LMR Drilling UK Ltd.

Another Record...

Rock & Peat Drill for 48" Gasline Completed by LMR Drilling

LMR Drilling UK Ltd., leader in the European Horizontal Directional Drilling (HDD) market, has recently successfully completed the installation of a section of 48" diameter steel pipeline on the Nailsea to St. Georges Project in SW England.

LMR 350T Rig

The drill was 904 m long and passed through peat and underlying rock. The nature of the rock varied considerably, ranging from weak mudstone to moderately hard siltstone. The crossing is thought to be the longest length of 48" steel pipe installed by HDD anywhere in the world. This, together with the varied ground conditions, presented a demanding challenge to the LMR team.

The Main Contractor on the Project, Entrepose Industrial Services Ltd. (EIS), had been contracted by Transco PLC to construct a 48" gas transmission pipeline totalling 12.2 km in length. The line passed in part through the North Somerset Levels with its low-lying landscape of wet pastures with peat soils intersected by numerous drainage ditches or rhynes. This exceptionally sensitive environment, with its rich and varied flora fauna, would have been damaged extensively by the use of conventional open-cut methods. It was decided, therefore, that HDD provided the best environmental, economic and practical solution.

LMR Drilling was awarded the contract for the HDD work towards the end of June 2001 and immediately began to mobilise its 'state-of-the-art' 350T maxi-rig to site from its premises in Birkenhead on Merseyside. This rig was designed and built 'in-house' by LMR during 1999 and commissioned towards the end of that year. With an ultimate maximum pullback force of 450 Tonnes it is the most powerful in Europe. Having designed the rig 'in-house', LMR were able to incorporate many innovative features and these have already proved their worth on the many crossings and outfalls completed with the rig to date. On this project, the mobility and power of the wrench assemblies proved invaluable in that they allowed easy, and above all safe dismantling of the large and heavy pieces of drilling equipment used on the project.

Aerial View Kenn Moor Road Site

The crossing passed beneath many obstacles including a 12" live gas main, one road, 8 rhynes and 2 further ditches. LMR designed a drill profile to ensure that these obstacles would be avoided and undisturbed. This profile gave a depth of cover below the road and rhynes of 19 metres and the pilot hole passed 7 metres below the live gas main.

Boreholes along the route showed a 2 to 3 metre thick layer of peat overlaying weak mudstone for the length of the crossing. The technique for tackling this combination of very soft sediment over rock required careful planning. It was decided that the best solution was to drill through the very soft peat with a standard jetting assembly and then to overrun

Kenn Moor Road Drill Site

this pilot pipe with a 12" diameter casing pipe. With this installed, the jet assembly could be pulled out of the hole and the specialist rock drilling equipment required for drilling the mudstone could be run through the casing pipe to the interface with the rock. During pilot drilling the casing pipe served several purposes. It acted as a conduit for the drilling mud through the peat, it supported the drill pipe though this section and it provided a safe passage back to the rock hole should the downhole equipment need to be pulled out of the hole for adjustment or servicing.

Pilot drilling through the rock began on 8th July 2001. The pilot hole establishes the direction and level at which the pipe is to be installed and follows a pre-defined profile. The equipment consisted of a milltooth tri-cone bit mounted on a mud-motor. This mud-motor converts the hydraulic energy of the drilling fluid passing through the drill string into mechanical energy to drive the drill bit. This rotating bit cuts the rock away as it is pushed against the formation ahead. Steering adjustments are possible as the mud-motor incorporates a bent sub, offsetting the last 3 metres of the drill of the string at 1.5° to the axis of the hole, thus creating a curved borepath following the required profile.

Steering was controlled with the use of a magnetic guidance system (MGS). This provides information to the driller's cabin on the horizontal and vertical angle at the end of the hole and of the orientation of the bend in the mud-motor. As each drill pipe is drilled down, a reading of the angles is taken and this information is used to calculate the position of the drill bit. For this crossing great care had to be taken to produce a smooth borepath, with a 48" steel pipeline being very inflexible. To maintain accuracy, and in addition to the MGS, LMR utilised a surface tracking system, the Trutracker system, to fine-tune the positional control.

Punchout Complete

Pilot hole drilling was completed on 16th July, 8 days after starting. This gave an average production rate above 100 m per day. The proposed exit point was missed by only 180 mm, well within the required tolerances.

The pilot drill, having established the line of the hole, had a diameter of just 9⅞". This now had to be opened up to the final 58" hole size. LMR chose on this occasion to use rock-reamer style hole-openers. These were mounted with milltooth cutters (the bit condition following completion of the pilot hole had confirmed these to be the right cutter style for this type of rock). The hole-openers were pulled from the exit point through the pilot hole back towards the drill rig. As they were pulled, the hole-openers were rotated with the drill rig, cutting away the rock ahead. The hole-opening operations progressively opened the hole from 9⅞", through 26", 42" and 52" steps up to 58".

58" Dia. Hole Opener

Having studied the ground investigation reports, LMR were concerned about the effect of the layering of the rock on hole-opening operations. In particular, that the hole-openers might deviate from the line of the pilot hole as they rode up over harder layers and dropped in the softer sections. To minimise this effect, centralisers were used during hole-opening operations. These are added to the drill string in front of the hole-openers and are slightly smaller than the existing hole diameter. This minimises the magnitude of any deviations from the pilot line and should ensure that the hole is straight and smooth enough for the product line.

In reality, the pilot hole drilling showed that the variation in hardness between layers was greater than indicated in the boreholes. Indeed, a section of the drill passed through ground better described as very stiff clay. It had been expected, following sample analysis, that the weak mudstone would be non-reactive in the presence of water and that this would produce cuttings that would be easily transported and removed from the mud. However, the section through the very stiff clay reacted totally differently, producing a thick, sticky sludge in the hole. This led to extremely high torque on the

drill string and LMR's decision to use their specialist hi-torque drill pipes downhole proved to be invaluable. These pipes have connections that can take 30% more torque than the equivalent standard connection and enabled completion of the second phase of hole-opening with minimal delay.

Having seen the ground conditions, LMR were able to adapt the drilling fluid with the addition of gypsum ($CaSO_4.2H_2O$) to the basic mud mix. This improved mud was introduced to the hole as LMR performed a hole conditioning run following the second phase of hole-opening. As a result of this torque dropped by 90% and the subsequent hole-opening could continue more efficiently.

Hole Opener and Centraliser
Hole Opening Complete

Hole-opening was completed on 13th August and preparation for pullback began. A hole cleaning run was performed to ensure no debris remained in the hole. As this was being completed, the pipeline, on its rollers, was formed into an overbend to align it with the 8° exit angle of the hole.

On 17th August all was ready and the pull commenced at 0800 hrs. As the pipe was pulled into the hole, water was added through a PE pipe laid inside the larger gas line. The additional weight of the water neutralised the buoyancy force created by the displacement of the drilling fluid. As a result the pullback was completed within 12 hours and with a maximum of 55 Tonnes (typically 40 Tonnes).

Commencement of Pullback

This considerable engineering achievement has been well received by Entrepose and Transco, with Transco Project Manager, Phil Evans, commenting that "It was an amazing feat of engineering to pull such a length of this size pipe without any problems".

Successful Pullback

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