LMR Drilling UK Ltd.

"3 Major Obstacles, 1 Simple Solution"

Cambridge to Matching Green, Saffron Walden, Essex

Fig. 1 LMR's 300 Ton Drilling Rig

Introduction

LMR Drilling UK Ltd., Europe's principal horizontal directional drilling company, has just completed a large diameter drill for Murphy Pipelines Ltd. (MPL) as part of the Cambridge to Matching Green Project. The drill, just south of the village of Saffron Waldon in Essex, passed under three major obstacles, the River Cam, the M11 motorway and the high speed, Kings Lynn to St. Pancreas railway lines.

Project Brief

The Client, Transco PLC, awarded the contract for the construction of a pipeline from Cambridge to Matching Green to MPL in late 2001. The contract involved the construction of 42 km of 48" diameter pipe for gas storage and transportation. As part of this, the pipe had to pass under the River Cam, the M11 and mainline rail tracks. The only realistic method for achieving this was to use horizontal directional drilling (HDD) techniques.

Drilling Engineering

The drilling contract was to be challenging in that the 48" diameter pipe was as large as any that had been installed in Europe by HDD and boreholes indicated that the drill was to pass through gravelly soils and rock. LMR were invited to visit the site and to discuss the project in early 2002. Following these discussions, LMR designed a 716 metre long drill profile which gave sufficient clearance underneath the various obstacles. The design also incorporated a 14° horizontal curve so as to enable the pipe string to be fabricated along the existing pipeline spread.

This design was submitted to MPL along with a detailed Method Statement and Quality Plan. Following approval by Murphy Pipelines, LMR were asked to attend meetings with Railtrack at which MPL were seeking the necessary permission for the drill to pass underneath the mainline, overhead electric, railway lines. After reviewing the Method Statement and drill profile, the necessary permits were forthcoming and the programme for the HDD was finalised ready for work to begin on site on 24th May 2002.

Drilling Operations

Due to the size of the product pipe and the length of the crossing, LMR used their 300 ton drilling rig (see Fig. 1). The first stage of the drilling operation was for the drilling and installation of a mud return line from the entry to exit sites. The mud return line was to be needed during the hole-opening operations for the main gas line, as a means of transferring drilling fluid

from the exit site back to the drill site. This is necessary as the drill fluid is recycled and re-used throughout the drilling operations and there is a tendency for the drill fluid to flow back to the exit side of the crossing during hole opening operations.

Following the installation of the mud return line, the drill rig was realigned to commence the drilling of the hole for the gas pipeline. Due to the fact that the drill passed through chalk (see Fig. 2) for a majority of the drill length, a mud motor was used for the drilling of the pilot hole (and for the mud return line drill). These pilot holes were drilled using a 9 " milled tooth tri-cone bit mounted on a 6¾" mud motor.

Fig. 2 Above: Rock Section Showing Chalk Strata
Below: Flint Nodule with 20 pence for scale

The pilot drill establishes the line of the hole and care has to be taken with such a large pipe to ensure that the rate of hole curvature is sufficiently low so as not to overstress the pipe during the subsequent pullback operation. Although originally proposed as a straight crossing, LMR suggested incorporating a horizontal curve into the design so as to be able to string the pipeline along the existing pipeline spread and avoid the need to obtain an additional strip of land solely for this purpose. This suggestion was welcomed by MPL and, as a result, the pilot hole for the product pipe had to be drilled with a horizontal curve turning through almost 14°. This strategy proved to be easily achievable and pilot drilling proceeded without a hitch before punching out within 1 metre of the exit point.

Following completion of the pilot drill, the hole opening operations began. These were completed in 3 stages of 26", 42" and 58" diameter. The style of hole-opener used was the low-torque Rock Reamer mounted with mill-tooth cutters (see Fig. 3). The hole-opening progressed smoothly, with the special high torque connections on the drill pipes and the capability of the drill rig itself enabling the tools to be pulled through at optimal rates.

Following the 58" hole-opening pass, a cleaning run was carried out using a 54" barrel reamer. This was essential as hole opening had confirmed the borehole reports in demonstrating that some fairly large flint nodules were present along the drill line and these could potentially cause major damage to the product pipe coating.

Fig. 3 The 58" Hole-Opener Coming Out of Hole

Pullback Operation

Following the fabrication and pressure testing of the pipe string, it was transferred onto pipe rollers so as to be able to be pulled into the drilled hole. Prior to the pullback, an overbend had to be constructed to align the product pipe with the hole. Additional, high load rollers were placed upon the overbend and cranes and side booms were used to place the pipe on the overbend and in position for pullback (see Fig. 4).

To neutralise the buoyancy of such a large pipe when it is pulled through a hole full of drilling fluid, the pipe had to be filled with water as it was pulled into the hole. A 6" diameter PE pipe had been installed into the pipeline for this

purpose and some 800 m^3 of water was pumped into the pipe as it was pulled.

Fig. 4 Overbend Construction

With the density of the drilling fluid having been controlled throughout the drilling operations, the net buoyancy of the pipeline was kept to a minimum which enabled the pipe to be pulled with an average pull load of just 50 tonnes (see Fig. 5).

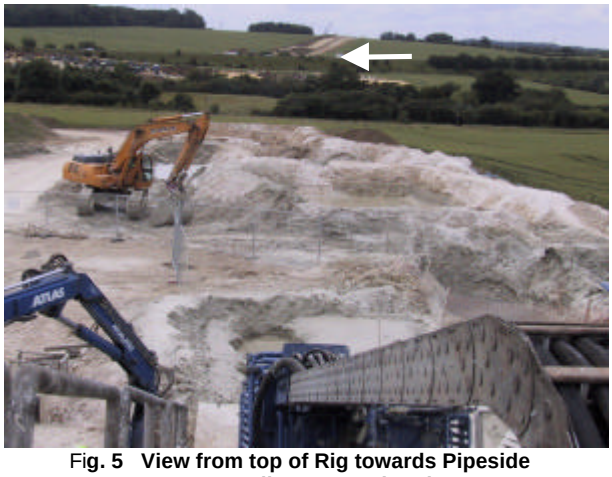

Fig. 5 View from top of Rig towards Pipeside Arrow Indicates Overbend

Geology & Drilling Fluid Management

Chalk is essentially a fine-grained limestone, and due to its soft nature, large amounts of solids tend to disperse within the drilling fluid as it is drilled. To counteract the negative effects that this has on the drilling fluid properties, such as higher densities, higher viscosities and the subsequent downhole pressures these create, a centrifuge and flocculation unit was mobilised to site following the completion of the installation of the mud return line. This centrifuge was connected to the active mud system and coagulants and flocculants were added to aid in the solids removal. This strategy greatly reduced the volume of drilling fluid that would otherwise have had to be disposed of throughout the drilling and hole-opening processes as well as minimising the risk of breakout of the drilling fluid above the drill line.

On completion of the pullback operation, the centrifuge was then used to separate the suspended chalk and clay particles from the drilling fluid thereby creating a thick, semi-solid paste that could be disposed of at local landfill sites and water that could be discharged to the local drainage system. This greatly reduced both the economic and environmental cost of disposing of the considerable volume of drilling fluid (870 m^3) displaced during the pullback of the product pipe.

Summary

Despite the fact that the size of this HDD project presented considerable challenges, the experience of both LMR Drilling and Murphy Pipelines enabled the optimum engineering solution to be developed. This solution satisfied the various authorities as to the feasibility of the crossing, minimised engineering risk and reduced the environmental impact while providing a very cost effective solution to the problem of crossing the various obstacles. The contract was completed on programme and on budget and to the satisfaction of all parties.

Once again, LMR Drilling UK Ltd have shown that with the right equipment, personnel and expertise, long, large diameter pipes can be installed under sensitive obstacles such as rivers, roads and rail tracks, to the satisfaction of all concerned.

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