HDD Method in Russia

56" Pipeline Installation Exceeds 1000m for the First Time

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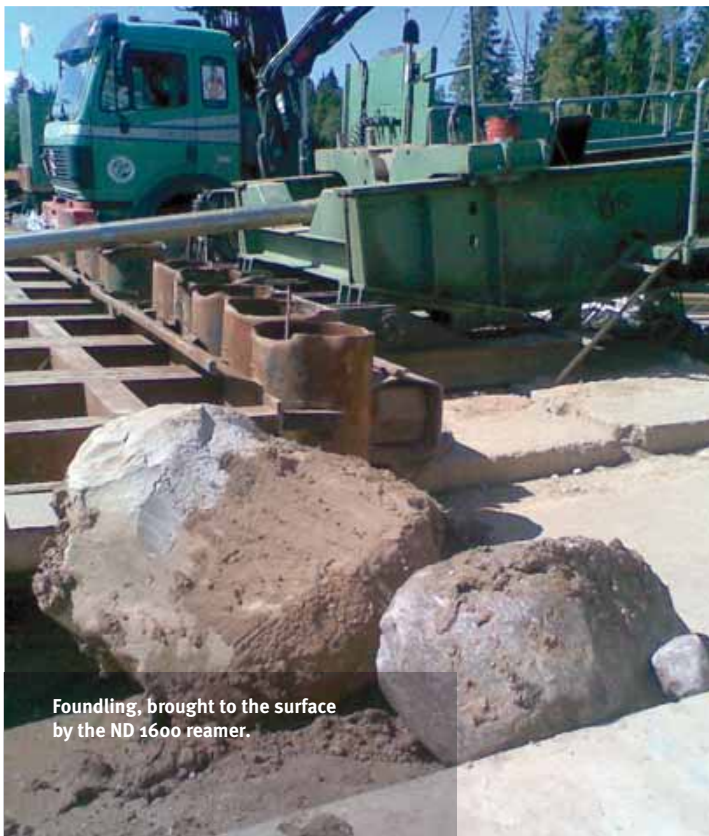
Pre-assembled "tunnel" ND 1400 on dollies.

The Russian company VIS-MOS managed to undercross the river Sheksna with a 450t Prime Drilling rig on a stretch longer than 1000m.

The plan was to also cross a length of 1043m beneath the river Sheksna with a 56" gas line within the bounds of the project „North-European Gas Pipeline", section Grjasowez – Wyborg. Although a 56" gas line has never before been installed at such diatances using the HDD method and the soil conditions were very complicated indeed, the decision was made to under-cross the river using the directional horizontal drilling technique. The river, situated approximately 400 km away from Moscow, was to be undercrossed in northern direction by the Russian company JV VIS-MOS/LLC. The contractor of the entire project is JSC „YamalGazInvest".

Foreword

Directional horizontal bores exceeding a length of 1000m are quite common these days, when even bores of 3000m in one go have been achieved already. But this is still an extraordinary challenge for pipe diameters of 56" (1420mm); pipes of this size have only ever been installed in shorter lengths with the HDD method by two or three companies worldwide. In order to pull a 56" steel pipe (1420 x 25.8mm) into a bore hole established by means of the horizontal drilling technique, you need a bore hole diameter of at least 1.80m (71"). The soil volume transported out of the bore hole amounts to approx. 2.5m³ per running metre, this makes a total of roughly 2650m³ of soil on the complete stretch of 1043m. Stored on a plane surface, you could use this soil to build a



Foundling, brought to the surface by the ND 1600 reamer.

10m high rectangular block with a surface area of 12m x 22m, weighing about 5.300 t. This excavated soil would be sufficient for covering a complete football ground with a 40cm thick layer. A truck capable of loading 10t of soil at a time would have to drive to a fro 530 times to transport this mass. Assuming 10 trips a day, his job would take 2 ½ months to complete.
Regarding the produced bore hole volume, under-crossing the Sheksna definitely belongs to the most ambitious HDD projects of all. Besides the appropriate technological approach, keeping a bore hole diameter of 1.80m open – this is a dimension belonging to the area of man-sized pipe ramming – and stabilising it untubed along a stretch of more than 1km requires a drilling fluid meeting the highest demands in reference to conveyance capacity and bore hole support. Just to illustrate this: even at a pump rate of 2000 l/min, the suspension only advances through the annulus at a speed of 80cm per minute during an expanding process of 1800mm in diameter. With such a bulk, this would mean pumping for more than 10 hours without interruption to allow the above ground inspection of a soil sample taken from the centre of the bore (500m). During all this time, in addition to the time required for the technologically necessary interruptions, the drilling fluid must be able to keep the loosened soil material in suspension. In this case, the flow velocity, other than in many small HDD projects and all vertical bores, is insignificant for the conveyance of the loosened material. Here, we have to concentrate on the viscosity in the lowest shear rate region, the actual flow limit and the gelling strength ratio during the time passing immediately after the circulation is interrupted until the instant when the operation is taken up again. In accord with the demands, this can only be achieved with top-quality Bentonites subject to constant control of all relevant parameters.

With its pulling force of 450t max. and a torque of 150 kNm, The Prime Drilling bore rig PD 450/150 AM is the horizontal drilling machine with the highest capacity in Russia.

Construction

The project took place during the summer of 2007 and went on for 5 months. For this horizontal drilling project, hovering on the brink of feasibility, the soil expertise showed extremely difficult and alternating geological conditions. Predominant were soft to hard clay soils with rubble and gravel inclusions up to 30%, boulder marl with foundlings and aquiferous sands and silty sands with rock deposits.
In an attempt to minimise the risk of damage to the pipe encasement in the process of pulling in, the gas line was completely coated with polypropylene (PP), the seams were insulated with shrink collars type „Dirax PP“.
Drilling was performed with two rigs of the Prime Drilling company. For the pilot bore and the first expansion stage to 500mm, the rig PD 100/50 was put into action, it can provide a pulling force up to 100t and 50kNm torque.
The following operation steps, expanding to 1800mm, calibration run and pipe pulling, were then performed with the bore rig PD 450/150 AM. With its pulling force of 450t max. and a torque of 150 kNm, it is the horizontal drilling machine with the highest capacity in Russia.
The drilling fluid was provided by the company Phrikolat Drilling Specialties, the product Bentonit W plus was applied. This product, traded in single bags, is a Bentonite specially designed for the horizontal bore application. It was capable of meeting the demands mentioned before without any further additives and proved it ability to cope with the very varying geological conditions.
When establishing the pilot bore, the following handicaps had to be considered:

- Interferences stemming from a parallel-running long-distance cable and affecting the locating system based on magnetic fields.
- A very long bore section beneath the river: the establishment of a magnetic field on the surface was very limited and hampered.
- The large diameter and great flexural stiffness of the pipe: very precise maintenance of the intended bore axis is crucial (radii!).

A 5" x 4 ½ IF drill rod with jetting assembly was selected for the pilot bore. In comparison with the usually applied monitoring system with 3 ½" drill rods, the increased stability of the 5" bore string allows greater pressure forces in the partially very hard soil formations.
Surveying was performed with the CHC-100 system developed in Russia; VISMOS claims that this system has a number of advantages when compared with similar foreign systems: greater precision, very short reaction times and an extremely high response sensitivity when artificially generated magnetic fields above-surface are utilised.
The difficult geological conditions were the cause for a whole row of complications and disasters. For instance, when crossing the regions of the river banks with their characteristic rubble, gravel and bed load (foundlings) inclusions, the drill tools often wore out rapidly and had to be changed frequently. In order to secure and stabilise the bore hole in the starting area, a length of approx. 250m of this area was washed over with a 13 casing string.
When the bore hole was expanded to 1600mm, the reamer brought several foundlings with diameters between 700 and 1200mm from a depth of 12m to the surface. As expected, the final reaming course, expanding the hole to

Emerging of the reamer and foundlings.

"Man-size" pipe diameter.

1800mm, lead to the greatest difficulties. Not only was the reamer severely worn by the rocks, some of the rods in front of and behind the reamer were also fractured. The strong torque (up to 120 kNm) and alternating bending stress when the reamer was wedged into the foundlings were simply too much, even for the 6 5/8" drill rods.

In order to improve the safety of the drilling operations, the 100t rig used for the pilot bore was positioned on the target side. Its job was to keep the bore string under stress while continuing the reaming work and pulling it back under control whenever it got jammed. The same method was also applied for the concluding pipe pulling process. To do so, the 5" bore string had to be connected to the ND 1400 pipe ends in a traction-tight fitting fashion and elongated in progress while pulling in. Whenever the pulling-in reamer was wedged, the crew could pull it away from the problematic zone at intervals and restart the operation.

A further technological challenge was the exit angle of 6°, which is rather steep for a size 1400 steel pipe. Because of the very large minimal bending radius of the gas line, this demanded a particularly elaborate upper-arch construction. If you mean to pull in a pipe ND 1400 through such a long hole and in complicated geological conditions, the required ballasting has to be as uplift-neutral as possible. In this case, filling up was modified in such a way as to give the pipe line buoyancy while passing through the river bank regions, allowing it to find its path above the rubble and foundlings. In the central part of the bore, it could be moved with neutral buoyancy.

Pipe pulling needed all of 12 hours, at times, a traction force of 280 t was required. This was mainly caused by the passage through the banks of the river and the foundlings in the bore hole, hampering the course. But the successful calibration run and the comforting fact that a pulling force of 450t was available at any time put the minds of the drillmaster and the responsible engineers at rest. Unnoticed by the "HDD community" and rather unspectacular, the employees of JV VISMOS/LLC ORION STROY have successfully completed a horizontal drilling project which has entered new dimensions in reference to the bore length and pipe diameter, in 5 months of building time. By the way, for VISMOS, this was already the 12th successful bore and installation of a 56" pipe.

Details are available at the e-mail address: info@phrikolat.de ∎

The reamer after demounting, filled with rocks.