100 t drill rig after pulling in the protection pipe OD 315

Three 700m long horizontal bores, running parallel with only 5m of space in between, successfully implemented beneath Norderney island biotope.

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Parallel Around the Bend

For the sake of establishing the required building grounds for future building measures, several supply lines on the island of Norderney needed to be re-located. The planned bore path crossed a biological reserve (rest area) belonging to the Nationalpark Niedersächsisches Wattenmeer (national park Lower Saxon tideland). According to the licensing requirements and orders of the regulating authority, the new installation of the various supply lines (power, water, sewerage, gas, telecommunication) crossing the biotope had to be performed completely without excavation works in the protection zone. The official interpretation also implies that the line installation bore path must not be entered under any circumstances.

Avoiding excavation works was not the prob-

Aerial photograph with bore path course (source: Horst Wirdemann, Norderney)

Backflow to the very end, no chance for blow-outs!

lem at all, since a company of consultant engineers specialised in trenchless pipe line installation had been commissioned to work out the structural engineering plan of the building project and to also take over the site management. On grounds of the pipeline route, the length of the installation section, the required line diameters and a large number of other criteria, horizontal directional drilling provided the resources needed to achieve the job. One problem really inconvenienced the crew: they had to rise to the challenge of boring, measuring and controlling the run of three 700m long 3-dimensional curves, each one lying only 5m apart from its neighbour, without setting a foot on the bore path. But a suitable solution was also found for this problem – this time by the executing company.

Building Ground Conditions

A total of ten ram core investigations was executed along the bore path in an attempt to draw information concerning the suitability of the soil as ground for the planned new building measures. The evaluation of these selective exposures, reaching only depths down to 2.5 m, resulted in mostly homogenous, fine to medium fine sandy building grounds – excellent for the application of the horizontal, directional drilling method. Because the extent and type of the building ground survey was customised to the open trench building method of the subsequent new building measures and the investigations were not all carried out along the HDD route, it transpired later on that several important building ground properties had remained in the dark.

Except for the start and target points of the bore, the groundwater level lay above the terrain in most parts.

Construction

On the planning side and in accordance with the authorities, a minimum cover of 3 m was intended for the bores. Because of the bore length exceeding 700 m, this presented too great a risk for drilling fluid break-outs on the terrain surface, therefore the drilling depths were increased to 9 m for the horizontal section. Break-outs of the clay-water suspension used for boring had to be avoided at all costs in this sensitive dune and biotope landscape, where every substance beyond sand or water means contamination.

The line route of the three bores running parallel, with a space of 5 m between them, was planned with a horizontal change of direction of approx. 30°. In this case, it meant a sideway deflection of approx. 65 m from the direct connection between start and target. In order to avoid any risk for the protection pipe previously installed at the same depth with a marginal separation distance of only 5 m, an extraordinarily exact measuring system, immune toward interference, was needed for locating the bore head. Let me remind you: it was not possible to set a foot on the bore path, therefore cables could not be installed. Even though a walk-over system would have been capable of detecting in depths of 9 m, this kind of direct position control had to be abandoned.

Strictly speaking, in this case there was no such thing as an exact location of the bore head, there was only a position calculation to rely on. This also makes the great demands on the applied measuring system plausible. The gyro compass

Initially, peat lumps in the drilling fluid discharge caused difficulties.

Pulling in the HDPE pipe bundle during the third bore.

measuring system selected by the drilling company and applied by them for the first time completely met all the demands. All three bores arrived at the target point according to plan and maintained their specified separation distance of 5 m along the complete track.

HDPE protection pipes OD 315, SDR 11, were intended for two of the bore ducts, the product and cable protection pipes (2 x HDPE 160, 1 x HDPE 110) for the third bore channel were to be pulled in directly.

From the view of drilling and measuring technique, the building measure ran smoothly and without unforeseen interruption. Each bore was expanded to 20“ and completed within 7 days. The maximum daily output of the pilot bore reached 340 m, although the drill stems were only 5 m long and a new cable connection had to be established after each drilled-out stem.

The building ground conditions – as so often the case – turned out to be quite different than expected and demanded certain modifications of the planned mode of operation. Instead of the homogenous sand near the surface, massive peat horizons and inclusions as well as enormous amounts of shell fragments were found in the depths around 5-6 m. The first mentioned proved to be very pressure sensitive and first lead to congestion of the annulus because of their lumpy consistence, later to partial loss of the drilling fluids. This became evident during the pilot bore and also while expanding with the 16” barrel reamer.

Several modifications of the drilling-technical equipment and the drilling fluid parameters were made for the second and third bore. These involved a different kind of drilling head, a change of the reaming tool design, aligning of the reaming speed and a clear improvement of the discharge properties of the drilling fluid and their continuous supervision (adaptation to the transport of peat lumps instead of fine and medium fine sand by a drilling fluid engineer on site). With the help of these measures, the problems which had cropped up during the first drilling operation were eliminated completely. In spite of the pressure-sensitive peat horizons, it was possible to sustain the backflow of the drilling fluid almost to the end of the pilot bore, drilling fluids emerging to the surface were completely avoided.

While pulling in the product and protection pipes, the traction forces did not exceed the admissible range, but they did reach the upper mark of the pre-calculated values. The supply lines were finally pulled into the protection pipes of the first two bores by means of a cable winch.

In accordance with the contract agreements, the complete jobsite was cleared to provide parking space for the gathering crowd of visitors to Norderney in the Easter holidays. This project could be the beginning of other possible projects in connection with the construction of off-shore wind energy conversion systems along the German coast. For undercrossing the coastal strips of the mainland and the island Norderney, HDD presents the installation method causing the merest interventions with the environmental equilibrium of the national park Niedersächsisches Wattenmeer. The part played by the horizontal, directional drilling method in the implementation of technical constructions is steadily growing, not only in the geothermic energy production sector, but also in the wind energy domain.

Executing drilling company: Bohlen & Doyen, Wiesmoor; planning and site management: Moll prd, Schmallenberg; local site supervision & drilling fluid service: Phrikolat Drilling Specialties GmbH. ▮