency or a worst case scenario event, we would not lose time procuring items and getting methodologies approved, as this was already in place.

Once we had priced the final work scope, we provided full visibility of the cost breakdown to the client in order to justify our cost plan. This was done in an open and transparent fashion, and helped to establish trust between all parties. The ECI stage was critical in developing these successful behaviours.

Outline and Detailed Design...

London Underground’s designer, Alan Auld (now Golder) carried out the temporary works and steel frame designs. This design had been suitably progressed by the time our team were engaged at ECI stage, however we provided extensive input to determine how the design would be sequenced in order to meet a practical and cost effective delivery method. This was achieved at the outset by holding additional collaborative design feasibility workshops to define the final design solutions. These were held with all stakeholders including several branches of London Underground (Operations, Project Management, Design, etc.), Conway and Alan Auld.

Once the design feasibility had been agreed by all stakeholders, the Barhale team worked closely with Alan Auld to ensure the sequencing aligned with the defined methodology and to factor in any changes in geology. The steel frame designs were managed through 3D modelling to ensure they would suit the existing brick arch structure.

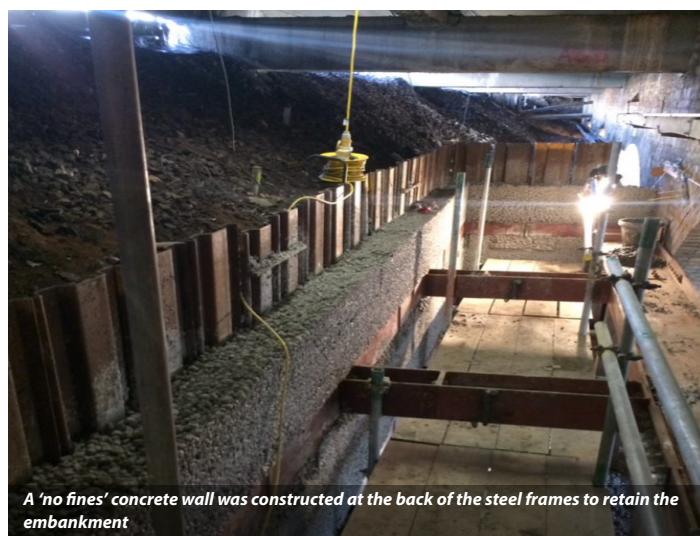
To support the permanent design teams Barhale carried out full site investigation, including trial holes. The team also proactively raised a number of technical queries with the clients to clarify exact details of the project; measuring structures to confirm the integrity of the detailed design.

Barhale employed the use of an embankment settlement monitoring system to ensure the works did not affect the live railway. Monitoring retro reflective targets were placed in key locations to ensure the ground stability was maintained throughout the excavation works. Monitoring data was processed by Barhale operatives and submitted to the client on a daily basis.

Due to longer travelling durations from the excavation point to the ‘muck-away’ location, Barhale utilised a Bobcat type of plant which proved to be faster and more economical than a bigger sized forward tipping tracked dumper. This decision was crucial for the project and facilitated the cutback of the construction programme by two weeks. To further reduce programme time Barhale planned, coordinated and safely delivered concurrent reinforced concrete works for the duration of the scheme, being able to install reinforcement, erect shutters and pour separate sections of the retaining wall at once. As a direct result, Barhale reduced the programme duration by approximately six weeks.



Installation of the steel frame design



A 'no fines' concrete wall was constructed at the back of the steel frames to retain the embankment

Built to Cost...

At the end of the ECI phase, Barhale tendered the project at £1.5m. The final delivery cost was £1.8m, however, this increase was a result of factors outside of our control, rather than errors within the Cost Plan. These factors mainly included small sections of pre-agreed design change. Barhale were one of several Contractors working on behalf of the Principal Contractor; FM Conway. Our team were therefore dependant on the sequencing and coordination of the project as a whole, in a very constricted work environment. This meant that there were instance where our team had to wait for other contractors to finish their areas before we could move in which added to the final out-turn cost.



One of six completed steel frame installation, prior to waterproofing