Expansion bore with simultaneous pulling in of the jacking pipes made of PP-HM with tensile multi-snap-lock connection.

Pilot Pipe Jacking ND 500

Installation with jacking pipes made of PP-HM in extremely confined space

The company Karo-san from Illingen has modified the pilot pipe jacking technology to that effect that the installation of PP-HM jacking pipes up to ND 500 becomes possible in a simple and economical way even in the most confined jobsite conditions.

By Dipl.-Ing. (FH) Jörg Sommer, Schmallenberg

Pipe jacking methods, directional or non-directional, have been applied successfully in Germany for many years, meanwhile they are standard. The Berliner Wasserbetriebe alone have installed approximately 600 km of sewerage with this method since 1984. The already rather versatile technology now profits from an economical process variant. Where directional pilot pipe jacking has been carried out with jacking pipes made of vitrified clay or concrete so far, it is now possible to also install PP-HM jacking pipes up to ND 500 in the most

Layout pipe jacking project wastewater treatment plant Heinzenberg

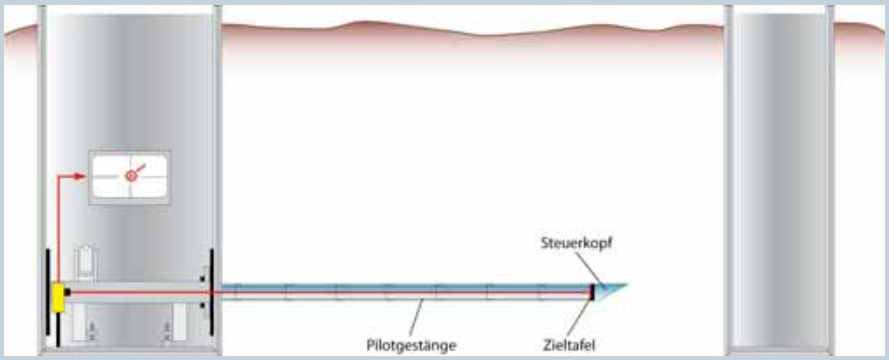
confined jobsite conditions, thanks to a technique modified by the company Karo-san from Illingen. Employing the latest technology, even an installation in densely packed soils and rock formations is imaginable.

The measure to tip the scale for the latest innovations in the matter of pipe jacking technologies was the renewal of the sewage treatment plant Heinzenberg belonging to the sewer association of Oberes Weiltal. In the course of these restoring measures, also involving the hydraulic renewal of the drainage system, a collector ND 500 was to be installed using the pipe jacking method to relieve the sewer network in the terrain of the wastewater treatment plant. Due to confined jobsite conditions, alternatives had to be found.

The marginal conditions forced the crew to use immersed shafts of maximally 2.0 m in diameter for installation. The constricted room on the jobsite made it difficult to apply heavy lifting equipment for transportation and lowering of the jacking pipes because as many as three companies of different trades were working on site at the same time during installation. A suitable solution was found with the directional "bore pipe technology", developed by Karo-san. As already mentioned before, this technique is a modification of directional pilot pipe driving, but it allows the uncomplicated installation of easy-to-handle jacking pipes made of PP-HM. Advantage: it can be used on sites with little space, lifting devices for the pipe material are not required.

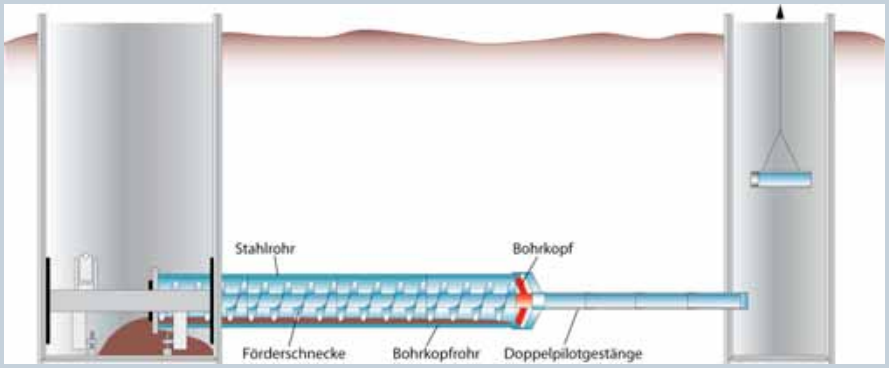
With phase 3 of the regular process variant "directional pilot pipe driving", the application of plastic pipes was strongly limited so far, because high pressing forces had to be transferred to the product pipe to overcome the coat friction and dead load when pushing out the steel pipes. Therefore, jacking pipes made of PP-HM were usually employed for smaller nominal widths alone and, depending on soil conditions, only up to 50 m driving length. Where this was concerned, the advantage was clearly on the part of flexurally rigid concrete or vitrified clay jacking pipes. "The modified technique now simply skips phase 3", describes Dipl.-Ing. Andreas Stolz of the HSE Darmstadt GmbH, who is responsible for the management of the project. Aided by the novel design of a combined bore head developed by Karo-san, the expansion bore with simultaneous pipe pulling is performed immediately after the pilot bore. And this is precisely the crux of the matter because the product pipe is not pushed

So far, directional pilot pipe driving usually took place in 3 phases



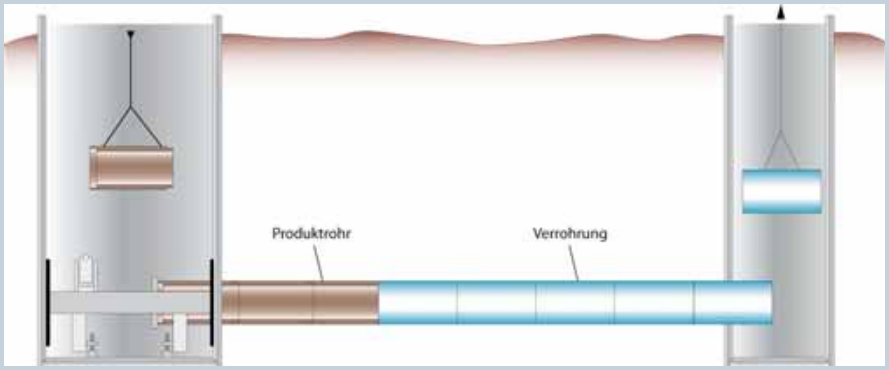
1. Phase: directional pilot bore

This is carried out with the help of pilot pipes with optical lane, steering head, and theodolite with charge-coupled device camera and monitor. The pilot pipe is pressed through the soil into the target pit while its direction and inclination are constantly being monitored. If the pipe deviates from the intended path, the inclined steering tip can countersteer and correct the direction at any time.



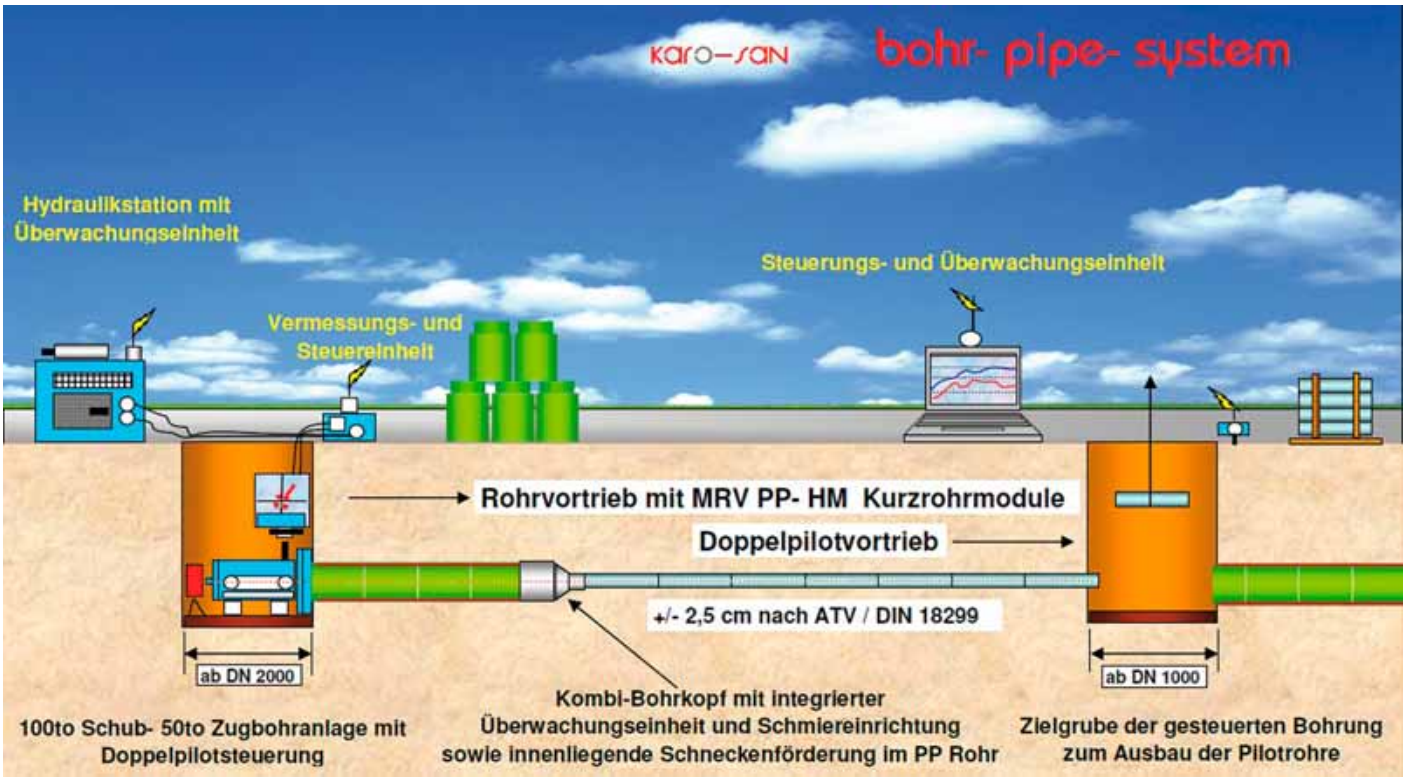
2. Phase: expanding bore with steel protection pipes

A bore head with integrated steel protection pipe (retrievable steel protection pipes) and internal conveyor spiral is linked to the already driven pilot pipe. During the successive drive of the steel pipes, the conveyor spiral discharges the soil into the jacking shaft.



3. Phase: subsequent pushing of the product pipes

Final working step is the subsequent pushing of the product pipes, the steel protection pipes are pushed out simultaneously.



Process schema drill-pipe-system (2-stage method) [1]

forward in this instant; thanks to it tight multi-snap-lock connection (MRV), it is pulled in. That is to say, the bore head is tightly connected to the product pipes which are going to be pulled in. The actual driving force is transferred to the bore head with the help of the retrievable steel pipes. These are fastened with spacers inside the product pipes which are to be pulled in. The combined bore head drills with the required overcut and breaks up the bore spoil which is then transported to the jacking shaft via conveyor spiral. Therefore we can say that the novel drilling technique works in two phases:

1. Phase: directional pilot bore

This is carried out with the help of pilot pipes with optical lane, steering head and theodolite with charge-coupled device camera and monitor. The pilot pipe is pressed through the soil into the target pit while its direction and inclination are monitored continuously. If it deviates from the intended path, the inclined steering tip can countersteer and correct the direction at any time.

2. Phase: expanding bore with product pipes and conveyor pipeworks within

3. A bore head with integrated tensile PP-HM jacking pipe (Schöngen concept HL with MRV connection) and internal steel pipe with con-

Arrival of the pilot bore in the target manhole.

Arrival of the combined bore head in the target pit.

View of the installed product pipe made of PP-HM, system Schöngen

veyor spiral is connected to the subsequently driven pilot pipe. The product pipe is pulled in simultaneously in the jacking process.

Karo-san apply a drill rig of the brand Bohrtec BM 400 with a pushing force of 1000 KN and a pulling force of 500 KN for the directional pipe driving job. This compact rig is predestined for the drilling operations of two or three stage processes. The application area of the new variant is in the range of the nominal widths between ND 200 and ND 500 mm. With a torque of 12000 Nm, the rig erected in the jacking shaft can also be employed for core bores in concrete or in the jacking shaft itself.

The basic preconditions (at present) for the application of such a steered pilot bore technique are displaceable soils with stroke rates ‹ 50 [2] for dynamic probing with light driving rod and a maximum single stone grain size of 80 mm. According to DIN EN 18319, this includes displaceable granular soils grade LNE 1-3, LNW 1-3, LBM 1-3 and LBO 1-3. Depending on the marginal conditions, maximum installation lengths up to 100 m are possible [1], whereupon the friction forces affecting the pipe string can be minimised by the addition of a Bentonite suspension. A safe pilot bore is guaranteed with the double pilot pipe system designed by Bohrtec. The external pilot pipe takes care of jacking while the pipe positioned inside is used to turn the bore tip with internal target board. The advantage is the clearly reduced coat friction affecting the rotating stems. This enables transferring the torque to the bore tip completely, even over longer distances.

A variant of the technique described above is the so-called vertical pipe boring system to integrate laterals in already existing sewer systems › ND 800 without the need for trenches. This method is intended for the use in inner-city areas, the applied jacking pipes are also made of PP-HM.

For several years now, pilot pipe jacking is also possible in densely packed soils or even rock formations (‹ 10MPa strength), for example with the application of the front steering technique, steered steel pipe pilot boring combined with the hole opener technique [3] by Bohrtec, on the market since 2010. There are many possibilities for the economical application of jacking pipes made of PP-HM when used with the bore pipe system.

The measure at the wastewater treatment plant Heinzenberg was carried out in consistently displaceable soils. A total of four sections, starting from three jacking shafts with diameters of only 2.0 m, was successfully installed within two weeks. The longest reaches were app. 41 m and 26.30 m long with inclines of 3.67 ‰ and 4.18 ‰. The target manholes also served as jacking pits for the connection bore with a spillway basin and a spiral pumping station. The fact that a target manhole with only 1.0 m in diameter is sufficient for the applied process method is particularly noteworthy. That is the reason why this method is also interesting for an application in inner-city areas.

When faced with the choice of the most suitable pipe material, we opted for a jacking pipe of the trademark Schöngen Concept HL with tensile multi-snap-lock connection (MRV). These pipes are produced according to the general demands made on pipes for sewers and sewer lines by DIN EN 476 and the material demands of DIN EN 1852-1 and DIN EN 681-1. They are available in the range between OD 110 and OD 630 mm and in lengths of 0.5 to 6.0 m. The system stands out due to its low weight, high impact strength, great stiffness properties and skin hardness, enormous pulling and pressure resistance as well as its chemical stability. The pipes used fort his measure have a permissible propelling force of 945 KN and a permissible tensile strength of 469 KN (OD 560 x 30.0 mm) when connected [4]. Reason enough for applying this material within the domains of TIP, pipe lining and pipe bursting methods for many years. The required general approval of the building authorities (DIBt) for trenchless pipe driving is also available.

The sewer association Oberes Weiltal and the specialised engineers of the HSE AG entrusted with the project were highly satisfied with the new procedural method. With the help of the bore pipe system, the demands on the project were fulfilled at all points while a friction-free building course was guaranteed in spite of the different trades working on site at the same time and, consequentially, the limited operating space.

[1] Information of the company Karo-san GmbH, Illingen
[2] Information of the company Bohrtec GmbH, Aachen
[3] Dr. Ing. Hans-Peter Uffamen: 25 years of development and design for the steered spiral / pilot bore technique (bi Umwelt Bau 6/11)
[4] Information of the company Karl Schöngen KG, plastic tubing systems, Salzgitter