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Top o' th' Cow Service Reservoirs

GHA Livigunn creates innovative design solution for Top o' th' Cow service reservoirs

Working in association with United Utilities, KMI+ and MWH, Cheshire-based GHA Livigunn has acted as lead structural design engineers for two new 4.15 mega-litres service reservoirs at Top o' th' Cow - an exposed rural location outside Bolton. The project which commenced in February 2006, with the new service reservoirs being brought into service in June 2007.

A United Utilities bespoke AMP4 project, this challenging task involved the replacement of two existing butyl-lined steel service reservoirs that had reached the end of their service life. The innovative solution provided by GHA Livigunn involved the use of considerable 3-D visualisation and finite element modelling to create an elegant structure in a landmark location. The design was carried out using STRAND 7 advanced Finite Element Analysis, with verification by traditional analysis methods.

Freely supported domed roof design

As a planning requirement stipulated that the new service reservoirs should have domed roofs in order to sympathise with the appearance of the original tanks, that had become local landmarks, GHA Livigunn also had to incorporate a freely supported domed roof design. These are believed to be the largest freely-supported concrete domed roofs in the country.

Special structural mesh reinforced walls

Each new service reservoir is 33m in diameter with 6m high, 300mm thick walls. The walls are reinforced with special structural mesh S786 (H10s at 100) and post-tensioned to achieve the client's requirements of a 0.1mm crack limiting criteria 'critical aesthetic appearance'.

Matching effective capacity

The 4.15 mega litre capacity of each new service reservoir was specified to match the effective capacity of the two existing service reservoirs at Top o' th' Cow, one of which had already been removed from service and demolished. Consequently, the remaining steel tank could not be withdrawn from service and demolished until at least one new service reservoir had been commissioned.

Alternative design solution

The Top o' th' Cow contract was tendered on a design and build basis, with GHA Livigunn and KMI+ being awarded the project with an alternative solution that involved a revised layout of the tanks and a valve house that was 50% smaller than originally specified. The net result of this design alternative was the creation of sufficient space for the two new service reservoirs to be built simultaneously on what was an extremely compact site and also avoided the need to remobilise specialist contractors.

Careful site analysis

The GHA Livigunn design solution was achieved through careful analysis of the site and considerable use of 3-D modelling. This provided a clear visualisation of the finished design and demonstrated to all stakeholders how a considerably smaller valve house, than originally proposed, could be built without compromising access or maintenance requirements.

Attention to detail

The base slab of each service tank sits on an embankment formed using imported fill from a nearby construction project and ensures gravity flow of all tank contents into the water distribution network.

The 300mm supporting walls were designed to resist the thrust from the domed roof and internal hydrostatic pressure in ring tension. A wall thickness of 300mm was adopted as this was considered to be the minimum thickness that could be poured in a single lift using a 170mm slump C35 concrete.

The post tensioning design was carried out by GHA Livigunn and involved close liaison with specialist sub-contractor, Balvac. Although GHA Livigunn explored a number of lightweight options for the roof domes, reinforced concrete was adopted as it met the required design life of 60 years and met United Utilities' security requirements. Designed as a flat dome, with a rise of 3.3m, each reservoir roof was the result of close working with SGB who were responsible for falsework and formwork to ensure the roofs would not become loaded during stressing operations.

Technically demanding

Comments GHA Director, Stewart Tennant: "Without a doubt, the design of the Top o' th' Cow service reservoirs was one of the most technically demanding structural engineering projects of my career – and one of the most challenging design projects faced by GHA Livigunn.

"The entire task," he continued, "includes a number of highly innovative design solutions and is the product of outstanding collaborative working on behalf of the entire project team. Since completing the project, we have been led to believe that Top o' th' Cow may well comprise the largest freely-supported domed roofs in the UK."

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