



Confined space concrete repairs

In 2014, Edwards Diving Services (EDS) – a specialist marine, diving and confined space civil engineering contractor – was engaged by Caerphilly County Borough Council to undertake engineering repairs to 11 culvert structures located in the county borough. The need for repairs was determined following a programme of specialist confined space condition inspections undertaken in previous years. Steve Richings of EDS reports.

The structures varied in construction form and sizes, ranging from small-span stone slab on masonry abutments, large span and height masonry arches, brick barrel culverts and reinforced concrete boxes. The full programme of repairs included stone and brick masonry repairs, repointing works, installation of steel soffit support braces and, significantly, large areas of invert reinstatement. All works were undertaken in live watercourses, in accordance with the requirements of *Ordinary Watercourse Regulation – Consenting*⁽¹⁾ and adhered to the *Civil Engineering Specification for the Water Industry*⁽²⁾.

Various methods of invert scour repair were assessed and mass concrete was judged to present the most economic approach, even where the surrounding areas were formed in stone or brick masonry. The speed of executing a concrete repair by pumping as opposed to masonry reconstruction kept costs low, while minimising health, safety and environmental risks associated with working in confined space watercourse environments, most notably manual handling of materials, fatigue, slips, trips and falls, and also changing environmental factors such as water flows. Other factors, such as access over third-party land, traffic management measures and the sensitivity of nearby residents/land users, were also taken into account. Again a compressed construction schedule ensured minimal impact to others.

Large-scale concrete repairs to the culvert inverts presented technical challenges in selecting a suitable mix that would enable pumping from the limited areas accessible to ready-mixed concrete trucks at surface level, via the confined space accesses (such as manhole shafts and inlet/outlet structures) to the areas to be repaired. In total, 87.5m³ of concrete was pumped at seven difficult access culvert sites, many involving pours at more than one location in the culvert. The maximum

pumped length was 140m, over which the supply line had to negotiate three 90° bends and drop a total of 12m in height.

EDS worked closely with its ready-mixed concrete supplier, Severn Sands, to determine a mix incorporating the required anti-washout additive, the high cement content required to enable a smooth pumping operation, a maximum aggregate size of 10mm to prevent blockages, a rapid curing time in order to minimise the hazard of seepage or washout (particularly pertinent when working in watercourses) and achieving a robust long-term abrasion-resistant concrete product that would stand the test of time against aggressive water flows.

A process of trials and fine-tuning settled on a final mix of sea-dredged sand, clean 10mm limestone aggregate, CEM I cement, GGBS and anti-washout additive (Sika UCS).

Temporary water management

In advance of any works, temporary water management measures consisting of a combination of sandbag dam walls, water bypass pipes and over-pumping were installed upstream of the works, in order to eliminate any flow across the repair area. These always presented a difficult challenge, especially in the environment of the Welsh valleys where the topology leads to watercourse flows and levels being particularly flashy and subject to rapid change with rainfall – an unfortunate common occurrence. Concrete pours were cancelled on many occasions at short notice due to the changeable weather, requiring a very understanding supply chain.

Once water management measures were installed, secondary pumps were used to empty the repair areas



Concrete pump supply line set up in Nant Tysswg culvert.

Water management temporary works in Nant Tysswg culvert.

of any standing water. The areas were then prepared by removing any loose material, cutting edges square and installing formwork where required, ready to receive the concrete.

Downstream, spillage containment measures were installed as a failsafe in the event of temporary works failure, in order to catch any washout or mobilised sediments, preventing them from entering the watercourse and protecting the aquatic life.

EDS engineers preparing concrete supply lines across a watercourse.



New manhole access constructed to enable concrete pump works at Nant Tysswg culvert.



Completed concrete invert reinstatement.



Nant Tysswg culvert

The most challenging environment was encountered at the Nant Tysswg culvert, a 451m-long stone masonry and engineering brick arch structure located in the village of Abertyswg, south-east of the town of Rhymney. The culvert had only two man-access points – the inlet and outlet – while large-scale concrete repairs were required throughout and as far as 220m from the nearest access point. In addition, both the inlet and outlet areas were difficult to access for concrete supply and pump vehicles, adding 50m to the pump length via these routes. The route passed under a busy main road and adjacent to a fishing lake, restricting access further.

EDS undertook a sond survey in order to trace the route of the culvert, identifying a set of defective soffit beams at chainage 140 as a location where a new manhole could be installed. This required construction of a widened 160m-long access track, which accessed the fishing lake, followed by opening of a 3m-deep battered excavation. A 4-tonne bespoke precast concrete slab with a centrally located access point, designed by a specialist precast supplier, CPM, was craned into place to reinstate



Masonry arch culvert with collapsed abutment and scoured invert, and with temporary works in place.

Typical scoured invert area in Nant Tysswg culvert, prior to preparing for repair.



the culvert soffit. Precast manhole rings and cover were installed up to ground level and the area backfilled, thus access was created for the concrete pump.

Pumping operations, involving moving 34.5m³ of concrete throughout the culvert, were undertaken over a period of four separate days, with intervening days being used for relocating the temporary works between repair locations. The operations were ultimately a success, resulting in a reinstated culvert invert providing stability to the structure and protection of the load-bearing abutments from washout for years to come.

EDS completed the contract works on time and to budget in 2014 and has, subsequently, successfully tendered for, and is presently delivering, the 2015 culvert repairs contract for the local authority, drawing on the techniques, technical know-how and personal experiences developed in 2014. Inspection of the completed concrete works from 2014, in advance of the defects date, has confirmed they have been unaffected by the intervening winter weather and high flows, a testament to well-executed repairs in very difficult working environments presenting challenging access methods and, not to forget, a durable, specialist concrete – exactly right for the job. ●

References

1. ENVIRONMENT AGENCY, Advice Note. *Ordinary Watercourse Regulation – Consenting*. London, February 2012.
2. WRC. *Civil Engineering Specification for the Water Industry*. Seventh edition, Swindon, 160pp, March 2011.