



DSI References

Reference Details

Client National Roads Authority, Ireland +++ **General Contractor** Direct Route, comprising: Roadbridge, Lagan, Sisk, Strabag +++ **Drilling Contractor**

DSI Unit DSI UK, Warwickshire, United Kingdom

DSI Scope Supply of 350 No T76S DYWIDAG Hollow Bar Anchors between 30m and 45m long, 47mm Prestressing Steel for post-tensioning



DYWIDAG T76S Hollow Bars Stabilise Limerick Casting Basin, Ireland

Excavation for the Production of Precast Elements for Tunneling, River Shannon

The City of Limerick, Ireland's third largest city, is currently Ireland's fastest growing city. Situated on the River Shannon, the city's picturesque waterfront has been a major attraction, but in recent times also a real hindrance, as the need for a South Ring Road and a new river crossing has led to virtual gridlock during rush hours.

The solution chosen for the river crossing by the NRA (National Roads Authority of Ireland) is an immersed tube tunnel, consisting of five separate precast sections, placed in the Shannon at a point known as Bunlicky. The tunnel is part of the Limerick South Ring Road, a €500m scheme linking the N7 Dublin Road with the N18 Ennis Road. When operational, the tunnel will carry up to 40,000 vehicles per day, with a small toll collected from each vehicle.

Roadbridge engaged DYWIDAG-Systems International at an early stage in the design of the casting basin, where anchors were proposed as the main support to the sheet piled wall. The ground conditions were known to be poor, consisting primarily of silty soils to a depth of 20m with very hard Limerick Limestone below. The challenge for the anchors was to install them at 45° through the silt and then achieve a rock socket in the hard Limerick Limestone.

Roadbridge were tasked with all of the excavations, earthworks and roads within the joint venture consortium known as Direct Route. Roadbridge's solution for the casting basin was to employ 330 No. T76S Dywidag hollow bar temporary anchors 30-35m long, installed over the full length of the 550m casting basin, on both sides. The rigs used to install the T76S anchors were two Casagrande M6 hydraulic drilling rigs, equipped with Eurodrill top hammers (drifters). Both these rigs were operated by Ray Hilliard Piling and Foundations Ltd. In addition, two Putzmeister P13 grout pumps were used to pump in a 0.4 w/c ratio grout, as part of the simultaneous drill and grout technique used with self-drilling hollow bar anchors. Both drill rigs featured a special swing-away fly jib fitted to the top of the drill boom, to facilitate the lifting and placing of the 4m T76S hollow bars (weight = 79kg) at a 45° drill angle.

The Limerick Limestone is known to be particularly hard in this location, with Quartz bands permeating the local strata. A special drill bit with Tungsten Carbide buttons and a drop centre was developed during the execution of the works, to improve drilling performance. The drill bit has a cutting diameter of 130mm, with the leading face featuring 8 No. 13mm T/C hemispherical buttons. Further features of the drill bit include 3 No. deep side scallops for increased spoil removal and a retroflush side port with 2 No. forward flush ports. These special T76 ESS-D 130 drill bits are now thought to be the best rock bits ever made for large diameter hollow bars. They offer superior cutting and spoil removal performance compared with any other hollow bar drill bit currently available on the market. It is now the most popular drill bit for forming rock sockets on temporary bar anchor projects.

In addition to the casting basin works, further T76S temporary anchors were required to stabilise the Combi-Wall at the North Side float out location, as part of the Lagan Group's works. This combi-wall consisted of 1400 x 20mm tubular piles, dowelled 10m into the rock and interspersed with a pair of LX20 sheet piles. At the top of the combi-wall was a capping beam (2.2 x 1.5m) post-tensioned with DYWIDAG 47mm prestressing steel threadbars. Through this capping beam were placed 10 No. DYWIDAG T76S anchors at 45m long, socketed 6m into the rock. These anchors are designed to resist the thrust on the bulkhead, spanning between the combi-walls, when a high tide passes up the River Shannon.

Testing of the anchors required special measures, applicable only to self-drilled systems. The installation technique, simultaneous drill and grout, results in a fully grouted column all the way up the anchor. This grouted column is essential for load transfer in the rock socket, but also has a distorting effect of picking up load in the overburden when the anchor is stressed. During the testing of the trial anchors, it was essential that the load picked up from the overburden during stressing was discounted from the overall test load. Load generated in the overburden (active wedge zone), does not contribute to the overall stability required

in the design.

To overcome the influence of the overburden, the trial anchors were overstressed (up to 95% of yield) in order to break the grout bond in the active wedge zone. This enabled load to be transferred directly to the rock socket and accurate load readings to be taken at the jack. It is very important that true displacement is measured, not a factor of the apparent free length. Therefore, the Test Method 1 from EN1537 (displacement test) should be used for hollow bar temporary anchors, not BS8081 (where extension readings are set as the criteria, based on a factor of the apparent free length).

All of the anchors are now installed and stressed, with construction of the tunnel segments almost completed. Float out of the tunnel segments will follow shortly, where they will be placed in a dredged trench across the River Shannon and then covered with gravel. Completion of the South Ring Road is due in 2010, which is sure to bring relief to all the residents of the City of Limerick.



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