Bramley Service Reservoir

pushing the boundaries of Building Information Modelling (BIM) and precast concrete engineering in the water industry

by Sally Russell MEng MICE

Bramley Service Reservoir (SRE) is owned and operated by Yorkshire Water Services (YWS), delivering a constant clean water supply to the large catchment area of Leeds, West Yorkshire. The two existing service reservoirs were constructed in 1880 and 1912 respectively and were reaching the end of their designed asset lifespan. A new £3.8m twin compartment service reservoir with a 16ML capacity was therefore required to maintain the critical link in the clean water distribution network for the surrounding catchment area.

Placing of the precast concrete elements - Courtesy of Mott MacDonald Bentley Ltd

Background

The No.1 SRE had been taken out of service, leaving a single compartment reservoir in service. This presented both operational and maintenance issues, due to the requirement for the asset to be completely removed from service for maintenance and cleaning. To overcome this issue, modern SRE design utilises a dual-compartment methodology allowing one to remain in service whilst the other is maintained as and when required.

Service Reservoirs such as Bramley provide a holding facility for clean water to be stored prior to distribution. In addition they provide stored reserves in the event of a burst or high demand periods. A new site was needed for the replacement reservoir in order to maintain the water supply to the city of Leeds during construction, as the existing No.2 SRE could not be taken out of service until the new facility was in place and fully commissioned for use. This resulted in all existing inlet and outlet pipework remaining in place and untouched during the construction phase. As No.1 SRE had already been removed from service it was to be demolished, making space for the construction of the new No.3 SRE.

Undertakings

The new SRE at Bramley is being delivered under the Reservoirs stream of Yorkshire Water's AMP5 Capital Investment Programme. This scheme is just one of a number of service reservoirs that have been delivered through the utilisation of Building Information Modelling (BIM), and standardised precast concrete solutions, developed by design and build contractor Mott MacDonald Bentley (MMB) in collaboration with the client YWS and key supply chain partners.

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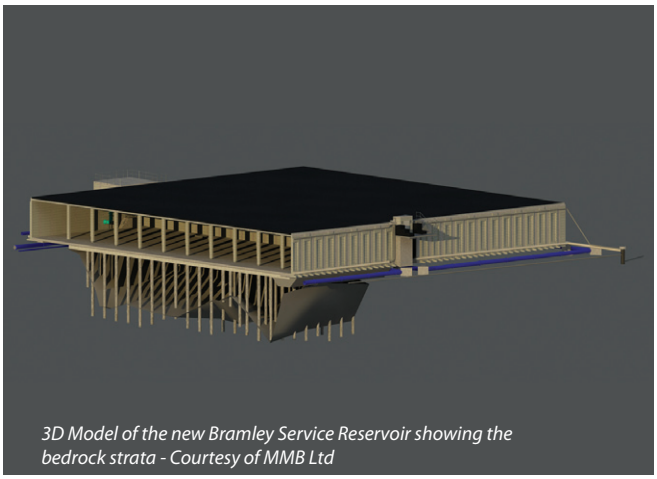

3D Model of the new Bramley Service Reservoir showing the bedrock strata - Courtesy of MMB Ltd

Use of tablet technology/BIM on site - Courtesy of MMB Ltd

Precast concrete wall units & columns - Courtesy of MMB Ltd

Utilisation of Tablet computers with the site team - Courtesy of MMB Ltd

Engineering challenges

The replacement SRE was required to connect into the existing water distribution network at a similar location and elevation as the existing facility, maintaining the current hydraulic conditions. Any decrease in elevation would reduce the water pressure in distribution and might create pressure problems to customers. Also, any significant increase in the elevation would compromise the flow capacity of the incoming water to the reservoir.

The connections were also required to be in the same location in order to avoid the need for laying significant lengths of new pipework whilst ensuring that the stored reserves provided by the reservoir are in the optimum location within the distribution network.

With demolition of No.1 SRE complete and the retaining wall secure, construction commenced on the new No.3 SRE. Whilst ground investigations identified suitable bedrock to sit the end-bearing continuous flight auger (CFA) piles on, they also recognised sections of historic landfill within the footprint of the proposed new structure – presenting a challenge to the foundation and structural design. The top layer of landfill was excavated and replaced with fill from the demolition of No.1 SRE to provide a suitable working platform for the piling rig.

Further site investigations were undertaken (dynamic probing) and determined that the landfill would not affect the perimeter wall construction; i.e. the landfill material was internal to the proposed wall location and could be easily piled through to the bedrock below.

MMB worked closely with supply chain partner and specialist sub-contractor Tritech Piling & Foundations Ltd during the piling design and installation phase, collaborating to ensure the correct solution was implemented. Whilst MMB knew suitable bearing strata sat below the landfill layer, until the installation process began it was unknown whether there were severe undulations in the bedrock, which would affect the length of the piles to be installed, potentially changing the number/size/location of piles required.

Information was fed back from the piling rig during the grid-type installation of piles. This enabled a model of the bedrock floor to be constructed, which identified ridges due to the piling rig only penetrating a fraction of the depth compared to other areas. In these areas further piles were installed to ensure the correct bearing capacity for the structure was achieved. Once the piles were cast the installation of the precast concrete products could commence to construct the new superstructure.

Innovations

Bramley made extensive use of precast concrete products in collaboration with MMB's long-standing supply chain partner Carlow Precast Concrete Engineering Ltd, with elements stitched together with in situ concrete. Walls have been constructed using 125 (No.) precast units of various dimensions and the roof structure is made up of 5m precast slabs supported by 120 (No.) columns and 132 (No.) internal beams.

Utilising this method of construction reduced programme time, risk and uncertainty, as well as vulnerability to inclement weather. Stringent QA testing, starting with visits to the manufacturing facility during production, as well as on-site QA ensured the highest quality standards throughout delivery.

MMB committed to delivering the Bramley SRE project through the adoption of Building Information Modelling. BIM has facilitated the off-site methodology, ensuring MMB had full confidence in the design for manufacture and assembly (DfMA) agenda, which has been honed over many years of working with YWS. The interactive BIM model has provided many benefits to the scheme, including:

- Real time updates.
- Reduced design time/instantaneous changes.
- Efficient optioneering/clash detection.
- Minimisation of errors.
- Significant reduction in carbon emissions.

Setting out was one of the first paperless tasks MMB undertook. The Total Stations received coordinates direct from the BIM model, eliminating the possibility of human input error. In total, over 700 (No.) precast structural components were accurately placed and 180 (No.) augered piles installed using the BIM model.

This saved seven weeks on the programme and assisted in a capital efficiency claim of £743,000; something that would not have been achievable without the use of BIM.

Another major advantage of utilising BIM was the ability of the site team to feed as-built information back into the model for O&M and QA recording purposes upon completion – providing a much more efficient process for capturing this information.

Lessons learnt

The lessons learnt through the Bramley SRE scheme have been shared via bulletins and newsletters, peer to peer presentations and adoption of our basic service reservoir product for schemes of similar nature with other clients.

MMB are leading a client and contract-partner working group for BIM, having realised that if clients are to see the full benefits of BIM we need to progress to Level 2 – client-led Building Information Modelling. By working more closely with fellow contract partners MMB will also be able to derive further efficiencies through sharing best practice. BIM will ultimately lead to greater efficiencies which will provide greater value to clients, which has been demonstrated on the Bramley SRE scheme.

Public engagement

As the project was located close to Bramley Primary School and densely populated residential areas, MMB worked with the YW Community Engagement Team, as public and stakeholder engagement was vitally important. Presentations were made to the children and staff at the local school and to further engage with the pupils and to teach them about site safety, they were asked to enter a competition to design posters about safety at the Bramley site, which were then displayed around the site.

MMB aim to deliver projects in a conscientious manner, ensuring that impacts on local communities are minimised. This is managed through our stakeholder engagement plan which identifies all the key customer and third party interfaces within a scheme which was particularly relevant at Bramley being located within a public park.

Conclusion

Bramley SRE was the perfect scheme to demonstrate both our Building Information Modelling capability as an organisation, and the strength of BIM as a platform to achieve project efficiencies. MMB pushed the boundaries of what could be achieved with BIM and precast concrete in the water industry. The team made great progress towards the goal of achieving paperless construction and has helped inspire cultural change. Through overcoming challenges and sharing lessons learnt, MMB is making a significant contribution to the adoption of BIM in the water engineering sector.

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