THE MAGAZINE OF THE CONCRETE SOCIETY

CONCRETE

Volume 58, Issue 2 March 2024

GAZEBO CONCRETO

Exploiting the sculptural potential of concrete

DECARBONISING CONSTRUCTION

The role of the main contractor in a lower-carbon industry

PHOENIX BRIDGE

3D-printed bridge built with recycled materials

TIME-SAVING CONSTRUCTION AND CO-ORDINATION ON TIDEWAY'S CARNWATH ROAD SHAFT

With a combination of steel, precast and reinforced concrete to consider, as well as complex geometric interfaces with numerous M&E, operation and maintenance requirements, Tekla's enhanced accuracy, co-ordination and visibility were essential in the construction of Tideway's Carnwath Road shaft. Steve Jackson reports.

Tideway is a multi-billion-pound project, designed to transform London's existing 150-year-old sewer system with the construction of a new 25km 'super sewer' underneath the capital city and River Thames. An immense project, Tideway has a complex series of construction works, sites and shafts all over the city.

The Carnwath Road shaft in Fulham is one example, measuring 25m in diameter and with a depth of 42m. Initially constructed to launch the main tunnel boring machinery for Tideway West, the shaft was subsequently used to extract the spoil from the tunnelling works, which, using the riverside location, could then be removed by barge. Once completed, the shaft will provide a junction between three tunnels and have a mezzanine chamber level for plant equipment and access. At the surface, the area will be landscaped to provide a public space on the north bank of the Thames.

DETAILING AND MODELLING

Hewson Consulting Engineers, the civil, structural and geotechnical consultant, was appointed by the BMB joint venture in early 2022 and tasked with detailing and modelling the upper shaft structure. Speaking about the project, Andrew Hodgkinson, director at Hewson, says, "While works had already commenced on the Carnwath Road site when we were appointed, BMB JV wished to explore changes to the construction methodology for the upper shaft structure, which formed the initial part of our contract. The focus was on improving the efficiency and delivery of the overall programme schedule, which was understandably a key priority.

"After consideration, a hung transfer truss solution was developed for the upper structure, enabling the site team to cast the slipform secondary lining of the whole shaft in a single streamlined process, rather than casting the shaft lining in two phases – the second of which would have required a colossal volume of falsework supported off the base of the shaft."

PRECAST ELEMENTS

In addition to the two underslung steel transfer trusses, Hewson's design also featured 37 precast elements. These included secondary support precast beams and a series of slabs (fabricated off-site by a precast manufacturer), all of which formed the mezzanine chamber slab floor for the plant room. For the shaft cover, a further two precast beams were required (approximately 100 tonnes each) and 14 precast units, weighing between 8 and 85 tonnes each, all of which were manufactured on-site in the casting yard.

Hodgkinson continues, "A major advantage of precast concrete being used here was that no formwork or falsework was required. This enabled site teams to continue the works further down in the shaft (pausing for the slabs to be lifted into position), all without disruption.

"The value of the 3D modelling environment was that we could build the precast structures digitally and model all geometrically complex interfaces before we even reached site, benefitting us hugely from a co-ordination point of view. By first considering the design in a detailed 3D environment, we could really visualise how all individual elements would work and fit together on-site.

"This same approach also helped us to identify any potential clashes, such as between reinforcement bar and other steelwork, which we were then able to resolve before reaching the site, mitigating any risk. For this sort of project, looking at off-site manufacturing and considering the interfaces between precast units, everything has to fit. Having the assurance that it would, was invaluable."

Co-ordination and constructability were understandably key factors on

the project. As well as co-ordinating with the various M&E elements and the interfaces between the multiple precast and prefabricated members of the redesign, Hewson also had to consider the shaft's operation and maintenance requirements.

SUFFICIENT SPACE

Hodgkinson explains, "We had regular meetings with Tideway and other stakeholders, during which we had to demonstrate that we were providing sufficient space for the operations and site teams throughout the redesign process and that there wasn't going to be an impact on the preapproved plans and strategies. Being able to bring up the Tekla model and visually demonstrate our plans and proposals was key in allaying these concerns.

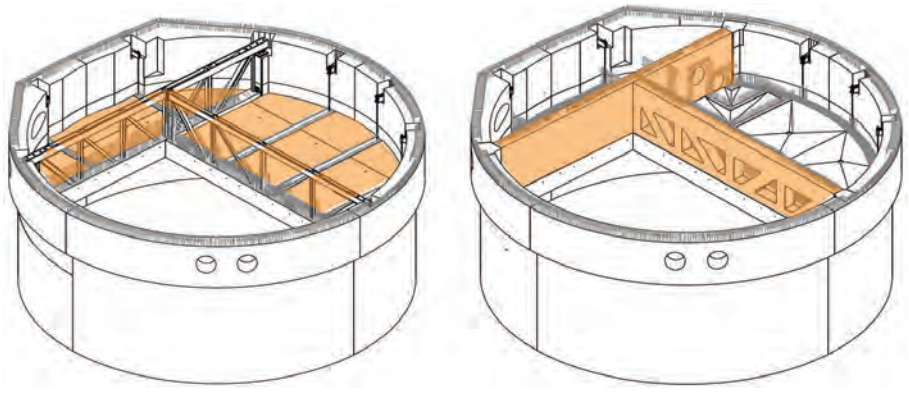
"Similarly, we were able to use the 3D model to plan out access and working methods in advance, which presented a major safety advantage. Working with precast concrete and taking a DfMA approach, we had to design the concrete elements with enough tolerance to ensure everything would fit on-site. By sharing the development model with the site team via Trimble Connect, we were able to get their feedback on whether the design would be constructible or if there was adequate space to safely work. In essence, by being able to explore the model as it was being created, the contractor team could benefit from a 'digital rehearsal' of the works."

Working with reinforced concrete elements presented another challenge on the project, with the potential for some highly congested areas of reinforcement and complex detailing. By working in 3D, Hewson was able to easily identify any congestion or potential problem areas and adjust the design in light of this.

Hodgkinson explains, "It's all about visualisation – congested areas of reinforcement can sometimes be difficult to spot in 2D. By using 3D modelling tools, we were also

ABOVE LEFT:
Looking up at the mezzanine chamber slab floor and shaft cover.

ABOVE:
On-site installation of precast elements.



ABOVE:
Top of shaft cover.

LEFT:
Precast slabs (left) and steel trusses (right).

able to optimise the design of the reinforcement, ensuring that we didn't have more reinforcement bar than was needed, in turn helping make the whole project more efficient.

"The steel transfer trusses are a good example of the reinforcement complexities we were faced with. The trusses were to be encased in reinforced concrete and we had to detail one of these trusses around the openings in the steelwork – required for airflow and pressure management in the shaft. This was extremely complex, both the process of co-ordinating the reinforcement bar with the truss steelwork and ensuring access for the concrete pour was possible. However, we were able to achieve this with no issues on-site; credit to our team's capabilities, the contractor's team and the Tekla software."

VALUABLE

Hodgkinson concludes, "The value of the digital software and the co-ordination and accuracy it offered us was evident in the limited number of issues we encountered as the works progressed on-site. As well as saving us valuable time, we received very few TQs from either the client or the teams on-site. Likewise, the construction of the slipformed secondary wall lining ran incredibly smoothly and was completed with zero issues associated with the reinforcement design detailed in Tekla."

Tideway is expected to be completed in 2025. Hewson's work on the project saw the team win 'Infrastructure Project' in the 2023 UK Tekla Awards, with judges praising the excellent combination of steel and concrete structures in the 3D model and the use of Trimble Connect to collaborate with other team members as a 'shining example of innovation and excellence'.