

THE MAGAZINE OF THE CONCRETE SOCIETY

# CONCRETE

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## THE AWARDS ISSUE



### HIGHLY COMMEDED

From Gull Wing Bridge to  
UCL East Marshgate

### ...AND THE SHORTLIST

From repurposed retail block to  
Belfast office building

## 'ENHANCING COMMUNITY ENGAGEMENT'

'Exceptional' Stockport Interchange  
is our 2025 Overall Winner



# LLYN CELYN PMF FLOOD CONVEYANCE SCHEME, NORTH WALES

Llyn Celyn is the largest reservoir by volume in Wales, with a capacity of 81 million cubic metres. The £45 million reservoir safety scheme is designed to protect the dam and communities along the River Dee, in the event of an extreme flood. The project features a new auxiliary spillway, including a culvert beneath the access road and precast concrete tipping gates.



**MAIN IMAGE:**  
Drone shot of the overall reservoir, showing the works site.

**L**lyn Celyn reservoir is situated on the Afon Tryweryn, approximately 8km north-west of Bala in the county of Gwynedd, North Wales. Following an inspection of the reservoir, it was found that the existing drop-shaft spillway was unable to safely contain flows associated with extreme flood events. The outcome of the inspection and subsequent studies required that a new auxiliary spillway be constructed.

The £45 million reservoir safety scheme at Llyn Celyn involved the construction of a new auxiliary spillway, with a culvert beneath

the access road and a downstream section to convey floodwater during extreme storm events past the dam safely, alongside upgrades to the associated pipes and valves.

Over recent years, Dŵr Cymru Welsh Water (DCWW) has faced challenging maintenance/end-of-life asset replacement works on critical dam safety schemes, many of which have been rectified through conventional construction methodologies. However, Llyn Celyn presented an extremely challenging, high-risk project that demanded innovative and collaborative thinking to navigate unique obstacles.

The reinforced concrete (RC) spillway structure is 260m long, culverted through the dam embankment, with a 67m overflow weir and tipping gate overflow operation. The structure is a mass concrete foundation topped with an RC base, with connecting dowels and formed walls.

## **CONCRETE AND INNOVATION**

The concrete designed for this scheme considered a key risk element, which was the remote location of the site, approximately one hour away from the nearest batching plant. The mix designs were developed with the concrete



### Llyn Celyn PMF Flood Conveyance Scheme, North Wales

#### Client

Welsh Water

**Contractor/designer/consultant**  
Mott MacDonald Bentley (MMB)

**Concrete supplier**  
Cambrian

**Reinforced concrete subcontractor**  
Concrete Structures and Floors

**Admixture supplier**  
Sika

**Formliners**  
Reckli



supplier (Cambrian-UK) to ensure suitability in terms of meeting the structural requirements and constructability on-site. The structure consisted of two different concretes – C16/20 strength class for the mass fill foundation and C40/50 for the structure base slabs, walls and roof. Each mix consisted of a 50:50 cement:GGBS blend with ADVA635 water-reducing admixture. The C40/50 strength-class mix included Sika Tard-R, which significantly improved retaining consistence and reduced the risk of having issues on-site.

The concrete structure required over 11,500m<sup>3</sup> of concrete and during the

pre-construction stage, a maximum concrete pour volume of 150–200m<sup>3</sup> was assumed due to batching plant location, logistics and construction site restraints. Working closely with subcontractors and the concrete supplier, confidence was gained in pouring up to 350m<sup>3</sup> per day and to maintain pouring concrete on consecutive days, with some weeks exceeding 1000m<sup>3</sup>.

The construction was split into five phases, with the requirement that all the Phase 1 walls were



**ABOVE:**  
Construction in progress.





**THIS IMAGE:**  
Llyn Celyn PMF Flood  
Conveyance Scheme –  
completed structure.

constructed prior to the excavation of Phase 5 (through the dam embankment), ensuring that a flood event during construction could be conveyed safely downstream of the dam core. The base slabs and walls of the downstream side of the dam were required to be constructed first to allow construction to progress through the dam crest.

Excavating through the dam crest and constructing the new spillway was a safety-critical activity requiring extensive planning due to the operational demands put on the reservoir and large catchment area. Managed under DCWW Silver Command, the team followed Mott MacDonald Bentley's (MMB) 'Beyond Zero' approach to address key dam safety risks, ensuring no one was ever in an unsafe position.

The dam safety construction management plan linked the construction programme to the reservoir water level management plan maintained by Natural Resources Wales (NRW). It was crucial to maintain the programme during these works and the team leveraged expertise from other phases of the scheme, reducing

construction risks, costs and programme duration.

### **SUSTAINABILITY CREDENTIALS**

The best way to reduce carbon is to not build anything at all. With this in mind, several opportunities were identified to propose 'no-build' solutions across the scheme. Studies of the existing drop-shaft spillway confirmed that, although cavitation would be expected to occur during extreme flood events, the expected outcome would be no damage at all, so physical strengthening works were not required.

Conventional design of modern reinforced concrete spillways includes a concrete chute from the overflow weir all the way down to the river channel – at Llyn Celyn, a distance of approximately 500m. Due to the remote nature of the environment, the low likelihood of extreme flooding and by using 2D hydraulic modelling, MMB confirmed that a full-length chute was not required.

### **VISUAL**

As Llyn Celyn lies within Snowdonia National Park, the spillway has

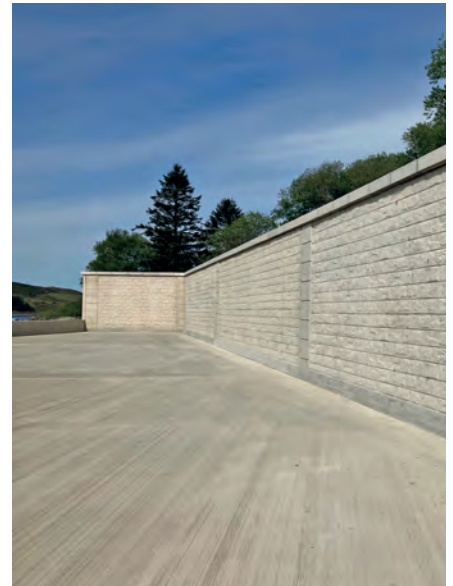
been carefully designed to blend in with its natural surroundings and work with the land adjacent to the dam. All exposed concrete walls have either a patterned concrete finish or stone cladding. Following a successful trial panel, the design was challenged and planning approval gained to reduce the stone cladding by 75% and replace it with the patterned concrete finish.

The patterned finish was carefully selected to match the pattern on the client's existing buildings. This was achieved using Reckli Pommern 2/130 formliner. The geometry of the spillway proved tricky, with varying heights to walls and grade changes on base slabs. This required meticulous planning of wall sequencing and detailing around the joints and pillars.

### **COMMUNITY VALUE**

Successful delivery of the complex project has culminated in multiple benefits for both the client and the community. The new, resilient spillway features increased capacity via an innovative 'tipping gate' design to avoid downstream flooding during lower return





periods, while the replacement of critical valves has improved public safety. MMB now has greater confidence and experience in delivering complex reservoir and dam safety schemes, and has significantly strengthened relationships within DCWW's capital delivery works.

Karen Morris, senior project manager at DCWW, comments, "From the start, we knew that this project would be a complex scheme. From a client perspective, technical understanding, stakeholder engagement and project delivery on time and quality have been excellent. The attention to technical detail and understanding of our needs has been vital to the ability to meet the demands of the project."

#### **COST AND PROGRAMME**

The original programme for the spillway concrete structure was 78 weeks from early November

2023 to the end of April 2025. MMB was able to work closely with subcontractor CSF to deliver this project in 65 weeks from January 2024 to the first week in April 2025. This meant beating the original programme dates even with a delayed start to the project. With detailed collaborative planning, key risk elements were overcome, such as weather and concrete-related issues due to the remote geographical location. This resulted in a cost saving of over £0.5m for the concrete structure. **C**

**TOP RIGHT:**  
Completed structure.

**ABOVE LEFT:**  
Tipping gates.

**ABOVE RIGHT:**  
Completed structure.

**BELOW:**  
Construction in progress.



### **Judges' Comments**

*Based on the remote site and the weather conditions experienced, to deliver the project on time and on budget is a testament to excellent teamwork and communication within the project team, and an example of how civil engineering projects can be delivered.*

*Careful planning and considerable expertise in concrete and engineering, all ensured that the solution not only met the brief but went above and beyond.*

*As Llyn Celyn lies within Snowdonia National Park, the spillway has been carefully designed to blend in with its natural surroundings. All exposed concrete walls have either a patterned concrete finish or stone cladding. The care and attention taken over the formwork liners is commendable considering few people will look closely at the finish, and if they do, many will assume that it is stone block not formed concrete.*

*Most people will see just a glimpse of this project as they drive along the A4212. This is a real shame, as the attention to detail and quality of finish deserve to be appreciated by more than those who will have access to the site.*